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Productivity of Cassava-Sweet Potato Intercropping System as Influenced by Varying Lengths of Cassava Cutting at Makurdi, Nigeria

Michael Ojore Ijoyah[1*] Richard Isa Bwala[2] Churchline Amaka Iheadindueme[1]
1.Department of Crop Production, University of Agriculture, P.M.B. 2373, Makurdi, Nigeria
2. Department of Crop Protection, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria
[*] E-mail of the corresponding author: mikejoy2005@yahoo.com

Abstract
Field experiments were conducted from April to December, 2009 and 2010 cropping seasons, at the Research Farm, University of Agriculture, Makurdi, Nigeria, to evaluate the productivity of cassava-sweet potato intercropping system, as influenced by varying lengths of cassava cutting and to assess the advantage of the intercropping system. The trial consisted of five treatments, replicated four times in a randomized complete block design. Three of the treatments consisted of cassava cuttings sown at varied lengths of 20 cm, 30 cm and 40 cm into sweet potato plots. Monocropped sweet potato and cassava, respectively sown at their recommended stem cutting lengths of 20 cm and 25 cm constituted the fourth and fifth treatments, which also served as control plots. Results obtained showed that the greatest intercrop yields of cassava and sweet potato were obtained when cassava cutting length of 30 cm was planted in the mixture. Although the lowest competitive pressure was recorded for cassava cutting length of 20 cm sown into sweet potato plots, however, intercropping sweet potato with cassava at cutting length of 30 cm gave the highest land equivalent ratio (LER) value of 2.15 in years 2009 and 2010, indicating that greatest productivity per unit area was achieved by growing the two crops together than by growing them separately. With this LER value, 53.5 % of land was saved in years 2009 and 2010, which could be used for other agricultural purposes. Both crops were found to be highly complementary and most suitable in mixture when 30 cm cassava cutting length was used. The implication of study showed that to maximize intercrop yields of cassava and sweet potato, the optimal cassava cutting length is 30 cm. This should therefore be recommended for Makurdi location, Nigeria.
Keywords: Intercropping, cutting length, cassava, sweet potato

1. Introduction

Cassava (*Manihot esculenta* L. Crantz) originated from Central and Southern America and has since then spread to various parts of the world (FAO Report, 2001). It is a perennial woody shrub with an edible root (IITA, 2002). It's systemic cultivation became generally accepted and integrated into the farming system in Nigeria and based on the area cropped and quantity produced, cassava was the country's most important root crop (Akparaobi *et al*., 2007). The tuber flesh is composed of about 62 % water, 35 % carbohydrate, 1-2 % protein, 0.3 % fat, 1-2 % fibre and 1 % mineral matter (Cock, 2001). The leaves have also been found to contain about 17 % protein and therefore a good source of protein in the diet of man and most ruminant animals (Elfick, 1998).
Sweet potato (*Ipomoea batata* L. Lam) is a perennial root crop belonging to the family Convolvulaceae (Cuminging *et al*., 2009). In Nigeria, among the root and tuber crops, sweet potato ranked third in production area, following cassava and yam (Anyaebunam *et al*., 2008). The crop is used as food for humans and domestic animals while in the industries, it is used to brew alcoholic beverages (Cuminging *et al*., 2009).
As a rule, cassava tubers are reproduced by stem cuttings, therefore, the cutting is of fundamental importance for obtaining greater yield in any productive system (Anselmo *et al*., 2000). A number of studies have been carried out on monocropped cassava as influenced by varying lengths of cassava cuttings (Ratanwaraha *et al*., 2000; Akparaobi *et al*., 2007; Eze, 2010), however these studies did not reveal the optimal cutting length of cassava, particularly in a cassava-sweet potato mixture. The experiment therefore aimed at evaluating the productivity of intercropped cassava-sweet potato as influenced by varying lengths of cassava cutting with the objective of identifying the optimal cutting length that will maximize the yields of both crops in mixture.

2. Materials and Methods

2.1 Site Description and Variety of Crops:

The experiments were conducted from April to December, 2009 and 2010 cropping seasons at the Research Farm of the University of Agriculture, Makurdi, Nigeria, to evaluate the productivity of cassava and sweet potato intercropping system as influenced by varying lengths of cassava cutting.

The study location (7^0 46/N, 8^0 42/E) and at an altitude of 228 m above sea level falls within the Southern Guinea Savanna agroecological zone of Nigeria. The variety of cassava used was 'TMS 14(2)1425', while that of sweet potato was 'TIS 2535-OP-1-13'. The variety of both crops were obtained from the National Root Crop Research Institute (NRCRI), Umudike, Nigeria. They are high yielding and shows wide adaptation to different environment.

2.2 Experimental Area, Design and Treatments

The experimental area (385.0 m2) which consisted of sandy-loam soil was ploughed, harrowed, ridged and divided into 20 plots. Each plot had an area of 16 m^2. The plot consisted of four ridges spaced 1 m apart. The trial area consisted of five treatments, replicated four times in a randomized complete block design. Three of the treatment consisted of cassava cutting sown at varying lengths of 20 cm, 30 cm and 40 cm into sweet potato plots. Sole sweet potato and sole cassava, respectively sown at their recommended cutting lengths of 20 cm and 25 cm (Ijoyah and Jimba, 2011; Echoi, 2011) constituted the fourth and fifth treatments, which also served as control plots.

2.3 Planting

In the intercrop, cassava was planted in a single row on top of the ridge, at an intra-row spacing of 1 m. Sweet potato vine cuttings measuring 20 cm with 4 nodes were cut for planting. One third (1/3) to two-thirds (2/3) of the cutting was buried in a single row on top of each ridge but in-between the cassava stands, at a spacing of 1 m x 0.5m (Ijoyah and Jimba, 2011). Each ridge had four cassava stands, given a total of 16 plants per plot (10,000 plants per hectare equivalent). Sweet potato had eight stands per ridge, giving a total of 32 plants per plot (20,000 plants per hectare equivalent). Under intercropping, the component crops were planted at their maximum plant population densities.

2.4 Cultural Practices

The recommended rate of mixed fertilizer (NPK) for sole sweet potato: 45 Kg N ha^{-1}, 15 Kg P ha^{-1} and 40 Kg K ha^{-1}; sole cassava: mixed fertilizer NPK (20-10-10) at the rate of 100 Kg ha^{-1} and for cassava-sweet potato mixture: 120 Kg N ha^{-1}, 120 Kg P ha^{-1} and 120 Kg K ha^{-1} was applied (Enwezor *et al*., 1989). The band method of fertilizer application was employed. The fertilizer was applied twice to each plot, at 4 and 8 weeks after planting (WAP) for the soles and intercrop. Weeding was done as the need arose.

Harvesting of sweet potato and cassava were respectively done at 16 and 32 WAP, when the leaves were observed to dry, turn yellowish and fallen off, which were signs of senescence and tuber maturity (Ijoyah and Jimba, 2011).

2.5 Data Collection

Data taken for cassava included days to 50 % sprouting and establishment, plant height, number of branches per plant, number of leaves per plant and leaf area taken at 16 WAP. Others are number of cassava tubers per plant, tuber length, tuber diameter, tuber weight and yield (t ha^{-1}).

Data taken for sweet potato included days to 50 % sprouting and establishment, vine length, number of leaves per plant, leaf area at 50 % flowering, number of tubers per plant and tuber yield (t ha^{-1}).

2.6 Statistical Analysis

All data were statistically treated using the Analysis of variance (ANOVA) for randomized complete block design and the Least Significant Difference (LSD) was used for mean separation ($P \leq 0.05$) following the procedure of Steel and Torrie (1980). The land equivalent ratio (LER), competitive ratio and percentage land saved as described by (Willey, 1985; Willey and Rao, 1980) were used to assess the advantage of the intercropping system.

3. Results and Discussion

3.1 Productivity of Cassava

The productivity of cassava in a cassava-sweet potato intercropping system as influenced by varying lengths of cassava cutting is given in Table 1.

Intercropping prolonged days to 50 % sprouting and establishment. Under intercropping, days to attain 50 % sprouting and establishment decreased as cutting length increased. This result agreed with the findings of Anselmo *et al*., (2000) who reported a decrease in days to establishment with increase in cutting length. The shorter cutting length have fewer number of nodes and could be more susceptible to rapid dehydration as a result of the low level of carbohydrate reserve, thus, prolonging days to establishment.

Under intercropping, for both years, plant height of cassava was higher than that produced from monocropped cassava. The highest plant height, number of branches per plant and number of leaves per plant were produced from cassava cutting length of 30 cm sown into sweet potato plots (Table 1). Longer cutting length of 30 cm could be expected to have greater number of nodes, thus, producing more branches with more vegetative growth. This view agreed with Onwueme (1978) but contradict that of Leihner (1983) who observed that longer cuttings (30-40 cm) produced lower number of branches and consequently less vegetative growth. The reason for contradiction in result might be due to differences in genetic potential of the cassava variety used and differences in the environment of the study locations. The number of branches per plant and number of leaves per plant at 16 WAP produced from cassava cutting of 30 cm and those obtained when cutting length of 40 cm was planted into sweet potato plots were not significantly ($P \leq 0.05$) different.

Although, number of cassava tubers per plant was not significantly ($P \leq 0.05$) affected by the different cutting lengths planted in the sweet potato plots, however, greatest tuber weight and best yield of cassava were obtained from cutting length of 30 cm sown into sweet potato plots. The greatest number of branches and vegetative growth produced from the cutting length of 30 cm could have also influenced its greatest tuber weight and yield. This view agreed with that of Ekanyake *et al*., (1997). Under intercropping with sweet potato, cassava yield obtained from cutting length of 30 cm and that obtained from cutting length of 40 cm showed no significant ($P \leq 0.05$) difference.

3.2 Productivity of Sweet Potato

The productivity of sweet potato in a cassava-sweet potato intercropping system as influenced by varying lengths of cassava cutting is given in Table 2. Although, days to 50 % sprouting and establishment, vine length and number of sweet potato leaves per plant were not significantly ($P \leq 0.05$) affected varying the lengths of cassava cutting, however, leaf area of intercropped sweet potato progressively decreased as cassava cutting length increased (Table 2). This view agreed with Silwana and Lucas (2002) who reported that intercropping reduced vegetative growth of component crops.

The number of tubers and yield of intercropped sweet potato were significantly ($P \leq 0.05$) reduced when cassava cutting was sown at varied lengths as compared to those obtained from monocropped sweet potato (Table 2). This could be due to inter-specific competition of the component crops and depressive effect of the intercropped cassava. Higher yield in sole over intercropped plants had been reported by Olufajo (1992), Muneer *et al*., (2004) and Ijoyah (2011).

3.3 Assessing Intercropping Advantages

In both years, the greatest intercrop yields of cassava and sweet potato were obtained when cassava cutting length of 30 cm was planted in the mixture (Table 3). The land equivalent ratio (LER) values were all above 1.00. This could be due to greater efficiency of resource utilization in intercropping. Intercropping sweet potato with cassava at cutting length of 30 cm gave the highest LER value of 2.15 in years 2009 and 2010, indicating that greatest productivity per unit area was achieved by growing the two crops together than by growing them separately. With this LER value obtained, 53.5 % of land was saved in years 2009 and 2010, which could be used for other agricultural purposes. The competitive pressure was lowest when cassava cutting length of 20 cm was sown into sweet potato plots.

4. Conclusion

From the results obtained, it can be concluded that the greatest intercrop yields of cassava and sweet potato were obtained when cassava cutting length of 30 cm was planted in the mixture. Both crops were found to be highly complementary and most suitable in mixture when 30 cm cassava cutting length was used. This is associated with the highest land equivalent ratio values and greatest percentage of land saved. It is however, recommended that further investigation be done to evaluate a wider range of cassava and sweet potato varieties in mixture and across different locations within the Guinea savannah agroecological zone of Nigeria.

References

Akparaobi, S.O.; Okonmah, L.U. & Londu, E.M. (2007). Comparing cassava yield in Wetland and Dryland zones of Nigeria. *Middle East Journal of Scientific Research*, 2(3-4): 120-132.

Anselmo, E.S.V.; Tocco, S. & Valterly, S.R. (2000). Effects of length in stem cutting and its planting position on cassava yield. *Acta Scientiarum*, 22(4): 1011-1015.

Anyaebunam, H.N.; Aswugba, G.N. & Nwosu, K.L. (2008). Guide to improved sweet potato production in Nigeria. *Extension Guide*, 2: 1-2

Cock, J.H. (2001). *Stability of performance of cassava genotypes in cassava breeding*: Proceedings workshop held in Phillipines, 4-7: 100-106.

Cuminging, J.H.; Beatly, E.R. & Englyst, H.N. (2009). Physiological properties of improved sweet potato varieties. *Journal of Nutrition*, 75: 733-737.

Echoi, E.E. (2011). Yield effects of cassava (*Manihot esculenta*, L. Crantz) as affected by different stem cutting lengths in Makurdi, Nigeria. B.Sc Project, Department of Crop Production, University of Agriculture, Makurdi, Benue State, Nigeria.

Ekanyake, I.J.; Osiru, D.S.O. & Porto, M.C.M. (1997). *Physiology of cassava.* IITA Research Guide 55 Training Programme, 3rd edition, pp. 22.

Elfick, J. (1998). *School Science lesion.* Cassava Project, School of Education, University of Deensland, Brisbane, Australia, pp. 45.

Enwezor, W.O.E.; Udo, J. & Ajotade, K.A. (1989). *Fertilizer procurement and Distribution*. Fertilizer use and management practice for crops in Nigeria. Savenda Publishers, Nsukka, Nigeria, pp. 25-28.

Eze, S.C. (2010). Evaluation of different stem portions of cassava (*Manihot esculenta* L. Crantz) in the management of its establishment and yield. *Research Journal of Agricultural and Biological Sciences*, 6(2): 181-185.

FAO Report (2001). *Food and Agricultural Organizature Report 2001*. Production Crops: Primary and Domain, pp. 35.

I.I.T.A. (2002). *International Institute of Tropical Agriculture Report 2002*. Integrated Cassava Project. www.uta.org.

Ijoyah, M.O. (2011). Yield effects of intercropping white Guinea yam (*Dioscoreae rotundata* P.) minisetts and maize (*Zea mays* L.) in the Southern Guinea savanna of Nigeria. *African Journal of Agricultural Research*, 6(23): 5227-5237.

Ijoyah, M.O. & Jimba, J. (2011). Effects of planting methods, planting dates and intercropping systems on sweet potato-okra yields in Makurdi, Nigeria. *Agricultural Research Journal*, 1(8): 184-190.

Leihner, D.E. (1983). *Current Practices in the production of cassava planting material*.
Programme of a regional workshop, Cali, Colombia 13-16 September, 1983, pp. 41.

Muneer, A.P.; Fida, H.M.; Mumtaz, A.K. & Muhammad, I.S. (2004). Performance of maize in intercropping system with soybean under different patterns and nitrogen levels. *Journal of Applied Sciences*, 4(2): 201-205.

Olufajo, O.O. (1992). Response of soybean to intercropping with maize in a sub-humid tropical environment. *Tropical Oil Seeds Journal*, 1: 27-33.

Onwueme, I.C. (1978). *The tropical tuber crops: yam, cassava, sweet potato and cocoyam.* John Wiley, Chichester, New York, pp.234.

Ratanwaraha, C.; Senanarong, N. & Suriyapan, P. (2000). *Status of cassava in Thailand*: Implication for future Research and Development. Department of Agriculture (DOA), Bangkok, Thailand, 26-28, April, 2000.

Silwana, T.T. & Lucas, E.O. (2002). The effect of planting combinations, weeding and yield of component crops of maize-bean and maize-pumpkin intercrops: *Journal of Agricultural Science*, 138: 193-200.

Steel, R.G.D. & Torrie, J.H. (1980). *Principles and Procedures of Statistics*. A Biometrical Approach, 2nd edition, McGraw Hill, New York, 633pp.

Willey, R.W. (1985). Evaluation and Presentation of intercropping advantages. *Expl. Agric*. 21: 119-133.

Willey, R.W. and Rao, M.R. (1980). A competitive ratio for quantifying competition between intercrops. *Expl. Agric*. 16: 117-125.

Dr. Ijoyah, Michael Ojore was born on 22nd April, 1963 in Ikeja, Lagos State, Nigeria. He holds an M.Sc degree (1988) in agronomy from the University of Agriculture, Havana, Cuba and a Ph.D degree in farming system obtained in 2002 from the University of Agriculture, Makurdi, Benue State, Nigeria, where he currently teach as a Senior Lecturer in the Department of Crop Production. He is presently the Head, Department of Crop Production, University of Agriculture, Makurdi, Benue State, Nigeria.

Mr. Bwala, Richard Isa was born on 24th November, 1974 in Maiduguri, Borno State, Nigeria. He holds a B.Sc degree (1997) and M.Sc degree (2005) in plant protection, obtained from the University of Maiduguri, Borno State,

Nigeria, where he currently teach as a Lecturer II in the Department of Crop Protection. He is presently undergoing a Ph.D programme in plant pathology at the University of Agriculture, Makurdi, Benue State, Nigeria.

Mrs. Iheadindueme Churchline Amaka was born on 22nd September, 1966 in Makurdi, Benue State, Nigeria. She holds a National Diploma in crop production obtained in 1991 from the College of Agriculture, Igbarian, Anambra State, Nigeria, a Higher National Diploma in crop production obtained in 1995 from the Federal College of Agriculture, Umudike, Abia State, Nigeria and a Postgraduate Diploma in crop production, obtained in 2002 from the University of Agriculture, Makurdi, Benue State, Nigeria, where she currently works as Assistant Chief Technical Officer (field research) in the Department of Crop Production.

Table 1: Productivity of cassava in a cassava-sweet potato intercropping system as influenced by varying lengths of cassava cutting

Lengths of cassava cutting	Days to 50% sprouting		Days to 50% establishment		Plant height at 16 WAP (cm)		Number of branches per plant at 16 WAP		Number of leaves per plant at 16 WAP		Number of tubers per plant		Tuber weight (kg)		Cassava yield (tha^{-1})	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
SC (25 cm)	12.8	12.2	17.8	18.2	100.8	102.4	9.6	11.0	160.2	160.3	4.4	4.8	0.39	0.37	4.6	3.9
SP (C-20 cm)	13.9	13.7	18.6	18.5	110.6	112.0	12.4	14.6	164.3	170.0	4.0	4.3	0.37	0.34	4.3	3.8
SP (C-30 cm)	13.6	13.5	18.4	18.3	141.2	158.5	17.0	18.3	175.2	176.3	4.6	4.8	0.47	0.45	5.6	5.0
SP (C-40 cm)	13.0	13.3	18.1	18.2	138.0	146.2	16.6	17.8	173.5	174.2	4.4	4.5	0.45	0.43	5.4	4.8
Mean	13.3	13.2	18.2	18.3	122.7	129.8	13.9	15.4	168.3	170.2	4.4	4.6	0.42	0.40	5.0	4.4
LSD (P≤ 0.05)	0.2	0.5	0.4	0.2	7.5	15.0	0.8	3.0	5.2	4.0	ns	ns	0.03	0.05	0.6	0.4
Cv (%)	12.3	10.4	8.5	5.2	17.8	13.2	10.2	15.3	7.4	10.3	12.5	17.1	10.3	15.4	7.6	10.0

SC: Sole cassava planted at recommended cutting length of 25 cm

SP (C-20 cm) : 20 cm of cassava cutting length planted into sweet potato plot.

SP (C-30 cm) : 30 cm of cassava cutting length planted into sweet potato plot.

SP (C-40 cm) : 40 cm of cassava cutting length planted into sweet potato plot.

WAP: weeks after planting

Table 2: Productivity of sweet potato in a cassava-sweet potato intercropping system as influenced by varying lengths of cassava cutting

Lengths of cassava cutting	Days to 50% sprouting		Days to 50% establishment		Vine length (cm)		Number of leaves per plant		Leaf area at 50 % flowering		Number of tubers per plot		Sweet potato yield (tha^{-1})	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
SSP (20 cm)	7.6	7.0	14.8	15.0	155.3	152.7	32.3	30.3	72.4	74.5	30.3	33.2	14.5	15.2
SP (C-20 cm)	8.2	7.3	15.2	15.4	160.2	164.2	38.2	38.5	67.9	69.0	25.3	28.6	12.5	12.6
SP (C-30 cm)	7.9	7.5	15.0	15.2	158.0	158.2	36.3	37.3	65.6	64.2	28.5	29.8	13.6	13.2
SP (C-40 cm)	7.8	7.5	15.1	15.3	152.2	150.3	30.5	29.7	51.3	50.8	24.5	25.2	11.0	12.0
Mean	7.9	7.3	15.0	15.2	156.4	156.3	34.3	34.0	64.3	64.6	27.2	29.2	12.9	13.3
LSD (P≤ 0.05)	ns	ns	ns	ns	ns	ns	ns	ns	3.5	5.0	0.8	2.8	0.7	0.5
Cv (%)	15.3	10.2	5.7	8.8	12.6	17.3	14.2	10.3	17.8	12.3	7.2	5.3	7.8	10.4

SSP: Sole sweet potato planted at recommended vine length of 20 cm.

SP (C-20 cm) = 20 cm of cassava cutting length planted into sweet potato plot.

SP (C-30 cm) = 30 cm of cassava cutting length planted into sweet potato plot.

SP (C-40 cm) = 40 cm of cassava cutting length planted into sweet potato plot.

Lengths of cassava cutting	Sole Crop Yield (tha^{-1})				Intercrop Yield (tha^{-1})												% Land saved	
	Sole cassava		Sole sweet potato		Cassava		Sweet potato		Lc		Lsp		LER		CR			
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Soles	4.6	3.9	14.5	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SP (C-20 cm)	-	-	-	-	4.3	3.8	12.5	12.6	0.93	0.97	0.86	0.83	1.79	1.80	1.08	1.17	44.9	44.4
SP (C-30 cm)	-	-	-	-	5.6	5.0	13.6	13.2	1.21	1.28	0.94	0.87	2.15	2.15	1.29	1.47	53.5	53.5
SP (C-40 cm)	-	-	-	-	5.4	4.8	11.0	12.0	1.17	1.23	0.76	0.79	1.93	2.02	1.54	1.56	48.2	50.5

Soles: Sole cassava and sweet potato planted at recommended cutting and vine length of 25 and 20 cm respectively.

SP (C-20 cm) = 20 cm of cassava cutting length planted into sweet potato plot. SP (C-30 cm) = 30 cm of cassava cutting length planted into sweet

SP (C-40 cm) = 40 cm of cassava cutting length planted into sweet potato plot.

potato plot.

$$LER = \frac{\text{Intercrop yield of crop A}}{\text{Sole crop yield of Crop A}} + \frac{\text{Intercrop yield of crop}}{\text{Sole crop yield of Crop B}}$$

Lc, Lsp = Partial LER of component crops(cassava and sweet potato)

CR=Lc/Lsp (Division of the partial land equivalent ratios of the component crops). land saved= 100-1/LERx100