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

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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 (Anyabeunam 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° 46' N, 8° 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 m². 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≤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 length of 30 cm and those obtained when cutting length of 40 cm was planted into sweet potato plots were not significantly (P≤0.05) different.

Although, number of cassava tubers per plant was not significantly (P≤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≤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≤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≤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


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

<table>
<thead>
<tr>
<th>Lengths of cassava cutting</th>
<th>Days in 50% sprouting</th>
<th>Days in 50% establishment</th>
<th>Plant height at 16 WAP (cm)</th>
<th>Number of branches per plant at 16 WAP</th>
<th>Number of leaves per plant at 16 WAP</th>
<th>Number of tubers per plant</th>
<th>Tuber weight (kg)</th>
<th>Cassava yield (t/ha$^1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC (25 cm)</td>
<td>12.0</td>
<td>12.2</td>
<td>17.8</td>
<td>18.2</td>
<td>100.8</td>
<td>102.4</td>
<td>9.6</td>
<td>11.0</td>
</tr>
<tr>
<td>SP (C-20 cm)</td>
<td>13.9</td>
<td>13.7</td>
<td>13.6</td>
<td>13.5</td>
<td>110.6</td>
<td>112.0</td>
<td>12.4</td>
<td>14.6</td>
</tr>
<tr>
<td>SP (C-30 cm)</td>
<td>13.0</td>
<td>13.3</td>
<td>13.4</td>
<td>13.3</td>
<td>141.2</td>
<td>150.5</td>
<td>17.0</td>
<td>18.3</td>
</tr>
<tr>
<td>SP (C-40 cm)</td>
<td>13.0</td>
<td>13.3</td>
<td>13.1</td>
<td>13.2</td>
<td>138.0</td>
<td>146.2</td>
<td>16.6</td>
<td>17.8</td>
</tr>
<tr>
<td>Mean</td>
<td>13.3</td>
<td>13.2</td>
<td>13.2</td>
<td>13.3</td>
<td>122.7</td>
<td>129.0</td>
<td>13.9</td>
<td>15.4</td>
</tr>
<tr>
<td>LCD (P&lt; 0.05)</td>
<td>0.2</td>
<td>0.1</td>
<td>0.4</td>
<td>0.2</td>
<td>7.5</td>
<td>15.0</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>CV(%)</td>
<td>12.3</td>
<td>10.4</td>
<td>8.5</td>
<td>5.2</td>
<td>17.8</td>
<td>13.2</td>
<td>10.2</td>
<td>15.3</td>
</tr>
</tbody>
</table>

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
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.

<table>
<thead>
<tr>
<th>Lengths of cassava cutting</th>
<th>Days to 50%</th>
<th>Vine length (cm)</th>
<th>Number of leaves per plant</th>
<th>Leaf area at 50% flowering</th>
<th>Number of tubers per plot</th>
<th>Sweet potato yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sprouting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSP (20 cm)</td>
<td>7.6</td>
<td>7.0</td>
<td>14.8</td>
<td>15.0</td>
<td>155.3</td>
<td>152.7</td>
</tr>
<tr>
<td>SSP (C-20 cm)</td>
<td>6.2</td>
<td>7.3</td>
<td>15.2</td>
<td>15.4</td>
<td>169.1</td>
<td>164.1</td>
</tr>
<tr>
<td>SSP (C-30 cm)</td>
<td>7.9</td>
<td>7.5</td>
<td>15.0</td>
<td>15.2</td>
<td>158.0</td>
<td>151.1</td>
</tr>
<tr>
<td>SSP (C-40 cm)</td>
<td>7.6</td>
<td>7.7</td>
<td>15.1</td>
<td>15.3</td>
<td>152.2</td>
<td>150.3</td>
</tr>
<tr>
<td>Mean</td>
<td>7.9</td>
<td>7.3</td>
<td>15.0</td>
<td>15.2</td>
<td>159.4</td>
<td>156.3</td>
</tr>
<tr>
<td>LSD (P&lt; 0.05)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Co (%)</td>
<td>15.3</td>
<td>19.2</td>
<td>5.7</td>
<td>8.8</td>
<td>13.6</td>
<td>17.3</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Lengths of cassava cutting</th>
<th>Sole crop yield (t/ha)</th>
<th>Intercrop yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cassava</td>
<td>Sweet potato</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Soles</td>
<td>4.6</td>
<td>5.9</td>
</tr>
<tr>
<td>SP (C-20 cm)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP (C-30 cm)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP (C-40 cm)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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

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

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/LER x 100
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