

EFFECT OF INTERCROPPING ON TUBER YIELD OF PRO VITAMIN A CASSAVA, *Manihot esculenta* Cranz AND POD YIELD OF VEGETABLE COWPEA, *Vigna unguiculata* ssp. *Sesquipedalis* IN TARABA STATE, NORTH-EAST NIGERIA

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ABSTRACT

The importance of Vegetable Cowpea ssp. *Sesquipedalis* and Pro Vitamin A Cassava in sustainable food production is more than significant. As they supply cheaper protein and vitamins which improve the health status of consumers. One Pro Vitamin A cassava cultivar, NR 07/0220, one long-podded and trailing vegetable cowpea accession TVu 14868 and one grain cowpea were intercropped in a Randomized Complete Block Design with three Replicates at Jalingo and Bali of Taraba State in North-East, Nigeria, with a view to evaluate the effect of intercropping on the tuber yield of Pro Vitamin A cassava and pod yield of vegetable cowpea ssp. *Sesquipedalis*. Data collected were analysed using analysis of variance. The results showed that sole vegetable cowpea produced longer pods, higher fresh weight, more number of seeds and higher seed weight in both locations than the Cassava-vegetable cowpea intercrop, with the intercropped vegetable cowpea coming second in importance. This indicates that vegetable cowpea performs better as a sole crop than when intercropped with vitamin A cassava. Similarly, sole grain cowpea performed better in both locations than the grain cowpea intercropped with vitamin A cassava in pod length, number of seeds per pod and 100 seed weight. The results also showed that sole vitamin A cassava performed better than vitamin A cassava intercropped with vegetable cowpea and grain cowpea in leaf area index, number of leaves, number of tubers, plant height and fresh tuber weight. The genotype by location interaction was significant for all the traits with the exception of number of days to first flower, days to first pod, fresh pod weight and 100 seed weight. Vitamin A cassava also interacted significantly with the locations for number of leaves, number of tubers, plant height and fresh tuber weight. As a result of their nutritional importance in food security, Vegetable Cowpea ssp. *Sesquipedalis* and Pro Vitamin A Cassava are, hereby, recommended (as sole crops) to be incorporated into the food security and poverty alleviation strategies of the Boko Haram ravaged North-East of Nigeria and other developing countries of the world.

Key Words: Vegetable Cowpea, Vitamin A Cassava, Nutrition, Food Security, Sustainable Development

INTRODUCTION

The 12th goal of the United Nations Vision 2030 agenda for sustainable development centers on Sustainable Food Consumption and Production Patterns (United Nations, 2015). This becomes necessary as up to 795 million of the 7.3 billion people in the world were suffering from chronic undernourishment in 2014-2016. Further, while almost all the 12.9% of the hungry people live in developing countries, there are up to 11 million people who are undernourished in the developed countries (FAO, 2014).

Taraba state borders Adamawa state which, along with Borno and Yobe states are the worst affected by the Boko Haram insurgency. It is now common knowledge that the Boko Haram conflict and the resulting mass displacements has led to the increased acute malnutrition and mortality.

Surveys conducted in the north-east has documented a Global acute malnutrition (GAM) ranging from 13.0% to 27.3% (UNICEF, 2016).

The National Bureau of Statistics has reported that 67.1% of Nigeria's population lives below the poverty line. Data collected from NGOs and UNICEF-supported teams in Yobe and Borno states, including Internally Displaced Persons (IDPs) have shown the proportion of children with GAM to be over 80%. The Nigeria Federal Government has already declared a **Nutrition Emergency** in the north-east in June 2016 and a Nigeria Nutrition in Emergency Working Group (NiEWG) is part of the response strategies of the Federal Government and UNICEF (UNICEF, 2016).

However, as the United Nations is developing and implementing strategies for responses to address the humanitarian situation in the north-east, a key sustainable factor, in

addition to aid, is the food production system considering the fact that over 70% of the people of the region depend on agriculture for their employment.

The major elements of hunger and undernourishment are Protein-Energy Malnutrition (PEM), denoting inadequate calories and protein, and, Micronutrient deficiency – deficiency in micronutrients especially Vitamin A, iron, iodine, etc. Those elements form the crux of what is referred to as Food Security. Thus, the sustainability in the consumption and production pattern of the United Nations agenda implies that the system should lead to food security to our citizens, that is, providing acceptable and nutritionally adequate food at all times for all people (IDRC/UN-HABITAT, 2003). This calls for a more efficient production system utilising a variety of nutritionally adequate crop plants that are either inherently rich or are bio-fortified for the purpose of providing required nutrients.

Vegetable cowpea sub species (ssp.) *Sesquipedalis* is a cowpea variety that has very long, succulent and fleshy pods. The pods can be eaten either raw (green vegetable) otherwise cooked, or are allowed to dry on the plant and harvested for dry grains from which many snacks and main meal dishes are produced. The young leaves are also edible. All the plant parts that are used for food are nutritious, providing protein, vitamins and minerals that are the key elements to sustainable food consumption. The grain contains about 23-25% protein, 8-9% vitamins A, B₁ and C; 1.3% fibre and 50-67% carbohydrate (Quin, 1997). The pods also mature early making it easy to utilize shortly after planting. The crop is also easily produced in household gardens, and it matures in just about 40 days.

Cassava, *Manihot esculenta* Cranz. is the fourth most important food calorie crop in the tropics and it is still grown mainly as a subsistence crop by small scale farmers. It is growing in importance as a food security crop in Africa as a result of its ability to grow in low-quality soil, its resistance to drought and diseases, as well as providing households with an alternative when the harvest of other crops fails (Aerni, 2006). Cassava's harvestable portion, the tubers, can be stored underground until needed (Nweke, 2003), thus giving it additional importance in food security especially at this time in the north-east region of Nigeria. Although the crop is a poor source

of nutrients required for food security, bio-fortified Pro Vitamin A cassava cultivars have been developed for cultivation and consumption in order to decrease vitamin A (a key micronutrient) deficiency among individuals. Vitamin A is an essential micronutrient for maintaining eye sight, immune function, and growth and development. Vitamin A Deficiency is caused by low dietary intake of vitamin A in combination with mal-absorption and high excretion of vitamin A due to common illnesses (Sommer, *et al.*, 2002).

The importance of vegetable cowpea and cassava in sustainable food production and consumption systems especially as it affects food security is very significant. This is more so when viewed in terms of sustainable increase in net harvests within a short time to provide needed food while reducing resource use. This will give very significant results when applied especially in the north-east region where response activities are going on. Cowpea is drought tolerant and better adapted to acidic soils similar to cassava. Thus, the two crops would seem to be compatible growing in the same environment.

A sole crop cassava does not efficiently use the available light, water and nutrients during its early growth stages due to its slow initial development. Thus a short duration second crop may be inter planted to make more efficient use of these growth factors. However, Mutsaers, *et al.* (1993) reported that the biological advantage of intercropping cassava with legumes decreases with the legume's growth duration. Olasantan (1988) reported a reduction in maize and cowpea yields when intercropped with cassava. Low growing soybean is also reported to dominate intercropped cassava by Tsay, *et al.* (1988). A decrease in cassava root yield when inter planted with legumes has also been reported by Polthanee, *et al.* (2007). Okoli (1996) has reported a significant reduction in dry matter yield and number of cassava roots in cassava intercropped with cowpea. Intercropping cassava with cowpea also reduced cassava yield by 14 to 24% (Mason, *et al.*, 1986a) and by 19 to 38% (Mason *et al.*, 1986c). However, because of the enormous pressure on land and other resources, there is urgent need for a sustainable increase in the net harvests of nutrients-rich foods within a short time to provide needed food while reducing resource

use. Vegetable cowpea is rich in nutrients and it is early maturing while vitamin A cassava is necessary in maintaining eye sight, immune function and growth and development. Moreover, a sole crop cassava does not efficiently use the available light, water and soil nutrients during its early growth stages due to its slow initial development. Thus intercropping with an early maturing vegetable cowpea would ensure a more efficient use of these resources.

Although previous reports as cited above appear to indicate a decrease in cassava root yield when intercropped with legumes, cassava-legume intercropping system would increase the land use efficiency and economic return over sole cassava (Mason, *et al.*, 1986; Okoli, 1996). In addition, most of the studies were on cassava intercropped with grain cowpea. There was little or no report on Vitamin A cassava intercropped with long-podded, trailing vegetable cowpea ssp. *Sesquipedalis*. The importance of these two crops as food security crops and in sustainable production system and land use efficiency makes the study of their interaction in intercropping systems imperative. Therefore, the objective of this work is to evaluate the effect of intercropping on tuber yield of Pro Vitamin A cassava and pod yield of vegetable cowpea ssp. *Sesquipedalis* in Jalingo and Bali agro-ecologies of Taraba state, North-East Nigeria.

MATERIALS AND METHODS

Planting material and growing conditions

The materials used in the study include one (1) Pro vitamin A (Bio fortified) cassava cultivar, NR 07/0220 with a Vitamin A content of 12 $\mu\text{g/g}$, one (1) long-podded and trailing vegetable cowpea accession, TVu 14868 and one (1) grain cowpea. The germplasm of both materials were originally collected from the International Institute of Tropical Agriculture, IITA Ibadan. The materials were planted out at the Teaching and Research Farm of Taraba state University, Jalingo and the School Farm of the Federal Polytechnic Bali.

Jalingo, in Latitude 8° 45' to 9° 01' N and Longitude 11° 09' to 11° 30' E, with an annual rainfall of 1016-1270 mm lies in the Northern Guinea Savanna zone and has an average

elevation of 351 m above sea level and an average temperature of 37.5°C. The soil type is an alluvial complex and the top soil is sandy loam. Bali lies between latitude 7° 46' and 7° 54' N and longitude 10° 30' to 11° 00' E and it is in Southern Guinea Savanna Zone. It has between 1350-1500mm rainfall annually.

In both locations, the land was cleared, ploughed, harrowed and ridged. Pre-emergent herbicide was applied immediately after harrowing and ridging to control weeds. However, manual weeding using hoe was employed subsequently.

Vitamin A cassava cuttings of 25cm length were planted on the crest of the ridges at a 1m x 1m spacing in a randomized complete block design with three replicates. Each replicate consisted of sole cassava, sole vegetable cowpea, sole bunch cowpea, cassava x vegetable cowpea and cassava x bunch cowpea, making 15 plots, and 140m² area in each location. In the intercrop with cassava, cowpea seeds were sown at an intra-row spacing 35cm. Staking for the vegetable cowpea was done at two weeks after sowing to enable the plants to climb and produce long drooping pods. A vegetable cowpea x bunch cowpea interaction was not investigated in this work as the main objective was cassava x vegetable cowpea interaction.

Data Collection

The cassava descriptor list developed by Fukuda *et al.*, (2010) was used as a guide for the vitamin A cassava cultivar. Leaf area index were collected at six months after planting. Number of tubers per plant, tuber length, fresh tuber yield (fresh weight of tubers), plant height and number of branches were collected at harvest. Germination percentage, leaf area index, number of days to first flower, number of days to first pod, pod length, fresh pod weight, number of seeds per pod and 100 seed weight were recorded for vegetable cowpea.

Statistical Analysis

The data was subjected to analysis of variance for each trait as described by Singh and Chaudhary (1985). Means were compared using the Duncan's Multiple Range Test as described by Duncan (1955).

RESULTS AND DISCUSSION

The leaf area index (LAI) for cowpea was significantly different for the two locations

in both the 3 weeks and 6 weeks after sowing (WAS) (Table 1). Sole vegetable cowpea in Bali had a higher LAI (20.79cm²) at 3 WAS, followed by sole bunch cowpea (17.42cm²). However, at 6 WAS, sole bunch cowpea in Bali location recorded the highest LAI (52.64cm²), followed by sole vegetable cowpea (43.6cm²) in the same location. The mean LAI at 6 WAS was generally higher in Bali (39.99cm²) than in Jalingo (31.39cm²).

There was a highly significant difference ($p < 0.05$) among the treatments on number of leaves per plant all through the sampled plots and in both locations (Table 1). In Jalingo, sole grain cowpea recorded the highest leaves per plant (12.6) at 3 WAS. This was followed by the intercropped grain cowpea (10.4) and sole vegetable cowpea (8.2). At 6 WAS, sole grain cowpea recorded the highest number of leaves (24.53) followed by sole vegetable cowpea (20.40) and intercropped grain cowpea (20.33). At Bali, the highest number of leaves at 3 WAS (12.47) was recorded by sole grain cowpea. This was followed by intercropped grain cowpea (10.47) and sole vegetable cowpea (8.40). At 6 WAS, sole grain cowpea produced more number of leaves per plant (25.40) while the lowest leaves at 6WAS was recorded by the intercropped vegetable cowpea (20.33).

There was no significant difference ($p > 0.05$) amongst the treatments and between locations in number of days to first flower and number of days to first pod (Table 2). This finding agrees with the report of Aliyu and Wachap (2014) who also reported no significant differences in number of days to first flower in the Northern and Southern Guinea Savannah zones of Adamawa state. However, intercropped grain cowpea (in Jalingo) was the earliest to flower at 38.67 days in all treatments and in both locations.

Jalingo). The results also showed that the materials generally flower earlier in Jalingo. However, Aliyu and Wachap (2014) reported the earliest flowering time of sole vegetable cowpea at 34 days while Usman (2017) reported 36 days for the same accession TVu 14868 in the Northern and Southern Guinea Savannah zones of Taraba state. For days to first pod, the intercropped grain cowpea was the earliest at 39.67 days (at Bali), followed by sole grain cowpea at 40.8 days at Jalingo. However, the materials generally produce pods earlier in Jalingo, a fact that was also reported by Usman (2017).

From the results, it can be observed that the LAI and number of leaves per plant for both the 3 WAS and 6 WAS in both locations were higher for sole vegetable cowpea than the intercropped vegetable cowpea with vitamin A cassava. This may imply that intercropping vegetable cowpea with vitamin A cassava negatively affects the growth and development of vegetable cowpea. Similarly, for the same characters in both locations, sole grain cowpea performed better than the grain cowpea intercropped with vitamin A cassava, implying that intercropping with vitamin A cassava did not favour the grain cowpea. In addition, the LAI and number of leaves per plant for both the 3 WAS and 6 WAS were significantly higher at Bali than at Jalingo. This implies that at Bali, the materials were more vigorous growing, a feature that is attributed to the higher rainfall characteristic of the Southern Guinea Savannah zone.

The last to flower in both locations were intercropped vegetable cowpea (42.47 days, at Bali) and sole vegetable cowpea (41.07 days in

Table 1: Mean Performance of sole and intercropped Cowpea on germination percentage, leaf length and leaf width at Jalingo and Bali locations

Treatments	Germination percentage (%)		LAI at 3WAP (cm ²)		LAI at 6WAP (cm ²)		NLPP at 3WAP		NLPP at 6WAP	
	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali
Bunch Cowpea x Vit A Cassava	71.88	72.92	9.38	12.58	21.11	34.46	10.40	10.47	20.33	21.53
Veg Cowpea x Vit A Cassava	78.13	71.36	9.10	15.30	22.94	29.26	7.87	8.27	19.60	20.33
Sole Bunch Cowpea	78.65	69.27	11.51	17.42	42.94	52.64	12.60	12.47	24.53	25.40
Sole Vegetable Cowpea	75.00	72.40	12.79	20.79	39.06	43.60	8.20	8.40	20.40	21.33
Mean	75.91	71.49	10.95	16.52	31.39	39.99	9.77	9.90	21.22	22.15
LSD	5.18 ^{NS}	6.88 ^{NS}	1.93 [*]	0.84 ^{**}	2.60 ^{**}	2.88 ^{**}	0.31 ^{**}	0.23 ^{**}	0.22 ^{**}	0.23 ^{**}

** = significant at 0.01 level; *=significant at 0.05 level NS = Not significant; LAI at 3 and 6 WAS = Leaf Area Index at 3 weeks and 6 weeks after sowing; Veg cowpea = Vegetable cowpea, Vit A Cassava = Vitamin A Cassava

Table 2. Mean performance of sole and intercropped cowpea on number of days to first flower and pod at Jalingo and Bali

Treatments	Number of days to first flower		Number of days to first pod	
	Jalingo	Bali	Jalingo	Bali
Bunch Cowpea x Vit A Cassava	38.67	40.87	39.67	41.87
Veg Cowpea x Vit A Cassava	41.40	42.47	42.40	43.47
Sole Bunch Cowpea	39.80	39.67	40.80	40.67
Sole Vegetable Cowpea	41.07	40.27	42.07	41.27
Mean	40.23	40.82	41.23	41.82
LSD	4.26 ^{NS}	3.14 ^{NS}	4.26 ^{NS}	3.14 ^{NS}

NS = Not significant; Veg cowpea = Vegetable cowpea, Vit A Cassava = Vitamin A Cassava

Sole vegetable cowpea produced significantly the longest pods in both locations (70.6cm) followed by the intercropped vegetable cowpea (Table 3). This result varies slightly from the 58.72cm and 65.57cm long pods for TVu 14868 and TVu 14869, respectively as sole crop pods reported by Usman (2017). The result is, however, closer to the 69.76cm pods produced by Aliyu and Wachap (2014) but far exceeded the average pod length of 37.23cm reported by Hazra, *et. al.* (1993) from India, 16.2cm pods reported by Uguru (1996) in South East Nigeria and 35.02cm by IITA characterization in Ibadan, South West Nigeria. In this study, the long pods recorded agrees with those of Aliyu and Wachap (2014) and Usman (2017) which are also closer to those of Hazra, *et. al.* (1993) because the vegetable cowpea utilized is from the long podded Subspecies *Sesquipedalis*. The results further showed that Jalingo produced slightly longer pods of vegetable cowpea than Bali, while the shortest pods were recorded from sole grain cowpea (13.6 cm) as well as the intercropped grain cowpea (13.33cm) respectively. This is because the grain cowpea is generally characterized by short pods (Tindall, 1986; Steele and Mehra, 1980; Smartt, 1990).as can also be seen in the data reported by Uguru (1996).

There was no significant difference ($p>0.05$) amongst the treatments and between locations in fresh pod weight (Table 3). However, sole vegetable cowpea in Jalingo recorded the highest fresh weight (0.16 kg) followed by the intercropped vegetable cowpea (0.14 kg) while the intercropped grain cowpea and sole grain cowpea recorded the same but lower fresh weight (0.07 kg), confirming that this was a grain cowpea with short pods while the vegetable cowpea is characterized by very long pods with the associated higher fresh weight (Smartt, 1990; Steele and Mehra, 1980). Similarly, in Bali, sole vegetable cowpea and

the intercropped vegetable cowpea recorded the highest fresh weight of 0.15 kg and 0.14 kg, respectively.

A highly significant difference ($p<0.01$) on number of seeds per pod was also observed in both locations (Table 3). Sole vegetable cowpea, in Jalingo, had the highest number of seeds per pod (17.6 seeds), followed by intercropped vegetable cowpea (16.53 seeds). These figures are higher than those reported by Usman (2017) who also studied the performance of sole vegetable cowpea accessions in the northern and southern Guinea savannah zones of Taraba State, implying that sole vegetable cowpea performs better than the intercropped vegetable cowpea with cassava. The least number of seeds per pod were obtained from sole grain cowpea (11.93 seeds) and the intercropped grain cowpea (11.33 seeds) respectively. A similar result was observed in Bali where sole vegetable cowpea recorded the highest number of seeds per pod (16.47 seeds), followed by intercropped vegetable cowpea (14.53 seeds) and sole grain cowpea (12.67). Significant differences were also observed on 100 seed weight with the sole grain cowpea recording the highest weight (0.14 kg) in both locations. This was followed by sole vegetable cowpea in Jalingo (0.12 kg) with the intercropped vegetable cowpea recording the least in both locations (0.10 kg, in Jalingo and 0.07 kg in Bali). This was because the grain cowpea is characterised by large seeds while the vegetable cowpea has small seeds. The results also agree with Smartt (1990), Steele and Mehra (1980) and Usman (2017) who also reported a 100 seed weight of 0.141kg for the vegetable cowpea accession TVu 14872.

From the results, it can be observed that the sole vegetable cowpea produced longer pods, higher fresh weight, higher number of seeds and higher seed weight in both locations than the intercropped vegetable cowpea, with

the intercropped vegetable cowpea coming second in importance while the grain cowpea was the least in those attributes. This indicates that vegetable cowpea performs better as a sole crop than when intercropped with vitamin A cassava. The results similarly showed that sole grain cowpea performed better in both locations

than the grain cowpea intercropped with vitamin A cassava in pod length, number of seeds per pod and 100 seed weight, while having the same performance for fresh weight. Furthermore, Jalingo recorded longer pods, higher fresh weight, more seeds per pod and 100 seed weight than the Bali location.

Table 3: Mean Performance of Sole and Intercrop Cowpea on pod length, fresh pod weight, number of seeds per pod and 100 seeds weight at Jalingo and Bali analysis

Treatments	Pod length (cm)		FPW (kg)		Number of seeds per pod		100 SW (kg)	
	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali
Bunch Cowpea x Vit A Cassava	13.33	14.13	0.07	0.08	11.33	11.40	0.11	0.10
Veg Cowpea x Vit A Cassava	70.20	70.13	0.14	0.14	16.53	14.53	0.10	0.07
Sole Bunch Cowpea	13.60	17.73	0.07	0.08	11.93	12.67	0.14	0.12
Sole Vegetable Cowpea	70.67	70.40	0.16	0.15	17.60	16.47	0.12	0.10
Mean	41.95	42.35	0.11	0.11	14.35	13.77	0.12	0.10
LSD	0.19**	0.20**	0.08 ^{NS}	0.06 ^{NS}	0.66**	0.30**	0.03*	0.04*

** = significant at 0.01 probability level; * = significant at 0.05 level; NS = Not significant; Veg cowpea = Vegetable cowpea, Vit A Cassava = Vitamin A Cassava; FPW= Fresh pod weight (kg); 100SW = 100 seeds weight (kg)

Significant differences also exist in Leaf Area Index (LAI) in the two locations for the intercropped vitamin A cassava (Table 4). Sole vitamin A cassava in Bali produced the highest leaf area index (44.79 cm^2). This was followed by vitamin A cassava intercropped with vegetable cowpea (37.11 cm^2) and with grain cowpea (36.49 cm^2). A highly significant difference ($p < 0.01$) was also observed on number of leaves per plant in both locations with the intercropped vitamin A cassava with vegetable cowpea in Jalingo recording the highest number of leaves (2.67), followed by sole vitamin A cassava (2.17). The lowest number of leaves per plant was recorded by intercropped vitamin A cassava with grain cowpea (1.58). In Bali, sole vitamin A cassava has the highest number of leaves per plant (8.5) followed by vitamin A cassava intercropped with vegetable cowpea (7.42), and with grain cowpea (5.50).

Vitamin A cassava intercropped with vegetable cowpea in Jalingo recorded the tallest plants (0.67 m), followed by its intercrop with grain cowpea (0.63 m) and sole vitamin A cassava (0.63 m) respectively, while in Bali, the sole vitamin A cassava recorded the tallest plants (1.32 m), followed by its intercrop with vegetable cowpea (0.95 m) while its intercrop with grain cowpea recorded the shortest plants (Table 4).

From these results, it is obvious that the LAI for both locations, number of leaves per plant and plant height in Bali were higher for the sole vitamin A cassava than its intercrop with either of the cowpeas, suggesting that vitamin A cassava performed better as a sole crop. Similarly, LAI, number of leaves and plant height for vitamin A cassava intercropped with vegetable cowpea for both locations

recorded higher figures than those for the intercrop with grain cowpea. The results also showed that Bali recorded significantly higher figures than the Jalingo location, implying that the materials grew more vigorously in Bali than Jalingo because of the higher rainfall in Bali.

Although there was no significant difference ($p > 0.05$) in number of tubers per plant in Jalingo, significant differences exist for the trait in Bali and for fresh tuber weight in both locations (Table 5). In Bali, sole vitamin A cassava recorded the highest number of tubers (5.17), followed by vitamin A cassava intercropped with vegetable cowpea (4.33) and with grain cowpea (4.25). In Jalingo, vitamin A cassava intercropped with vegetable cowpea recorded the highest fresh tuber weight (0.76 kg), followed by the sole vitamin A cassava (0.48 kg) and its intercrop with grain cowpea (0.54 kg). However, in Bali, sole vitamin A cassava recorded the highest fresh tuber weight (1.40 kg), followed by its intercrop with vegetable cowpea (1.07 kg) and with grain cowpea (0.96 kg). The results indicate that although sole vitamin A cassava recorded fewer tubers per plant in Jalingo (3.17) than its intercrop with both vegetable cowpea (4.25) and grain cowpea (4.08 tubers), the Bali location recorded higher number of tubers for sole vitamin A cassava (5.17) than its intercrop with vegetable cowpea (4.33) and with grain cowpea (4.25). Fresh tuber weight was also lower for sole vitamin A cassava in Jalingo (0.48 kg) than for its intercrop with vegetable cowpea (0.76 kg) and with grain cowpea (0.54 kg). But in Bali, sole vitamin A cassava recorded higher fresh weight (1.40 kg) than vitamin A cassava intercropped with vegetable cowpea (1.07 kg) and with grain cowpea (0.96 kg).

Table 4. Mean performance of sole and intercropped Vitamin A Cassava on leaf area, number of leaves per plant and plant height at Jalingo and Bali locations

Treatments	Leaf Area at 6 MAP (cm ²)		NLPP		Plant height (cm)	
	Jalingo	Bali	Jalingo	Bali	Jalingo	Bali
Bunch Cowpea x Vit A Cassava	25.66	36.49	1.58	5.50	0.63	0.90
Veg Cowpea x Vit A Cassava	26.75	37.11	2.67	7.42	0.67	0.95
Sole Cassava	38.33	44.79	2.17	8.50	0.63	1.32
Mean	30.24	39.46	2.14	7.14	0.64	1.05
LSD	0.744**	3.395*	0.189**	0.499**	0.024 ^{NS}	0.007**

** = Significant at 0.01 level; * = Significant at 0.05 level; NS = Not significant; NLPP = number of leaves per plant; Veg cowpea = Vegetable cowpea, Vit A Cassava = Vitamin A Cassava

Table 5: Mean Performance sole and intercropped vitamin A cassava on numbers of tuber per plant, and fresh tuber weight at Jalingo and Bali locations

Treatments	Numbers of tuber per plant		Fresh tuber weight (kg)	
	Jalingo	Bali	Jalingo	Bali
Bunch Cowpea x Vit A Cassava	4.08	4.25	0.54	0.96
Veg Cowpea x Vit A Cassava	4.25	4.33	0.76	1.07
Sole Cassava	3.17	5.17	0.48	1.40
Mean	3.83	4.58	0.59	1.14
LSD	2.118 ^{NS}	0.73 [*]	0.14 [*]	0.29 [*]

** = significant at 0.01 level, * = significant at 0.05 level, NS = Not significant, Veg cowpea = Vegetable cowpea, Vit A Cassava = Vitamin A Cassava

The genotype by location interaction was significant for all the traits with the exception of number of days to first flower, number of days to first pod, fresh pod weight and 100 seed weight (Table 6). This agrees with the findings of Aliyu and Wachap (2014) who reported significant interactions with both the location and year of production. Other workers such as Usman (2017) also reported significant interaction with the location of production for days to first pod, pod length, and grain yield. This implies that location significantly affects the performance of the materials. The genotypes in Bali recorded higher leaf area index, number of leaves per plant, number of seeds per pod and pod length, suggesting higher pod and seed yield in Bali than in Jalingo. Sole vegetable cowpea exhibited longer pods, number of seeds per pod and fresh pod weight than the vegetable cowpea intercropped with cassava. Sole grain cowpea also performed higher than the grain cowpea intercropped with vitamin A cassava in leaf area index at 3 and 6 WAS, number of leaves per plant at 3 and 6 WAS, number of seeds per pod, plant height and 100 seed weight, suggesting that both the sole vegetable cowpea and sole grain cowpea performed better in pod and seed yield than the intercrop with vitamin A cassava. However, the performance of vegetable cowpea intercropped with vitamin A cassava was lowest for leaf area

index at 6 WAS and number of leaves per plant at 3 and 6 WAS.

The materials also interacted significantly with the locations in number of leaves per plant, number of tubers, plant height and fresh tuber weight (Table 7). The genotypes in Bali also exhibited higher leaf area index, number of leaves, number of tubers, plant height and fresh tuber weight than those in Jalingo implying that the genotypes had more vigorous growth in Bali. Sole vitamin A cassava performed better than vitamin A cassava intercropped with vegetable cowpea and grain cowpea in leaf area index, number of leaves, number of tubers, plant height and fresh tuber weight. This implies that vitamin A cassava intercropped with vegetable cowpea and grain cowpea performed lower than the sole vitamin A cassava. This finding is similar to the finding of Okoli (1996) who reported a significant reduction in dry matter yield and number of cassava roots intercropped with cowpea. Intercropping cassava with cowpea has also been reported to reduce cassava yield by 14 to 24% (Mason *et al.*, 1986a) and by 19 to 38% (Mason *et al.*, 1986c). A decrease in cassava root yield when intercropped with legumes has also been reported by Polthanee, *et al.* (2007), Tsay, *et al.*, (1988), Olsantan (1988) and Mutsaers *et al.*, (1993).

Table 6. Combined interaction effect of treatments x locations

Treatments	GP	LAI at 3WAS	LAI at 6WAS	NDFP	NDFP	NLPP 3	NLPP 6	NSPP	PL (m)	FPW (kg)	100 SW (kg)
<u>Location</u>											
Bali	71.49	16.52	39.99	40.82	41.82	9.90	20.11	17.05	42.35	0.11	0.10
Jalingo	75.91	10.95	31.39	40.23	41.23	9.76	19.02	13.54	41.95	0.11	0.12
LSD	4.886	1.395	3.281*	2.822	0.822	0.259	0.213	0.521	0.425	1.022	1.526
<u>Treatments</u>											
Bunch Cowpea x Vit A Cassava	72.40	10.98	27.78	37.77	40.77	10.43	20.33	11.33	13.73	0.08	0.11
Veg Cowpea x Vit A Cassava	74.74	12.20	25.85	44.93	42.93	8.06	19.60	16.53	70.16	0.14	0.09
Sole bunch cowpea	73.96	14.47	47.79	39.73	40.73	12.53	24.53	11.93	14.16	0.08	0.13
Sole vegetable cowpea	73.70	17.29	41.33	40.67	41.27	8.30	20.40	17.60	70.66	0.16	0.11
Mean	73.70			40.23	41.52	9.833	21.21	14.350	42.15	0.12	0.11
LSD	3.834	0.937**	1.726**	4.25	3.177	0.3052	0.240	0.66	0.1884	1.020	1.314
Genotype x Location	*	*	**	NS	NS	*	**	**	**	NS	NS

** = Significant at 0.01 level; * = Significant at 0.05 level; NS = Not significant

GP=Germination percentage (%), LAI at3WAP = Leafarea index after 3 weeks planting (m²); NDFP= No. of days to first flowering; NDFP = No. of days to first pod; NLPP 3 = No. of leaf per plant after 3 weeks; NLPP 6 = No. of leave per plant after 6 weeks; NSPP = No. of seeds per pod; PL = Pod length (cm); 100SW = 100 seeds weight (kg); G x E = Genotypes cross (x) environment

Table 7. Combined Mean Performance of Cassava Intercrop at Bali and Jalingo

Treatments	LA 6 (cm ²)	NL	NTPP	PH 6 (m)	FTW (kg)
<u>Location</u>					
Bali	39.46	7.14	4.58	10.06	1.14
Jalingo	30.24	2.14	3.83	0.65	0.59
LSD	3.523*	0.55	1.04	0.01	0.104
<u>Treatments</u>					
Bunch Cowpea x Vit A Cassava	31.08	3.83	3.71	0.77	0.68
Veg Cowpea x Vit A Cassava	31.93	4.50	4.21	0.79	0.79
Sole Cass	41.56	5.58	4.71	0.99	1.124
Mean	34.85	4.639	4.21	0.85	0.812
LSD	3.523*	0.221	0.93	0.01	0.104
Genotype x Location	NS	**	*	**	*

** = significant at 0.01 level; * =significant at 0.05 level; NS = Not significant

LA = Leaf area (cm²); NLPP: Numbers of leaves per plant; NTPP= Number of tubers per plant; PH = Plant height (m); FTW= Fresh tuber weight (kg)

SUMMARY, CONCLUSION AND RECOMMENDATION

This study was aimed evaluating the effect of intercropping on tuber yield of Pro Vitamin A cassava and pod yield of vegetable cowpea ssp. *Sesquipedalis* in Jalingo and Bali agro-ecologies of Taraba state, North-East Nigeria. One Pro Vitamin A cassava cultivar, NR 07/0220, one long-podded and trailing vegetable cowpea accession TVu 14868 and one grain cowpea were intercropped in a Randomized Complete Block Design with three Replicates. The results showed that sole vegetable cowpea produced longer pods, higher fresh weight, higher number of seeds and higher seed weight in both locations than the intercropped vegetable cowpea, with the intercropped vegetable cowpea coming second in importance while the grain cowpea was the least in those attributes. This indicates that vegetable cowpea performs better as a sole crop than when intercropped with vitamin A cassava. The results similarly showed that sole grain cowpea performed better in both locations than the grain cowpea intercropped with vitamin A cassava in pod length, number of seeds per pod and 100 seed weight, while having the same performance for fresh weight. Further, Jalingo recorded longer pods, higher fresh weight, more seeds per pod and 100 seed weight than the Bali location. The leaf area index, LAI, for both locations, number of leaves per plant and plant height in Bali were higher for the sole vitamin A cassava than its intercrop with either of the cowpeas, suggesting that vitamin A cassava performed better as a sole crop. Similarly, LAI, number of leaves and plant height for vitamin A cassava intercropped with

vegetable cowpea for both locations recorded higher figures than those for the intercrop with grain cowpea.

The results also indicate that although sole vitamin A cassava recorded fewer tubers per plant in Jalingo (3.17) than its intercrop with both vegetable cowpea (4.25) and grain cowpea (4.08 tubers), the Bali location recorded higher number of tubers for sole vitamin A cassava (5.17) than its intercrop with vegetable cowpea (4.33) and with grain cowpea (4.25), indicating sole vitamin A cassava performs better than its intercrop with either of two cowpeas. Although fresh tuber weight was also lower for sole vitamin A cassava in Jalingo (0.48 kg) than for its intercrop with vegetable cowpea (0.76 kg) and with grain cowpea (0.54 kg), in Bali, sole vitamin A cassava recorded higher fresh weight (1.40 kg) than vitamin A cassava intercropped with vegetable cowpea (1.07 kg) and with grain cowpea (0.96 kg).

The genotype by location interaction was significant for all the traits with the exception of number of days to first flower, number of days to first pod, fresh pod weight and 100 seed weight. For the vitamin A cassava, the genotype by location interaction was significant for number of leaves, number of tubers, plant height and fresh tuber weight.

As a result of their nutritional importance in food security, Vegetable Cowpea ssp. *Sesquipedalis* and Pro Vitamin A Cassava are, hereby, recommended, as sole crops, to be incorporated into the food security and poverty alleviation strategies of the Boko Haram affected

North-East of Nigeria and other developing countries of the world.

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REFERENCES

- Aerni P 2006. Mobilizing Science and Technology for Development: the case of the Cassava Biotechnology Network (CBN). *The Journal of Agrobiotechnology Management and Economics* 9: 1–14.
- Aliyu, B. and E. Wachap, 2014. Vegetable cowpea as a source of cheap protein and an environmentally friendly crop for urban cities. *Wessex Institute of Technology Transactions on Ecology and the Environment*, 181:301-312; www.witpress.com; ISSN 1743-3541. WIT Press.
- Duncan, D. 1955. Multiple Ranges and Multiple F-Tests. *Biometrics*, 11: 1-42.
- FAO, IFAD and WFP, 2014. The State of Food Insecurity in the World. Strengthening the Enabling Environment for Food Security and Nutrition. Rome, FAO.
- Fukuda, W.M.G., Guevara, C.L., Kawuki, R. and M.E. Ferguson. 2010. *Selected Morphological and Agronomic Descriptors for the Characterization of Cassava*.
- International Institute of Tropical Agriculture, IITA, Ibadan, Nigeria. 19 p.
- Hazra, P., Das, P.K. and M.G. Som, 1993. Characterization of the three cultigroups of cowpea (*Vigna unguiculata* (L) Walp.). *Crop Res.*, 6:465-474
- IDRC/UN-HABITAT, 2003. Guidelines for Municipal Policy Making on Urban Agriculture. In: *Urban Agriculture: Land Management and Physical Planning*. 13(1).
- Mason, S.C. and Leihner, D.E. and J.J. Vost 1986a. Cassava-cowpea and cassava-peanut intercropping I. Yield and land use efficiency. *Agron. J.* 78:43-46
- Mason, S.C., Leihner, D.E. and J.J. Vost 1986c. Cassava-cowpea and cassava-peanut intercropping III. Nutrient Concentration removal. *Agronomy Journal*
- Mutsaers, H.J.W., Ezumaha, H.C. and D.S.O. Osiru, 1993. Cassava-based intercropping: a review. *Field Crops Research*, 34 (3-4): 431-457
- National Bureau of Statistics, NBS, 2015 Report.
- Nweke, F. I. 2003. “New Challenges in the Cassava Transformation in Nigeria and Ghana.” Conference Paper No. 8. Paper presented at the INVENT, IFPRI, NEPAD, CTA Conference. Successes in African Agriculture, December 1 and 3, Pretoria.
- Okoli, O.O. 1996. Effect of planting dates and growing habits of cassava and cowpea on their yield and compatibility. *Tropical Agriculture*, 73(3):169-174
- Olasantan, P.O. 1988. Intercropping of cassava with maize or cowpea under different row arrangement. *Field Crops Research*, 19 (11): 41-50
- Polthanee, A., Wanapat, S., Wanapat, M. and Wachirapokorn, C. 2007. Cassava-Legumes inter-cropping: A potential food-feed system for dairy farmers. Use of Cassava as Animal Feed, Khon Kaen University, Thailand. <http://www.mekarn.org/procKK/polt.htm>
- Singh, R.K. and B.D. Choudhary, 1985. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers, New Delhi, India. PP. 69-78
- Smartt, J. 1990. *Grain Legumes: Evolution and Genetic Resources*. Cambridge University Press, Cambridge. 397p.
- Sommer A, Davidson FR, Annecy A (2002) Assessment and control of vitamin A deficiency: The Annecy Accords. *The Journal of Nutrition* 132: 2845S–2850S.
- Steele, W.M. and K.L. Mehra, 1980. Structure, Evolution and Adaptation to Farming Systems and Environment in *Vigna*. In: *Advances in Legume Science*, Edited by R.J. Summerfield and A.H. Bunting, London. PP393-404

- Tindall, H.D., 1986. *Vegetables in the Tropics*. Macmillan, London. 298p.
- Tsay, J.S., Fukai, S. and G.L. Wilson. 1988. *Field Crops Research*, 19 (3): 211-225
- Uguru, M.I. 1996. A note on the Nigerian Vegetable cowpea. *Genet. Res. Crop Evol.* 43: 125-128
- Usman, B. 2017. Evaluation of the Performance of some Accessions of Vegetable Cowpea (*Vigna unguiculata* (L) Walp.) ssp. *Sesquipedalis* in two Agro-ecological Zones of Taraba State, Nigeria. *M.Sc Thesis, Taraba State University, Jalingo*.104p
- United Nations, 2015. Transforming Our World: The 2030 Agenda for Sustainable Development, United Nations, New York, USA.
- UNICEF, 2016. *Nutrition and Food Security Surveillance: North-East Nigeria. Emergency Survey Final Report*. November 2016.

