Octa Journal of Biosciences
International peer-reviewed journal
Octa J. Biosci. Vol. 6(1):13-18

ISSN 2321 – 3663
Jan-June 2018

Octa Journal of Biosciences

journal homepage: www.sciencebeingjournal.com

Growth And Yield Of Some Pigeonpea [*Cajanuscajan*(L.) Millspaugh] Varieties As Influenced By Row-Intercropping With Cocoyam [*Xanthosoma sagittifolium*(L.) Schott] In Makurdi, Southern Guinea Savanna Of Nigeria

Akaazua Barnabas Wanger[1],Akorga Moses Terngu[2], Agbo Moses Agbo[3], Iortyer Mson Samuel[3], Owoyemi Stephen Segun[4] and Adzer Yadoo[5]

1 Department of Crop Production, University of Agriculture, P.M.B.2373, Makurdi, Nigeria
2 Department of Agricultural Technology, AkperanOrshi College of Agriculture Yandev, Nigeria
3 Centre for Food Technology and Research, Benue State University Makurdi, Nigeria
4 Catholic Relief Services Nigeria Programme, Agricultural and Economic Growth Unit, Abuja
5 Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi, Nigeria

ARTICLE INFO

Received 03 March 2018
Revised 15 May 2018
Accepted 25 June 2018
Available online 30 June 2018

Keywords: *Pigeonpea, cocoyam, variety, rowinter cropping, sole cropping*

Email: akaazuabarnabas@gmail.com

ABSTRACT

A field experiment was conducted for two years(2012 and 2013) at the Teaching and Research Farm of the University of Agriculture, Makurdi, Benue State, Nigeria. The experiment was undertaken to determine the growth and yieldof some pigeonpea varieties when intercropped with cocoyam.The treatments consisted of two cropping systems (sole cropping and row intercropping)as the main plot,combined with 3 pigeonpea varieties (ICPL 87119, ICPL 187-1 and one traditional cultivar 'Igbongbo')as the sub-plot, laid out as a split-plot in randomized complete block design with three replications. The result obtained from the experiment showed that row intercropping increasedthe plant height at harvest, number of leaves and primary branches at harvest, pod bearing length, leaf litter, number of seeds per pod and grain yield of pigeonpea. Irrespective of the cropping system, ICPL 87119 produced the highest number of primary branches and pod bearing length. 'Igbongbo' produced the highest plant height at harvest, leaf litter, pod length and number of seeds per pod in both cropping systems. ICPL 187-1was found to give the highest number of leaves at harvest, number of pods per plant, grain yield and 100-seed weight under row intercropping as well as sole cropping. Intercropping depressed plant height at harvest, number of cormels and corms per plant, cormel and corm length and cormel and corm weight of cocoyam. Yield advantages measured by land equivalent ratio and land equivalent coefficient indicated benefits of intercropping the tested pigeonpeavarieties with the cocoyam cultivar in Makurdi environment. Pigeonpea proved the more dominant component of the pigeonpea + cocoyam intercropping system. These results suggested that intercropping these pigeonpeavarieties with the tested cocoyam cultivar was more productive than the sole crop of either of the intercropped components and may therefore serve as an alternative production system to both pigeonpea and cocoyam growers in the area.

INTRODUCTION

Pigeonpeas (*Cajanuscajan*(L.) *Millspaugh*) numerous uses for food, feed, wood, medicine, fencing, shade, soil improvement, erosion control and pest management makes it a very important crop in the Southern Guinea Savanna of Nigeria. Little seem to be known about its level of production in Nigeria, but surveys conductedby Remanandan and Asiegbu (1993) and Egbe and Kalu (2006) indicated that pigeonpea is widely cultivated in Nigeria and it appears that the intensity of pigeonpea cultivation is influenced by the culture and food habits of its people (Egbe and Kalu, 2009).

Cocoyam belongs to the monocotyledonous family Araceae known as the Aroids (Ugbajah and Uzuegbuna, 2012). It ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria (Udealoret al., 1996). Nigeria is the largest producer of cocoyam in the world accounting for about 40% of the total world output of cocoyam (Eze and Okorji, 2003).

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; Egbeet al.,2010).Pigeonpea/cocoyam intercropping is not a common crop production practice in Southern Guinea Savanna of Nigeria but enormous potentials exist for it in the region. Pigeonpea and cocoyam could be intercropped as they have differential morphological features that make them compatible. Pigeonpea which has deep root system may offer less competition for soil nutrients and water to cocoyam which is a shallow feeder.Cocoyam is a shade tolerant crop; this makes it a compatible crop for intercropping with pigeonpea which can grow as tall as four meters. Pigeonpea's canopy may not have any significant negative effect on the growth of the cocoyam. The height difference between pigeonpea and cocoyam also minimizes competition for sunlight. Pigeonpea's ability to fix nitrogen and deposit huge leaf litter may be beneficial to the cocoyam component of the pigeonpea/cocoyam intercropping. Pigeonpea and cocoyam have different growth characteristics and leafing patterns and their combination can maximize the use of available sunlight.

Several studies (Moyin-Jesu, 2008; Egbe and Idoko, 2009 and Egbeet al, 2015) have been carried out on pigeonpea intercropping with other root and tuber crops but information on pigeonpea/cocoyam row intercropping is scarce if not lacking. The study reported here was carried out to fill this knowledge gap with a view to improving the productivity of this intercropping system. The objectives of the study were:

i.to evaluate the suitability of three pigeonpea genotypes for row-intercropping with cocoyam in Makurdi.

ii.to determine the productivity of the pigeonpea/cocoyam row-intercropping in Makurdi.

MATERIALS AND METHODS

A field experiment was carried out during the cropping seasons of 2012 and 2013 at the Teaching and Research Farm of the University of Agriculture, Makurdi [Latitude 07º45' - 07° 50' N, Longtitude 08° 45'- 08º 50' E, elevation 98 meters above sea level] in Benue State, located in Southern Guinea Savanna of Nigeria (Kowal and Knabe, 1972). The objective of the experiment was to determine the performance of some pigeonpea varieties when intercropped cocoyam. Total precipitations during the cropping seasons were 1326.6mm and 1432.2mm in 2012 and 2013, respectively. Eight core samples collected from 0-30cm depth before land preparation were bulked into a composite sample, air-dried and ground. The samples were sieved through 2mm and 0.05mm screens for the determination of the physical and chemical properties of the soil (Table 1) before planting. The experiment was laid out as split- plot in randomized complete block design with three replications. The main plot treatment comprised of two cropping systems [sole cropping (pigeonpea, cocoyam) and row intercropping (pigeonpea + cocoyam)] while the sub-plot treatment was 3 pigeonpea varieties (ICPL 87119, ICPL 187-1 and one traditional cultivar "Igbongbo"). A traditional cocoyam cultivar, 'Ikiko' was used for intercropping with pigeonpea varieties.Each sub-plot consisted of five (5) ridges spaced 1m apart and 3m long (5m x 3m=15m2). The net plot measured $9m^2$.

Land was prepared manually using hoes and cutlasses. Pigeonpea and cocoyam were sown either as sole crop or intercrop on ridges on the same day in both experimental years. 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 pigeonpea seeds were planted per hill at a spacing of 30cm within row and thinned 8 days after planting as recommended by BNARDA (2000). Cocoyam was planted at a spacing of of 50cm within rows. One cormel (200g weight) was planted per hill at a depth of 4-5 cm. The approximate plant population density for pigeonpea in both cropping systems was 66,666 per ha while that of cocoyam was 20,000 per ha. Intercropping had a 3:2 (pigeonpea:cocoyam) row proportion. All plots received a basal application of 30kg N, 30kg P2O5 and 30kg K2O per hectaresupplied as 200 kg of NPK 15:15:15 compound fertilizer broadcast and incorporated before sowing of both crops on 23rdand 21stMay, 2012 and 2013, respectively (BNARDA, 2003). Sole and intercropped pigeonpea were top-dressed with an equivalent of 100kg single super phosphate (SSP) per ha at 3 weeks after planting (WAP). At 4 WAP, cocoyam was top dressed with 200kg of NPK 15:15:15 by side placement (BNARDA, 2003). Two hoe-weeding were done at three and seven WAP for all plots. Cocoyam plots were earthened up as the need arose. At first flower opening, pigeonpea plants were respectively sprayed with Best'® (Cypermithrin 10% EC) at a dose of 60 ml in 10 litres of water for the control of pigeonpea pod borers and pod sucking bugs. This was repeated three times at fortnightly intervals. The crops were harvested at physical maturity. Harvesting of both crops was done from the inner 2m x 3m at physical maturity and this represented the yield per plot.

Parameters measured for pigeonpea component included plant height at harvest, number of leaves at harvest, number of primary branches at harvest, pod bearing length, pod length, number of pods per plants, number of seeds per pod, grain yield, 100-seed weight and leaf litter. The characters measured for the cocoyam component were plant height at harvest, number of cormels per plant, number of corms per plant, cormel length, corm length, weight of fresh cormels and weight of fresh corms.

Productivity of the various pigeonpea varieties intercropped with cocoyam in this work was determined by using land equivalent ratio (LER) as described by Ofori and Stern (1987) and land equivalent coefficient (LEC) as illustrated by Adetiloyeet al. (1983). Competitive ratio (CR) which indicates the number of times by which one component crop is more competitive than the other was calculated using the formula proposed by Willey et al, (1980).

Year effect was not significant, so data for both years were pooled together and analyzed. Standard procedures were followed in collecting all data and analysis was done using GENSTAT statistical software. Whenever differences between treatment means were significant, means were separated by Fishers Least Significant Difference at 5% level of probability.

RESULTS

Pigeonpea Component
Plant Height

The plant height of pigeonpea at harvest as influenced by the main effect of cropping systems and pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpea varieties was significant ($P \leq 0.05$). Irrespective of the cropping system used, 'Igbongbo' produced the highest plant height of pigeonpea at harvest (Table 3). Row intercropping gave significantly higher plant height (3.57m) of pigeonpea at harvest than sole cropping (3.46m) (Table 2).

Number of Leaves at Harvest

The main effect of cropping systems and pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpeavarieties on the number of leaves of pigeonpea at harvest was significant ($P \leq 0.05$). Data presented in Table 3 revealed that ICPL 187-1 gave significantly higher number of leaves at harvest than all the other varieties in both sole cropping (1897.05) and row intercropping (1966.73). Regardless of the pigeonpea variety used, row intercropping gave higher number of leaves at harvest than sole cropping.

Number of Primary Branches at Harvest

Cropping systems x pigeonpea varieties interaction effects as well as the main effect of cropping systems and pigeonpea varieties on the number of primary branches of pigeonpea at harvest was significant ($P \leq 0.05$). ICPL 87119 produced significantly higher number of primary branches at harvest than ICPL 187-1 which in turn produced higher number of primary branches than 'Igbongbo' in both cropping systems (Table 3). Row intercropping systems had higher number of primary branches at harvest (18.05) than sole systems (16.17) (Table 2).

Pod Bearing Length

All treatment effects (cropping systems, pigeonpea varieties and their combination) showed significant ($P \leq 0.05$) difference on the pod bearing length of pigeonpea. The pod bearing length produced by ICPL 87119 (2.92m) was significantly higher than that produced by ICPL 187-1 (2.74m) and 'Igbongbo' (2.65m) respectively under row intercropping. A dissimilar trend was observed under sole cropping where ICPL 87119 (2.93m) produced significantly higher pod bearing length than 'Igbongbo' (2.55m) and ICPL 187-1 (2.45m) respectively (Table 3). The mean pod bearing length produced by intercropped pigeonpea (2.77m) was generally higher than that of the sole (2.64) counterpart (Table 2).

Leaf Litter

The main effect of cropping systems and pigeonpea varieties and the interaction effects of cropping systems x pigeonpea varieties on the leaf litter of pigeonpea was significant ($P \leq 0.05$). ICPL 87119 produced the highest leaf litter (3.21t/ha) under row intercropping but this was not so under sole cropping where 'Igbongbo' gave the highest leaf litter (2.69t/ha) (Table 3). Intercropped pigeonpea gave higher mean leaf litter (3.09t/ha) than sole pigeonpea (2.67 t/ha). Among the pigeonpea varieties evaluated, ICPL 87119 generally gave the highest leaf litter (2.99t/ha) but the difference was only significantly higher than that produced by ICPL 187-1 (2.71t/ha) (Table 2).

Pod Length

The main effect of pigeonpea varieties and the interaction effects of cropping systems x pigeonpea varieties showed significant ($P \leq 0.05$) difference on the pod length of pigeonpea but the main effect of cropping systems showed no significant ($P \geq 0.05$) difference. Regardless of the cropping system used, 'Igbongbo' produced significantly longer pod length than all the other varieties. ICPL 87119 gave the shortest pod length in both cropping systems (Table 5).

Number of Pods per Plant

The main effect of cropping systems and pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpea varieties on the number of pods per plant of pigeonpea was significant. Under both cropping systems, ICPL 187-1gave significantly higher number of pods per plant than ICPL 87119, which in turn gave significantly higher number of pods per plant than 'Igbongbo' (Table 5). The number of pods per plant produced by row intercropping (856.14) was generally higher than that produced by sole cropping (781.35) (Table 4).

Number of Seeds per Pod

The main effect of pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpea varieties showed significant ($P \leq 0.05$) difference on the number of seeds per pod of pigeonpea but the main effect of cropping systems showed no significant ($P \geq 0.05$) difference. A cursory look at Table 5 showed that regardless of the cropping system, 'Igbongbo' produced the highest number of seeds per pod. ICPL 87119 and 'Igbongbo' gave the same number of seeds per pods from statistical view point in both cropping systems.

Grain Yield

The grain yield of pigeonpea as influenced by the main effect of cropping systems and pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpea varieties was significant ($P \leq 0.05$). Data presented in Table 5 revealed that the grain yield produced by ICPL 187-1 under row intercropping (1.61t/ha) and sole cropping (1.56t/ha) was significantly higher than that produced byICPL 87119 (1.03 and 0.81t/ha respectively) which in turn gave significantly higher grain yield than 'Igbongbo' (0.91 and 0.76t/ha respectively). Generally, row intercropping gave significantly higher grain yield than sole cropping (Table 4).

100-Seed Weight

The main effect of pigeonpea varieties as well as the interaction effects of cropping systems x pigeonpea varieties on the 100-seed weight of pigeonpea was significant ($P \leq 0.05$) but the main effect of cropping systems was not. Regardless of the cropping system, ICPL 187-1 gave the highest 100-seed weight of pigeonpea and this was significantly higher than that produced by 'Igbongbo' and ICPL 87119 respectively (Table 5).

Cocoyam Component
Plant Height

The plant height of cocoyam at harvest as influenced by intercropping with pigeonpea varieties was significant ($P \leq 0.05$). Sole cocoyam gave significantly higher plant height at harvest than any other treatment. Intercropped cocoyam with ICPL 187-1 produced the lowest plant height of cocoyam at harvest (Table 6).

Number of Cormels per Plant

Cocoyam intercropping with pigeonpea varieties had significant ($P \leq 0.05$) effect on the number of cormels per plant of cocoyam. Row intercropping significantly depressed number of cormels per plant. Intercropping cocoyam with 'Igbongbo' gave higher number of cormels per plant but this was only significantly different from intercropping cocoyam with ICPL 187-1 (Table 6).

Number of Corms per Plant

The number of corms per plant as influenced by intercropping with pigeonpea varieties was significant ($P \leq 0.05$). Sole cocoyam produced the highest number of corms per plant (1.87) but this was only significantly higher than that produced when cocoyam was intercropped with ICPL 187-1 (1.43) and 'Igbongbo' (1.17) respectively (Table 6).

Table 1: Physical and chemical properties of the surface soil at the experimental site in 2012 and 2013.

Parameters	Value	
	2012	2013
Sand (%)	73.20	73.40
Silt (%)	11.30	12.00
Clay (%)	15.50	14.60
Textural class	Sandy loam	Sandy loam
pH (H_2O)	6.23	6.11
Organic Carbon (%)	0.85	0.76
Organic Matter (%)	1.23	1.31
Total Nitrogen (%)	0.63	0.73
Available Phosphorus (ppm)	3.77	3.43
Cal^{2+} Cmol kg^{-1} soil)	4.32	3.41
Mg^{2+} (Cmol kg^{-1} soil)	2.24	2.23
K^{+}Cmol kg^{-1} soil)	0.30	0.29
Na^{+}Cmol kg^{-1} soil)	0.57	0.60
CEC Cmol kg^{-1} soil)	6.11	6.45
Base Saturation (%)	96.40	95.40

Table 2: Effect of Cropping Systems and Pigeonpea Varieties on the Plant Height at Harvest, Number of Leaves at Harvest, Number of Primary Branches at Harvest, Pod Bearing Length and Leaf Litter of Pigeonpea in Makurdi

Treatment	Plant Height at Harvest (m)	Number of Leaves at Harvest	Number of Primary Branches at Harvest	Pod Bearing Length (m)	Leaf Litter (t/ha)
Cropping Systems					
Row Intercropping	3.57	921.15	18.05	2.77	3.09
Sole Cropping	3.46	883.85	16.17	2.64	2.67
F-LSD (0.05)	0.05	10.78	1.39	0.03	0.13
Pigeonpea Varieties					
ICPL 187-1	3.05	1931.89	16.75	2.60	2.71
ICPL 87119	3.35	408.41	19.08	2.93	2.95
'Igbongbo'	4.15	367.20	15.50	2.60	2.99
F-LSD (0.05)	0.06	13.20	1.70	0.04	0.16

Table 3: Effect of Cropping Systems x Pigeonpea Varieties on the Plant Height at Harvest, Number of Leaves at Harvest, Number of Primary Branches at Harvest, Pod Bearing Length and Leaf Litter of Pigeonpea in Makurdi

Cropping Systems	Pigeonpea Varieties	Plant Height at Harvest (m)	Number of Leaves at Harvest	Number of Primary Branches at Harvest	Pod Bearing Length (m)	Leaf Litter (t/ha)
Row Intercropping	**ICPL 187-1**	3.08	1966.73	17.83	2.74	2.90
	ICPL 87119	3.45	416.38	20.33	2.92	3.21
	'Igbongbo'	4.19	380.34	16.00	2.65	3.16
Sole Cropping	**ICPL 187-1**	3.01	1897.05	15.67	2.45	2.51
	ICPL 87119	3.24	400.44	17.83	2.93	2.69
	'Igbongbo'	4.12	354.06	15.00	2.55	2.82
F-LSD (0.05)		0.08	18.66	1.41	0.06	0.23

Table 4: Pod Length, Number of Pods per Plant, Number of Seeds per Pod, Grain Yield and 100-Seed Weight of Pigeonpea as Influenced by Cropping Systems and Variety in Makurdi

Treatment	Pod Length (cm)	Number of Pods per Plant	Number Seeds per Pod	Grain Yield (t/ha)	100-Seed Weight (g)
Cropping Systems					
Row Intercropping	5.43	856.14	4.23	1.18	9.81
Sole Cropping	5.32	781.35	4.02	1.04	9.70
F-LSD (0.05)	NS	20.54	NS	0.04	NS
Pigeonpea Varieties					
ICPL 187-1	5.53	914.67	3.81	1.59	10.45
ICPL 87119	4.66	808.24	3.83	0.92	9.32
'Igbongbo'	5.94	733.34	4.74	0.84	9.51
F-LSD (0.05)	0.15	25.15	0.31	0.05	0.08

Key: NS: Not significant at 5% level of probability

Table 5: Effect of Cropping Systems x Pigeonpea Varieties on the Pod Length, Number of Pods per Plant, Number of Seeds per Pod, Grain Yield and 100-Seed Weight of Pigeonpea in Makurdi

Cropping Systems	Pigeonpea Varieties	Pod Length (cm)	Number of Pods per Plant	Number Seeds per Pod	Grain Yield (t/ha)	100-Seed Weight (g)
Intercropping	ICPL 187-1	5.54	967.14	3.99	1.61	10.33
	ICPL 87119	4.74	824.73	3.85	1.03	9.46
	'Igbongbo'	6.02	776.56	4.85	0.91	9.65
Sole Cropping	ICPL 187-1	5.52	862.19	3.62	1.56	10.57
	ICPL 87119	4.58	791.74	3.80	0.81	9.17
	'Igbongbo'	5.86	690.12	4.63	0.76	9.36
F-LSD (0.05)		0.17	35.57	0.30	0.04	0.11

Table 6: Yield and Yield Components of Cocoyam as Influenced by Intercropping with Pigeonpea Varieties in Makurdi

Treatment	Plant Height at Harvest (m)	Number of Cormels per Plant	Number of Corms per Plant	Cormel Length (cm)	Corm Length (cm)	Cormel Weight (t/ha)	Corm Weight (t/ha)
ICPL 187-1 + Cocoyam	1.28	3.67	1.43	20.83	19.94	2.93	2.85
ICPL 87119 + Cocoyam	1.43	8.00	1.50	19.92	20.25	3.70	3.62
'Igbongbo'+ Cocoyam	1.41	10.00	1.17	17.71	19.75	4.07	3.98
Intercrop Mean	**1.37**	**7.22**	**1.37**	**19.49**	**19.98**	**3.57**	**3.48**
Sole Cocoyam	1.54	16.33	1.87	22.04	23.42	7.45	5.06
Grand Mean	1.42	9.50	1.49	20.13	20.84	4.54	3.88
F-LSD (0.05)	0.09	4.86	0.42	1.56	2.78	2.49	1.14

Table 7: : Land Equivalent Ratio (LER), Land Equivalent Coefficient (LEC) and Competitive Ratio (CR) of Intercropped Pigeonpea with Cocoyam in Makurdi

Treatment	LER	LEC	CR (Pigeonpea)	CR (Cocoyam)
ICPL 187-1 + Cocoyam	1.43	0.41	2.62	0.38
ICPL 87119 + Cocoyam	1.77	0.63	2.56	0.39
'Igbongbo' + Cocoyam	1.74	0.65	2.19	0.46
Intercrop Mean	1.65	0.56	2.46	0.41
F-LSD (0.05)	0.21	0.18	0.14	0.11

Cormel Length

Pigeonpea/cocoyam intercropping had significant (P≤ 0.05) effect on the cormel length of cocoyam. Among the treatments evaluated, sole cocoyam produced the highest cormel length (22.04cm) of cocoyam and the difference was significant. The cormel length produced when cocoyam was intercropped with ICPL 187-1 and ICPL 87119 (20.83cm and 19.92cm) was statistically at par. Intercropped cocoyam with 'Igbongbo' gave the lowest cormel length of cocoyam (Table 6).

Corm Length

The corm length of cocoyam as influenced by intercropping with pigeonpea varieties was significant (P≤ 0.05). Data presented in Table 6 showed that sole cocoyam gave the highest corm length (23.42cm) and the difference was significant. The corm length produced when cocoyam was intercropped with ICPL 187-1, ICPL 87119 and 'Igbongbo' was statistically the same.

The effect of pigeonpea/cocoyam intercropping on the cormel weight of cocoyam was significant (P≤ 0.05). Intercropping depressed the cormel weight of cocoyam. Among the treatments intercropped, cocoyam intercropped with 'Igbongbo' gave the highest cormel weight (4.07t/ha) but this was not significantly different from that produced when cocoyam was intercropped with ICPL 187-1 (2.93t/ha) and ICPL 87119 (3.70t/ha) (Table 6).

Corm Weight

The corm weight of cocoyam as influenced by intercropping with pigeonpea varieties was significant (P≤ 0.05). Data presented in Table 6 revealed that sole cocoyam produced the highest corm weight (5.06t/ha) and this was significantly higher than that produced when cocoyam was intercropped with 'Igbongbo', ICPL 87119 and ICPL 187-1 respectively (3.98, 3.62 and 2.85t/ha respectively).

Assessment of Measures of Intercrop Productivity

All intercrop combinations had LER figures above 1.0 and LEC values above 0.25. The combinations of cocoyam with ICPL 87119 had higher values of LER while the combinations of cocoyam with 'Igbongbo' had higher LEC values. CR values of pigeonpea were consistently higher than those of cocoyam in all intercrop combinations (Table 7).

DISCUSSION

Pigeonpea Component

Pigeonpea was taller than the cocoyam component at harvest implying that it shaded the cocoyam. Pigeonpea is known to grow reaching a height of up to 4m or more at harvesting, depending on the variety (Egbe, 2005; Valenzuela and Smith, 2002), but cocoyam plant is only capable of growing up to 2 m in good growth environment (Uguru, 1996). Pigeonpea and cocoyam plant heights at harvest were a maximum of 4.19m and 1.54m, respectively in this study. Though shaded by the pigeonpea component, cocoyam is tolerant to shading (Quayeet al., 2010; Ogunniyi, 2008). Row intercropping increased the plant height, number of leaves and primary branches at harvest, pod-bearing length, leaf litter, number of pods per plant and grain yield of pigeonpea. These increases might be due to the ability of the component crop to exploit different soil layers without competing with each other. Pigeonpea and cocoyam have different morphological features that make them compatible. Pigeonpea is known to have robust and deep rooting system which exploits deep and wide soil horizons for nutrient and water while cocoyam is known to be shallow-rooted. Better use of resources such as light, nutrients and water has been reported by some researchers (Willey, 1990; Ghanbari and Lee, 2003; Gustavo et al., 2008). The soil cover provided by the broad cocoyam leaves could also have ameliorated the rate of water loss by evaporation and temperature effects, thereby conserving water for pigeonpea growth and yield especially in times of water stress during the early dry season when grain filling was taking place in pigeonpea (Egbeet al., 2015).Ogindo and Walker (2005) also reported that intercropping conserves water. IntercroppedICPL 187-1 with cocoyam produced higher grain yield probably because it had higher number of leaves,number of pods per plant and 100-seed weight.Musaana and Nahdy (1998) and Vange and Egbe (2009) found high and positive correlations between seed yield of pigeonpea and other yield components such as number of pods per plant and 100-seed weight. ICPL187-1 may be a choice variety if the target of production by the farmer is grain yield. "Igbongbo" (local pigeonpea), produced the lowest number of leaves at harvest, number of primary branches at harvest, number of pods per plantand grain yield, but it had the highest plant height, leaf litter, pod length and number of seeds per pod. The superior stem girth (data not shown) and height of the local pigeonpea as observed in this study may have endeared it over the years to the subsistent farmers in Southern Guinea Savanna of Nigeria. The robust and tall plants of this variety serve as fuel wood after seeds have been harvested from them. The local pigeonpea may also have been retained in the cropping systems of the farmers in Southern Guinea Savanna of Nigeria because of its ability to improve soil organic matter, soil structure and fertility through its high leaf litter and ability to fix atmospheric nitrogen. Egbe (2007) had reported that "Igbongbo" (the local pigeonpea) produced profuse leaf litter and fixed as much as 99 kg/ha of nitrogen when intercropped with sorghum in Otobi, Benue State,Nigeria.

Cocoyam Component

The reductions observed in the plant height at harvest, number of cormels and corms per plant, cormel and corm length and cormel and corm weight of cocoyam intercropped with pigeonpea varieties might be associated with inter-specific competition between the intercrop components for growth resources such as light, water, nutrients, air, etc. and the depressive effects of pigeonpea. The taller pigeonpea component shaded the low canopy cocoyam, thus reducing light availability for optimum photosynthetic activity and subsequently culminating in the low growth and yields of cocoyam. Molatudi and Mariga (2012) and Egbe and Idoko(2009) made similar observations in legume/cereal intercropping and legume/root crop intercropping respectively. When component legume is taller than non-legume, the legume can grow well due to high photosynthetic and high biological nitrogen fixation activities with adequate solar radiation and that the non-legume growth is severely affected due to reduction in photosynthetic activities through decreases in irradiance (Fujita and Ofosu-Budu, 1996).

Intercrop productivity

Land equivalent ratio (LER) values were above 1.0 in all intercrop combinations signifying intercropping advantages for all treatments. Similarly, LEC figures were above 0.25, further indicating the yield advantage of intercropping pigeonpea varieties with cocoyam. These results indicate that more land would be saved if both crops were intercropped than when the crops were grown separately under sole systems. Other authors have also confirmed higher land productivity in legume/tuber crop intercropping systems (Egbe and Idoko, 2009; Egbeet al., 2015). Complementarity in the pigeonpea/cocoyam intercropping may have been derived from the differences in the rooting systems of the component crops. These differences may have resulted in a fuller exploration of the whole soil profile by component crops than can be achieved by separate sole crops. Willey (1996) had indicated that complementarity in intercropping could be achieved when shallow-rooted crops and deep-rooting are combined. Pigeonpea produced higher CR figures than cocoyam indicating its superior competitive ability underground when compared to cocoyam. Pigeonpea has a more robust and deep rooting system than cocoyam, implying that it might become a strong competitor for nutrients in the soil when intercropped.

CONCLUSION

The results of this field study showed that it is advantageous to intercrop pigeonpea varieties with the local cocoyam cultivar (Ikiko). This is associated with a greater total intercrop yield, high land equivalent ratio greater than 1.0 and high land equivalent ratio greater than 0.25.

Disclosure statement: No potential conflict of interest was reported by the author.

Financial and proprietary interest: Nil

Financial support: Nil

REFERENCES

1. Adetiloye, P.O., Ezedinma, F.O.C. and Okigbo, B.N. (1987). A land coefficient concept for evaluation of competitive and productive interactions on simple complex mixtures, Ecological Modelling, 19 27-39.
2. Anders, M.M.,Potdar, M.V. and Francis, C.A. (1996). Significance of intercropping in cropping systems, in: O. Ito, K. Katayama, C. Johansen, J.V.D.K. Kumar-Rao, J.J. Adu-Gyamfi, T.J. Rego(Eds), Roots and Nitrogen in cropping systems of the semi-arid tropics, JIRCAS, Ohwashi, Ibaraki, Japan,pp1-18.
3. Benue State Agricultural and Rural Development Authority (BNARDA) (2000). Agricultural production recommendation for Benue State (Extension Bulletin No 3) Benue State Agricultural and Rural Development Authority, Makurdi, Nigeria, pp. 76.
4. Benue State Agricultural and Rural Development Authority,BNARDA. (2003) "Annual Report of Benue State Agricultural and Rural Development Authority", 2003. Makurdi ,Nigeria. pp.1-21.
5. Egbe, O.M. and Kalu, B.A. (2006). Farming systems study: Participatory Rural Appraisal of Pigeonpea Cropping Systems in Southern Guinea Savanna of Nigeria. Abia State University Environment Review (ASUER), 5(1) 37-39.
6. Egbe, O.M. andKalu, B.A. (2009).Evaluation of pigeonpea genotypes for intercropping with tall sorghum in Southern Guinea Savannah of Nigeria, ARPN Journal of Agricultural and Biological Science, 4(4) 54-55.
7. Egbe,O.M.,Alibo,S.E. andNwaeze,I. (2010).Evaluation of some extra- early- and early-maturing cowpea varieties for intercropping with maize in Southern Guinea Savanna of Nigeria, Agricultural and Biology Journal of North America 1 (5)845-858.
8. Egbe,O.M andIdoko,J.A. (2009)Agronomic assessment of some sweet potato varieties for intercropping with pigeonpea in Southern Guinea Savannah of Nigeria, ARPN Journal of Agricultural and Biological Science, 4(4) 23-32.
9. Egbe,O.M.,Idoko,J.A. andAkaazua,B.W. (2015).Productivity of tannia cocoyam varieties + pigeonpea intercropping in Southern Guinea Savanna of Nigeria. ARPN Journal of Agricultural and Biological Science, 10 (6) 235-240.
10. Egbe,O.M. (2005). Evaluation of agronomic potentials of some pigeonpea genotypes for intercropping with maize and sorghum in Southern Guinea Savanna of Nigeria,Ph.D thesis, University of Agriculture, Makurdi, Nigeria.
11. Egbe, O.M. (2007). Assessment of biological Nitrogen fixing potentials of pigeonpea genotypes intercropped with sorghum for soil fertility improvement in Southern Guinea Savanna of Nigeria, Agro-Science, 6(1) 33-45.
12. Eze, C.C. and Okorji, E.C (2003). Cocoyam production by women farmers under improved and local technologies in Imo State. Nigeria Journal of Science, 5(1) 113-116.
13.Fujita, K. and Ofosu-Budu, K.G (1996). Significance of legumes in intercropping systems, in: O. Ito, K. Katayama, C. Johansen, J.V.D.K. Kumar-Rao, J.J. Adu-Gyamfi, T.J. Rego (Eds.) Roots and Nitrogen in cropping systems of the semi-arid tropics, JIRCAS, Ohwashi,Tsuskuba 19-40.

14. Ghanbari, A. andLee, H.C. (2003). Intercropped wheat (Triticumaestivum.) and bean (Vicia faba.) as whole-crop forage: Effect of harvest time on forage yield and quality, Grass Forage Sci. 1 28-36.
15. Gustavo, N.M., Jean, F., Ois, L. and Xavier, D. (2008). Shoot and root competition in potato/maize intercropping: Effects on growth and yield. Environ. Exp. Bot. 64 180-188.
16. Kowal, J.M. andKnabe, D.T. (1972)Anagroclimatological atlas of the northern states of Nigeria with explanatory notes,Ahmadu Bello University Press, Zaria.
17. Molatudi, R.L. and Mariga, I.K. (2012). Grain yield and biomass response of a maize/dry bean intercrop tomaize density and dry bean variety, African Journal of Agricultural Research, 7(20) 3139-3146.
18. Moyin–Jesu, E.I.(2008).Use of pigeonpea (Cajanuscajan L.) as soil amendment for the growth, leaf chemical composition and yield of white yam (Dioscorearotundata L.), Continental Journal of Agricultural Science, 2 6 – 17.
19. Musaana, M.S. and Nahdy, M.S. (1998). Path coefficient analysis of yield and yield components in pigeonpea, African Crop Science Journal, 6(2) 143-148.
20. Ofori, F. and Stern, W.R. (1987). Cereal –legume intercropping systems. Advances in Agronomy, 41 41-90.
21. Ogindo, H.O. and Walker, S. (2005). Comparison of measured changes in seasonal and water control by rained maize-bean intercrop and component cropping in semi arid region, South Phy. Chem. Earth, 30 799-808.
22. Ogunniyi, L.T. (2008). Profit efficiency among cocoyam producers in Osun State, Nigeria, International Journal of Agricultural Economics and Rural Development, 1(1) 38-41.
23. Quaye, W., Adofo, K.,Agyeman, K.O. and Nimoh. F. (2010).Socio-economic survey of traditional commercial production of cocoyam and cocoyam leaf, African Journal of Food, Agriculture, Nutrition and Development, 10(9) 4060-4078.
24. Remanandan, P. and Asiegbu, J.E. (1993). Pigeonpeagermplasm collection in Nigeria ICRISAT Genetic resources report No. 79 ICRISAT, Patancheru, India, pp. 4
25. Ugbajah, M.O. andUzuegbuna, C.O. (2012). Causative factors of decline in cocoyam production in Ezeagu Local Government Area of Enugu State: Implications for sustainable food security, Journal of Agriculture and Veterinary Sciences, 4 35-36.
26. Udealor, A.,Nwadukwe, P.O. andOkoronya, J.A. (1996). Management of crop production crops and cropping systems, in: S.O. OdurukweA. Udealor (Eds), Diagnostic survey of farming system of Onitsha zone of Anambra State, Agricultural Development Project, National Root Crop Research Institute, Umudike, pp.33-52.
27. Uguru,M.I. (1996).Crop Production: Tools, techniques and practice,Nsukka: Fulladu Publishing Company.
28. Vange, T. andEgbe, O.M. (2009). Studies on Genetic Characteristics of Pigeon Pea Germplasm at Otobi, Benue State of Nigeria. World Journal of Agricultural Sciences, 5(6) 714-715.
29. Valenzuela, H. Smith, J. (2002).Pigeonpea. Sustainable Agriculture Green Manure Crops, Aug, SA-GM-8.
30. Willey, R.W. and Rao, M.R. (1980). Natarajan, Traditional cropping systems with pigeonpea and their improvement, in: Proceedings of the International Workshop on Pigeonpeas, 15 - 19 December 1980, ICRISAT Center, Patancheru, India, pp. 11-25.
31. Willey,R.W. (1990).Resource use in intercropping systems. Agric. Water Manage, 17 215-231.
32. Willey,R.W. (1996). Intercropping in cropping systems: Major issues and research needs, in: O. Ito, K. Katayama, C. Johansen, J.V.D.K. Kumar-Rao, J.J. Adu-Gyamfi, T.J. Rego(Eds.), Roots and Nitrogen in cropping systems of the semi-arid tropics, JIRCAS,Ohwashi, Tsuskuba, Ibaraki,Japan, pp. 93-102.