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PRODUCTIVITY OF TANNIA COCOYAM VARIETIES + PIGEONPEA INTERCROPPING INSOUTHERN GUINEA SAVANNA OF NIGERIA

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ABSTRACT

Two field experiments were conducted between July, 2011 and December, 2013 at the Teaching and Research Farm of the University of Agriculture, Makurdi, Benue State, Nigeria. The main objective of the two studies was to evaluate the suitability of some tannia cocoyams for intercropping with pigeonpea genotypes to improve the productivity of pigeonpea/cocoyam intercropping systems in the area. The first experiment consisted of three improved tannia cocoyams and a local check evaluated for yields and nutrient content in Randomized Complete Block design with three replications. The second experiment was a 2 x 2 x 3 split-split plot laid out in Randomized Complete Block Design with three replications. Preliminary results indicated that the local tannia cocoyam ('Ikiko') proved superior in cormel length, diameter and fresh cormel yields to all the improved ones, except NXS001. Corm and cormel weights of the cocoyam component were reduced by intercropping. The results also showed that intercropping pigeonpea genotypes with cocoyam varieties increased the number of pods per plant, dry pod weight, dry seed yields and leaf litter of pigeonpea component. Also, intercropping pigeonpea with NXS 001 cocoyam gave significantly higher dry pod weight and seed yields than intercropping with traditional cocoyam. Intercrop productivity indices indicated benefits of intercropping pigeonpea with the cocoyam. Pigeonpea proved more competitive than cocoyam under intercropping. These results suggested that intercropping pigeonpea with cocoyam was more productive than the sole crop of either of the intercrop components and may therefore serve as an alternative production system for the farmers.

Keywords: pigeonpea genotypes, tannia cocoyam, row intercropping, compatibility.

INTRODUCTION

Increasing interest in sustainability and environmental concerns has shifted attention back to intercropping as a means of better utilization of resources while preserving the environment (Anders *et al.*, 1996). Intercropping pigeonpea with cocoyam has several advantages. Other than transferring fixed N to the companion crop, pigeonpea has the ability to bring minerals from deeper soil horizons to the surface thereby improving availability of nutrients (Kumar Rao *et al.*, 1983) to cocoyam. The slow growth of pigeonpea in the early stages offers less competition for light, water and soil nutrients to the associated crop and this tends to minimise negative effects on the cocoyam thereby making it a good companion crop to the cocoyam.

Some researchers (Moyin-Jesu, 2008; Egbe and Idoko, 2009; Egbe *et al.*, 2011.) had undertaken some studies on pigeonpea intercropping with cassava and sweet potatoes in Nigeria but documented information on pigeonpea/cocoyam intercropping is scanty, if not completely lacking. This study was carried out to evaluate the suitability of three pigeonpea genotypes for intercropping with some cocoyam varieties in Makurdi with a view to improving the productivity of these intercropping systems.

MATERIALS AND METHODS

Two field experiments were conducted between 2011 and 2013 at the Teaching and Research Farm of the Federal University of Agriculture, Makurdi [Latitude 07º/45' - 07º 50' N, Longtitude 08º 45'- 08º 50' E, elevation 98 msl] in Benue State, located in Southern Guinea Savanna of Nigeria.

Experiment 1: Evaluation of some Tannia Cocoyam genotypes for growth and yield in Makurdi environment

This experiment was conducted between July, 2011 and February, 2012. The treatment consisted of three improved tannia cocoyam genotypes (NXS 001, NXS 002, NXS 003 and a local check ('Ikiko'). The treatments were set out in randomized complete block design (RCBD) with three replications. The gross plot comprised of five ridges, 4m long (5m x 4m = 20m^2). The net plot was the middle 3m of the central 3 ridges (3m x 3m = 9m^2). Planting was done on 20th July, 2011. Tannia cocoyam corm cuttings with at least 2-3 eyes were planted at the crest of the ridge at a spacing of 50 cm and at the depth of 5 cm (plant population of 20,000 plants/ha). Fertilizer was applied before planting by broadcasting at the rate of 400 kg NPK: 15:15:15 p ha^{-1}. All other agronomic practices recommended by BNARDA (2003) for the production of tannia cocoyam were observed. At harvest, data oncormel length, cormel diameter (cm) and fresh cormel weight (t ha^{-1}). A simple proximate analysis of the tannia cocoyam varieties (NXS 001, NXS 002, NXS 003 and 'Ikiko') was done at Animal Nutrition Laboratories of the Federal University of Agriculture, Makurdi. Standard procedures of analysis for moisture content, ether extract, ash, crude protein and crude fibre was adopted.

Experiment 2: Effect of Pigeonpea genotypes on the growth and yield of intercropped Tannia Cocoyam varieties in Makurdi

The objective of the experiment was to determine the performance of pigeonpea genotypes when intercropped with some tannia cocoyam varieties. The

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experimental site received a total rainfall of 1326.6 mm within the period of experimentation. Eight core samples of soil were collected from different parts of the field from 0-30cm and bulked into a composite sample and used for the determination of physical and chemical properties of the soil (see Table-1) before planting. Both the physical and chemical analyses were done in the NICANSOL Soil Testing Laboratory of the University of Agriculture, Makurdi.

Table-1. Physical and chemical properties of the surface soil (0-30 cm) at the experimental site in 2011 and 2012.

Parameter	2011 Tannia cocoyam site	2012/2013 Pigeonpea/cocoyam site
Sand (%)	69.10	75.10
Silt (%)	16.00	11.20
Clay (%)	14.90	13.70
Textural class	Sandy loam	Sandy loam
pH (H_2O)	6.45	6.44
pH (KCl)	5.78	5.61
Organic carbon (g kg^{-1})	0.88	0.90
Organic matter (g kg^{-1})	1.52	1.56
Total Nitrogen (g kg^{-1})	0.91	0.88
Available Phosphorus (Bray 1)(cmol kg^{-1}	3.10	2.90
Ca^{2+} (cmol kg^{-1})	3.75	3.77
Mg^{2+} (cmol kg^{-1})	1.86	1.90
K^{+} (cmol kg^{-1})	0.61	0.35
Na+ (cmol kg^{-1})	0.75	0.55
CEC (cmol kg^{-1}	7.10	6.80
Base Saturation (%)	98.30	97.00

The experiment was a 2 x 2 x 3 split-split plot laid out in randomized complete block design with three replications. The main plot treatments were two cropping systems [sole cropping (cocoyam, pigeonpea), intercropping (cocoyam + pigeonpea)]. The sub plot treatments were made up of two cocoyam cultivars (NXS 001, traditional cultivar, *'Ikiko'*). The sub-sub plot treatments comprised of three (3) pigeonpea genotypes (ICPL 87119, ICPL 187-1 and one traditional cultivar, *'Igbongbo'*.). The improved pigeonpea genotypes were obtained from International Crop Research Institute for Semi-arid Tropics (ICRISAT) in India while the traditional cultivar was obtained from a local market in Otobi, Benue State. The cocoyam varieties were obtained from National Root Crops Research Institute (NRCRI) Umudike. Each sub-sub plot consisted of 5 ridges spaced 1m apart and 3m long.

Pigeonpea and cocoyam were sown on the same day in both experimental years (23rd and 21st May, 2012 and 2013, respectively) and both crops were planted on the sides near the top of the ridge. Pigeonpea seeds were dressed with Apron Plus® 50DS (10% metalaxy, 1.34% furanthiocarb, 61% carboxin) at the rate of one sachet per three kilogrammes of seed. Three seeds of pigeonpea were planted per hill and thinned to two seedlings per stand 10 days after planting (DAP). Cocoyam was planted at a spacing of 50cm within row. One cormel (200g weight) was planted per hill at a depth of 4-5 cm. In both sole and intercropped plots, pigeonpea population density was maintained at approximately 66, 666 plants ha^{-1} and cocoyam at 20,000 plants ha^{-1}. Intercropping had a 3:2 (pigeonpea:cocoyam) row proportion. All plots received a basal application of 200kg NPK 15:15:15 at the rate of 30kg N, 30kg P_2O_5 and 30kg K_2O ha^{-1} by broadcasting (BNARDA, 2003). At three weeks after planting (W.A.P), the pigeonpea plants in each plot received equivalent of 100kg single super phosphate (SSP) ha^{-1} as top-dressing by side placement. At 4 W.A.P, cocoyam plots in both sole and intercropped plots were top dressed with 200kg of NPK 15:15:15 by side placement (BNARDA, 2003). Two manual weeding were done at three and seven W.A.P for all the plots. Earthening up of cocoyam plots was done as the need arose. Harvesting of both crops was done from (2m x 3m) and this represented the yield per plot. The crops were harvested at physical maturity. At mid-floweing, pigeonpea plants were sprayed with a mixture of Cypermethrin (Cymbush 10EC®) and Dimethoate (Perfekthion 40EC®) applied at rate of 0.13 kg a.i./ha and 0.65 kg a.i.ha^{-1}, respectively to control insect pests. This

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was repeated at fortnightly intervals for a maximum of six weeks.

Data collection and analysis

a) The following data were collected for the cocoyam component: number and weight of cormels ha^{-1}.

b) Grain yield ha^{-1} was measured for the pigeonpea component.

Assessments of intercrop productivity

Productivity of cocoyam/pigeonpea intercropping systems in this study was evaluated using the following tools:

a) Land equivalent ratio (LER) as described by Ofori and Stern (1987)

b) Land equivalent coefficient (LEC) (Adetiloye *et al.,* 1983)

c) Competitive ratio (CR) indicates the degree with which one crop competes with the intercrop. This was calculated using the formula proposed by Willey *et al.* (1980).

All data were collected following standard procedures and analysed using GENSTAT Release 7.23 (2007).The data obtained from the cocoyam/pigeonpea intercropping in 2012 and 2013 were pooled together and analysed, as the year effect was not significant. Least significant difference (LSD) test at 5% probability level was used to compare the treatment means.

RESULTS

Experiment 1: Evaluation of some Tannia Cocoyam genotypes for growth and yield in Makurdi.

Table-2 presents the cormel weight of tannia cocoyam in Makurdi in 2011. Cormel weight varied from 1.1t t/ha to 7.92 t ha^{-1} with a mean of 4.18 t/ha in Makurdi in 2011. The local check gave the highest cormel weight (7.92 t ha^{-1}) and this was significantly higher than the cormel weight of NXS 001 (6.00 t ha^{-1}), which in turn was significantly higher than those produced by NXS 003 (1.61 t ha^{-1}) and NXS 002 (1.17 t ha^{-1}).The local check had the highest moisture content and crude fibre values when compared to the other genotypes, while NXS 001 had the highest value of ether extract (Table-3). The Figures for ash and crude protein contents were similar for all the genotypes (Table-3).

Table-2. Number of stands and cormels per ha, cormel length and diameter (cm) and the weight of fresh cormels of tannia cocoyam genotypes at harvest in Makurdi in 2011.

Tannia varieties	Number of cormels	Cormel length	Cormel diameter	Weight of fresh cormels
NXS 001	55,811.00	7.71	2.93	6.00
NXS 002	6,109.00	3.39	2.40	1.17
NXS 003	14,161.00	3.65	2.50	1.61
Local check (‘Ikiko’)	99,421.00	9.98	3.84	7.92
Mean	43,875.50	6.18	2.92	4.18
FLSD (0.05)	28,738.00	2.39	0.56	1.82

Table-3. Proximate analysis of tannia cocoyam genotypes in Makurdi in Makurdi.

Tannia cocoyam genotypes	Moisture content (%)	Ether extract (%)	Ash (%)	Crude protein (%)	Crude fibre (%)
NXS 001	57.60	6.80	2.30	2.19	4.45
NXS 002	52.20	6.70	2.30	2.19	4.45
NXS 003	60.40	4.60	2.30	2.19	4.45
Local check (‘Ikiko’)	63.40	4.90	2.30	2.19	4.45
Mean	58.30	5.75	2.30	2.19	4.45

Cormel weight of Cocoyam varieties as influenced by cropping systems in Makurdi

The main effect of cropping systems and variety and the interaction effects of cropping systems x variety on the cormel weight of cocoyam had significant ($P \leq 0.05$) differences. Table-4 presents the results of the influence of cropping systems on the cormel weight of cocoyam varieties in Makurdi. Intercropping of cocoyam with pigeonpea reduced the cormel weight of both cocoyam varieties. The percentage reduction of cormel weight of cocoyam was higher in ‘Ikiko’ than in NXS 001. NXS 001 gave significantly higher weight of cormels (9.29 t ha^{-1}) than ‘Ikiko’ (6.00 t ha^{-1}).

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Table-4. Influence of cropping systems on the cormel weight (t/ha) of Cocoyam varieties in Makurdi.

Cropping systems		Cormel weight	
		Cocoyam varieties	
	NXS001	'Ikiko'	Mean
Sole Cropping	11.55	9.05	10.30
Intercropping	7.03	2.95	4.99
Mean	9.20	6.00	7.65
% Cormel reduction by intercropping	38.70	67.40	53.05
FLSD (0.05) CRS	0.05		
CO-VAR	0.04		
CRS X CO-VAR			

Dry seed weight of intercropped Pigeonpea with Cocoyam varieties in Makurdi

All treatment effects on the dry seed weight of pigeonpea were significant except the main effect of cocoyam variety, which was not (P≥ 0.05). ICPL 187-1 and ICPL 87119 intercropped with NXS 001 had significantly higher seed weight than the sole counterpart but not so with 'Igbongbo' which had the reverse trend (Table-5). The effect of intercropping 'Ikiko' (local check) with pigeonpea varieties on the dry seed weight of the pigeonpea varieties tested in this study was erratic. While intercropping with 'Ikiko' had no effect on the dry seed yield of ICPL 187-1, it significantly increased the seed yield of ICPL 87119 and decreased the seed yield of 'Igbongbo' (local pigeonpea variety). Generally, intercropping increased the seed weight of pigeonpea genotypes. ICPL 187-1 gave significantly higher seed weight (1.70 t ha^{-1}) than ICPL 87119 (1.00 t ha^{-1}), which in turn had higher dry seed yield than 'Igbongbo' (0.78 t ha^{-1}). Intercropped pigeonpea with NXS 001 produced higher seed weight than intercropping with 'Ikiko'.

Table-5. Effect of cropping systems x cocoyam variety x pigeonpea variety on the dry seed weight of pigeonpea in Makurdi.

	Dry seed weight (t ha^{-1}) **Pigeonpea genotypes**			
Cropping systems	**Cocoyam variety**	**ICPL 187-1**	**'Igbongbo'**	**Mean**
Sole cropping		1.58	0.89	1.07
Intercropping	NXS 001	1.84	0.75	1.19
	'Ikiko'	1.56	0.82	1.14
Mean for intercropping		1.70	0.78	1.16
FLSD (0.05)				
CRS		0.08		
CO-VAR		0.04		
PPEA VAR		0.03		
CRS x CO-VAR		0.07		
CRS x PPEA VAR		0.06		
CO-VAR x PPEA VAR		0.04		
CRS x CO-VAR x PPEA VAR		0.07		

Land Equivalent Ratio (LER), Land Equivalent Coefficient (LEC), Competitive Ratio (CR) of Intercropped Pigeonpea with Cocoyam in Makurdi in 2012.

All intercrop combinations had LER Figures above unity except ICPL 187-1 + 'Ikiko' and LEC values above 0.25 (Table-6). CR values of pigeonpea were consistently higher than those of cocoyam in all intercrop combinations. The combinations of pigeonpea with NXS 001 had higher values of LER and LEC than the combinations of the pigeonpea varieties with the local cocoyam ('Ikiko'). The competive ratio (CR) values of pigeonpea were consistently higher than those of cocyam.

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Table-6. Land equivalent ratio (LER), land equivalent coefficient (LEC), competitive ratio (CR) of intercropped pigeonpea with cocoyam in Makurdi.

Treatment	LER	LEC	CR (Pigeonpea)	CR (Cocoyam)
ICPL 187-1 in NXS 001	1.73	0.67	3.05	0.31
ICPL 187-1 in 'Ikiko'	1.43	0.44	3.25	0.35
ICPL 87119 in NXS 001	1.80	0.73	3.24	0.33
ICPL 87119 in 'Ikiko	1.72	0.66	3.69	0.30
'Igbongbo' in NXS 001	1.31	0.53	2.25	0.46
'Igbongbo' in 'Ikiko'	1.27	0.46	3.56	0.36
Mean of intercropping	1.54	0.58	3.17	0.35
F-LSD (0.05)	0.19	0.05	0.26	0.03

DISCUSSIONS

The rainfall received within the period of experimentation was considered adequate for both crop growth and development. The differences observed in Experiment 1 among the four tannia cocoyam genotypes in the number of stands and weight were to be expected as the genetic composition of these materials were likely to differ. Sen *et al*. (2006) had made a similar observation in taro cocoyams and attributed such differences to peculiar genetic characteristics and potentials. The similar nutritional composition observed in the tannia cocoyam genotypes in this work was in agreement with the study by Ekwe *et al.* (2008), who reported that cocoyams had high moisture content at harvest and also contained appreciable amount of mineral nutrients and proteins. The amount of crude protein reported here was however lower than 20% reported by Ekwe *et al.* (2008). The superior performance of the local check ('Ikiko') over the improved genotypes (NXS 001, NXS 002, NXS003) in cormel yield indicated better adaptation of the local check to the Makurdi environment than the improved ones. It is worthy of note that NXS 001 had comparable cormel yield to the local check. The reductions observed in the cormel weight of cocoyam intercropped with pigeonpea varieties might be due to interspecific competition from the taller pigeonpea component for both above- and below- ground growth resources (light, air, water, nutrients). The tall pigeonpea might have depressed photosynthetic capacity of the cocoyam through shading. This finding is consistent with the reports of Egbe and Idoko (2009) in their work on pigeonpea intercropped with sweet potato in Southern Guinea Savanna of Nigeria. These authors had indicated that the depression in yields of sweet potato varieties was due to depression of photosynthesis through reduced irradiance. Okpara *et al.* (2009) had observed depressive effects of intercropping cocoyam with cowpea on the corm yields of cocoyam in Umudike, Southeast Nigeria. The higher cormelyield of NXS 001 than 'Ikiko' might have resulted from the superior number of cormels and cormel diameter (data not shown) produced by NXS001. NXS 001 is an improved variety of cocoyam and may therefore be endowed with some genetic traits that make it perform better than 'Ikiko' under improved management systems. Intercropping increased the dry seed yield of pigeonpea. These increases might be due to the conducive intercrop environment created by the cocoyam component, which provided a ground cover for the pigeonpea rows with its broad leaves. The broad leaves of cocoyam may have ameliorated the high temperature effects and rate of water loss by evaporation, thereby conserving water for pigeonpea growth and yields, especially in times of water stress during the early dry season when grain filling was taking place in pigeonpea. The broad leaves of cocoyam also minimized the direct impact of rain drops on the soil around the component crops, thereby reducing erosion, runoff, nutrient loss and subsequent lodging. The suitable intercrop environment was made possible because of row arrangement of the component crops. Each intercrop plot had 3:2 (pigeonpea:cocoyam) ratio, with the cocoyam sandwiched between the pigeopea in alternate ridges. Yield increases of the legume component had been reported by some researchers (Lesoing and Francis, 1999; Mahmoudi *et al*., 2013) in cereal/legume intercropping. Such increases were associated with border row effects and in some cases inside row effects. In this study involving pigeonpea and cocoyam (legume/root crop) intercropping, the pigeonpea unexpectedly produced higher seed yields under intercropping than the sole counterpart probably because of the better growth environment(earlier discussed) provided by the associated cocoyam, which was absent for the sole pigeonpea. The results obtained in this study showed that intercropping pigeonpea varieties with NXS 001 cocoyam may be more suitable than intercropping them with 'ikiko'(the local cocoyam). The reasons for better performance of pigeonpea with NXS 001 than 'Ikiko' need further investigation. ICPL 187-1 had higher dry seed yields than the other pigeonpea genotypes in both sole and intercropping with cocoyam probably because it had higher number of leaves, pods/plant, dry pod weight and 100-SW (data not shown) than the other two genotypes. High and positive correlations have been found between seed yield of pigeonpea and such other yield components as dry pod weight, number of seeds/plant,100SW (Vange and Egbe, 2009). If seed yield is the target of production by the farmer, then ICPL187-1 may be a choice variety.

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The indices (LER and LEC) used to evaluate intercrop productivity in this study indicated intercrop advantages, implying that both land and time would be saved by adopting intercropping rather than sole cropping of either pigeonpea or cocoyam in Southern Guinea Savanna. Okwuowulu *et al*. (2000) had reported that row intercropping of cocoyam with upland rice in Umudike and Otobi enhanced the total yield of mixture components through complimentary yield advantages, resulting in high productivity efficiency. The higher values of productivity indices for NXS001/pigeonpea intercropping systems than 'Ikiko'/pigeonpea intercropping systems further proved the higher biological efficiencies of the NXS001/pigeonpea combinations. Pigeonpea was the more dominant component of the cocoyam/pigeonpea intercropping systems, probably because of its height advantage and its robust and deep rooting system which exploit deeper and wider soil horizons for nutrient and water than the rather shallow-rooted cocoyam component. No wonder pigeonpea is often referred to as the 'biological plough' because its tap root system is reported to break plough pans. Extensive ground cover by pigeonpea prevents soil erosion by wind and water, encourages infiltration of rain water and smothers the weeds.

CONCLUSIONS

Intercropping resulted in decreased corm and cormel weights of the cocoyam component. NXS 001 cocoyam proved more suitable for intercropping with pigeonpea. The results of this field study also showed that intercropping pigeonpea genotypes with cocoyam varieties increased the dry pod weight, dry seed yields and leaf litter of pigeonpea. Yield advantages measured by land equivalent ratio and land equivalent coefficient indicated benefits of intercropping the tested pigeonpea genotypes with the cocoyam varieties in Makurdi environment. Pigeonpea proved the more dominant component of the cocoyam + pigeonpea intercropping system in Makurdi.

REFERENCES

Adetiloye P.O., Ezedinma F.O.C. andOkigbo B.N. 1983. A land coefficient concept for evaluation of competitive and productive interactions on simple complex mixtures. Ecol. Modelling. 19: 27-39.

Anders M.M., Potdar., M.V. and Francis C.A. 1996. Significance of intercropping in cropping systems. In: Ito, O., Katayama, K., Johansen, C., Kumar Rao, J.V.D.K., Adu- Gyamfi, J.J. andRego T.J. (Eds.). Roots and nitrogen in cropping systems of the semi-arid tropics. JIRCAS. Ohwashi, Ibaraki, Japan, pp1-18.Benue State Agricultural and Rural Development Authority (BNARDA). (2003): Annual Report, 2003, Makurdi, Nigeria.

Egbe O.M., andIdoko J.A. 2009. Agronomic assessment of some sweet potato varieties for intercropping with pigeonpea in Southern Guinea Savanna of Nigeria. ARPN Journal of Agricultural and Biological Sciences. 4(4): 23-32.

Egbe O.M., Egbo C.U. and Odaba B.O. 2011. Residual benefits of pigeonpea to cassava intercropped with maize at Otobi, Benue State, Nigeria. J. Agric. Tech. 7(3): 835-848.

Ekwe K.C., Mbanaso E.N.A., Nwosu K.I., Nwachukwu I. andEkwe C.C. 2008. Examining the under exploited values of cocoyam for enhanced household food security, nutrition and economy in Nigeria. Acta Hort. 806: 71-78.

Kumar-Rao J.V.D.K., Dart P.J. and Sastry P.V.S.S. 1983. Residual effect of pigeonpe on yield and nitrogen response of maize. Expl. Agric. 19: 131-134.

Lesoing G.W. and Francis C.A. 1999. Strip intercropping effects on yield and yield components of corn, grain sorghum and soybean. Agron. J. 91(5): 807-813.

Mahmoudi R., Jamshidi K. and Pouryousef M. 2013. Evaluation of grain yield maize (*Zea mays* L.) and soybean (Glycine max L.) in strip intercropping. Int. J. Agron. Plt. Prod. 4(9): 2388-2392.

Moyin-Jesu E.I. 2008. Use of pigeon pea (Cajanuscajan L.) as soil amendment for the growth, leaf chemical composition and yield of white yam (*Dioscorea rotundata* L.). Continental J. Agric. Sci. 2: 6-17.

Ofori F and Stern W.R. 1987. Cereal –legume intercropping systems. Adv. Agron. 41: 41-90.

Okpara D.A., Nwofia G., Chukwuekezie G. andOjikpong T. 2009. Productivity of cocoyam/cowpea intercrops as influenced by cowpea growth habits. Nig. Agric. J. 40(1-2):

Okwuowulu P.A., Asiegbu J.E. andNnado W.F. 2002. Effect of row intercropping of cocoyam minisett on tuber/garri yield and productivity in South Eastern Nigeria. J. Sust. Agric. Environ. 2: 214-225.

Sen S.A.M., Bhattacharya Sen, H; Das A.K. andPal S. 2006. Nutrient and antinutrient composition of Colocasia esculentua var. antiquorum. Vegetable Sci.11: 17-33.

Vange T. and Egbe O.M. 2009. Studies on Genetic Characteristics of Pigeonpea Germplasm at Otobi, Benue State of Nigeria. World Journal of Agricultural Sciences. 5(6): 714-715.

Willey R .W, Rao M.R. and Natarajan M. 1980. Traditional cropping systems with pigeonpea and their improvement In: Proceedings of the International Workshop on Pigeonpeas, 15 - 19 December 1980, ICRISAT Center, Patancheru, India. 1: 11-25.