African Crop Science Journal, Vol. 12. No. 2, pp. 115-122, 2004
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ISSN 1021-9730/2004 $ 4.00


# INFLUENCE OF CASSAVA PLANTING PATTERNS AND PRUNING METHODS ON CROP YIELD IN A CASSAVA-BASED CROPPING SYSTEM

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*(Received 26 October, 2002; accepted 3 December, 2003)*

## ABSTRACT

Field experiments were conducted at the University of Ibadan, Nigeria on the effect of cassava (*Manihot esculenta* Crantz) planting pattern and pruning methods on cassava yield and yield of associated crops, namely, maize (*Zea mays* L.), melon (*Colocynthis vulgaris* L.) and cowpea (*Vigna unguiculata*) in a cassava-based cropping system. Cassava planting patterns had significant effects on maize and melon yield in the 1995 but had no effects in 1996. Cowpea yield values under triangular planting pattern were 15 and 19% higher than regular planting pattern in 1995 and 1996, respectively. Its yield components differed only slightly under the two planting patterns. Number of cassava tubers and tuber weight plant$^{-1}$ were superior under triangular planting pattern to regular planting pattern. The overall yield of cassava was, however, higher under regular planting pattern than triangular planting. The least cowpea yield and yield components were recorded under unpruned cassava. Yield and yield components of cassava reduced when pruned irrespective of the type of pruning method.

*Key Words*: Cowpea, maize, *Manihot esculenta, Zea mays*

## RÉSUMÉ

Des expériences de champs étaient conduites à l'Université d'Ibadan-Nigeria sur les effets de la façon de planter et de l'élagage du manioc (*Manihot esculenta* Crantz) sur son rendement et le rendement des plantes associées, notamment, le maïs (*Zea mays* L.), le melon (*Colocynthis vulgaris* L.) et le niébé (*Vigna unguiculata*) dans un système de culture basé sur le manioc. La façon de planter le manioc avait un effet significatif sur le rendement du maïs et du melon en 1995 mais pas en 1996. Les valeurs du rendement du niébé en arrangement triangulaire étaient 15 et 19% plus élévées que celles obtenues par arrangement régulier en 1995 et 1996 ; respectivement. Les composantes du rendement diffèrent très légèrement sous les deux arrangements. Le nombre de tubes de manioc et le poids de tube par plante étaient supérieurs dans l'arrangement triangulaire par rapport à l'arrangement régulier. Le rendement du manioc était, cependant, élévé sous l'arrangement régulier par rapport à l'arrangement triangulaire. Le rendement le plus faible du niébé et des ses composantes étaient enregistrés sous le manioc dont l'élagage n'a pas été pratiqué. Le rendement et les composantes du rendement du manioc étaient réduits quand l'élagage était pratiqué.

*Mots Clés*: Niébé, maïs, *Manihot esculenta, Zea mays*

## INTRODUCTION

Cropping systems aim at making efficient use of growth resources so that high and/or stable productivity can be achieved (Papendick *et al.*, 1976; Okigbo, 1982). Multiple cropping is the most common traditional cropping system in tropical Africa. It provides the farmer with a

variety of returns from the land, often increases the efficiency of resource utilisation by combining variety of crops and reduces the risk of dependence on a single crop which may suffer from environmental or economic fluctuations. It also gives scope for increased labour use efficiency and provides early income (Prabhakar and Pillai, 1984) Systems involving cassava are the most common throughout the humid and sub-humid regions of Africa.

Cassava is well suited to intercropping with short duration crops because of its initial slow growth as well as its length of stay in the field (12 to 18 months). In the southern part of Nigeria, it is commonly grown in association with crops like maize which exploits the micro-environment early in the growing season and melon a low canopy crop that serves a dual purpose of protecting the soil against erosion and for weed control. The crops are selected on the basis of differences in growth habits and can be combined in either simple or complex mixtures. Complex mixtures consisting of three or more crop species are known to give higher financial and calorie returns (IITA, 1990). Farmers adopt no definite planting pattern when planting these crops. Cassava is often left scattered in the field to mature after the other crops have been harvested (Edje, 1982). However, it has been observed that the fields become very weedy and, while a few farmers carry out weeding after harvesting the early season crops, some plant a few stands of okra and other vegetables in the cassava farm in the late season (Isola, 1998). Cropping could possibly be intensified with appropriate plant arrangement on the field and by modifying cassava canopy in order to introduce a late season crop like cowpea. This will not only increase the productivity of the land, but will also prevent weed from taking over.

Cassava is planted primarily for tuber production but is cutback, pruned or defoliated for various reasons in different parts of Africa. Its prunings are usually fed to small ruminants in the southern part of Nigeria. Castellanos (1981) noted that pruning of cassava to reduce light interception and excess leaf area produced by some cultivars benefited legumes planted in the late season. While Okoli and Wilson (1982) found that simulated cutback of cassava at different heights was similar to the damage done to cassava plants by maize harvesting machine and did not adversely affect the performance of cassava, thus, allaying the fear of negative effects of pruning/ orcutback on cassava yield .

This study aimed at studying the effect of cassava planting patterns and pruning methods on its yield and yields of associated crops, namely, maize, melon and cowpea in a cassava-based cropping system

## MATERIALS AND METHODS

Field experiments were conducted during the 1994/95 and 1995/96 growing seasons at the Teaching and Research farm of the University of Ibadan in the south-west area of Nigeria ($7^0$30'N; $3^0$54E). The total annual rainfalls were 1,140.1 and 1,673.1mm for 1994/95 and 1995/96. The soil of the site is an Alfisol (USDA, 1975) of the basement complex. Treatments included cassava planting pattern which was at 2 levels: regular planting pattern where cassava was planted at a spacing of 1m x 1m to give a plant population of 10,000 plants $ha^{-1}$, and triangular planting pattern where cassava was planted in quincunx (i.e. arranged in squares of 2 m x 2 m with one plant at each corner of the squares and one in the centre). This gave a plant population of 5,000 plants $ha^{-1}$ (Fig. 1).The second factor was pruning method, introduced after the early season (i.e. after harvesting maize and melon at 18 weeks after planting cassava). This was at 3 levels; namely, no pruning, cutback at 60 cm above ground level and debranching. Planting pattern was the main plot while pruning method was the sub-plot treatment. The design of the experiment was randomised complete block (RCB) in a split - plot with three replications. The size of the main plot was $72m^2$ which was later divided into three equal parts (24 $m^2$), which constituted the sub-plot.

Cassava, maize and melon were planted in April, 1994 and 1995. Maize variety DMR-LSR-W was planted with a local variety of melon and cassava variety TMS 30572. Ife-brown variety of cowpea was planted in the late season. Maize and melon were planted at a spacing of 1 m x 1 m at 2 plants $stand^{-1}$ to achieve a plant population of 20,000 plants $ha^{-1}$ for each of the crop. Plant

population for cowpea was 55,555 plants $ha^{-1}$ from a spacing of 0.6 m x 0.6 m with 2 plants per stand. These were based on recommendations for each crop under intercropping system (Anonymous, 1991).

NPK 15-15-15 was applied to the plots at a rate of 400 kg $ha^{-1}$ based on the recommendations for cassava/maize/melon mixture (Fondufe, 1995). Cowpea pests (insects) were controlled with Karate(R) (Lambda-cyhalothrin) at a rate of 800 ml $ha^{-1}$. Spraying was commenced 5 weeks after planting (WAP) and weekly until full pod formation.

Maize was harvested at 14 WAP and was sun-dried to 14% moisture content. Melon was harvested and processed at 18 WAP. Cowpea pods were harvested from the 10th WAP to avoid shattering and weevil infestation. Cassava was harvested 12 months after planting (MAP).

Seed yield of maize and melon were recorded. Cowpea data included emergence percentage, grain yield, number of pod $plant^{-1}$ and weight of 1000 seeds. Data were taken on number of tubers $plant^{-1}$, tuber weight and fresh root yield of cassava at harvest.

Economic assessment was carried out using the partial budget technique, which involved the analysis of variable costs and benefits of the various treatments as well as the marginal rate of return.

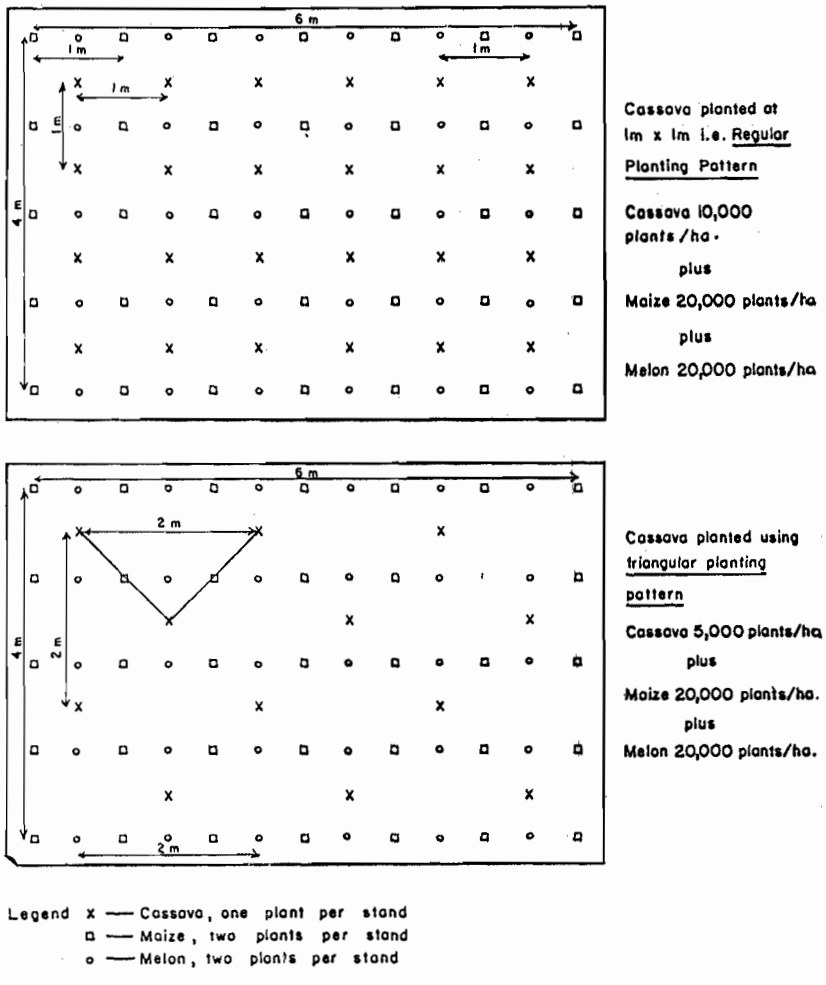


Figure 1. Arrangement of crops in the field.

Yield data on maize and melon were analysed using t-test while data collected on cassava and cowpea were subjected to analysis of variance (ANOVA) for a split plot design and separation of means was by the Least Significant Difference (LSD) test at 5% probability level.

## RESULTS

Cassava planting pattern had significant effect ($t_{0.05}$) on maize and melon yield 1995 but it had no effect in 1996 (Table 1). The emergence of cowpea was significantly ($P<0.05$) affected by cassava planting patterns in the first year alone (Table 2). Cowpea emergence percentage did not differ in the various pruning methods in 1995 but there were significant differences in 1996. The lowest cowpea percent emergence values were from unpruned plots.

There were no significant differences in pods/plant under the two planting patterns in 1995, but differences were evident in 1996. Number of pods plant$^{-1}$ did not differ among the pruning methods in 1995, but the lowest number of pods plant$^{-1}$ was from the control (unpruned cassava) plots.

In 1996, the highest number of pods/plant values were obtained from cassava cutback at 60 cm above ground level (Table 3). The weight of 1000 seeds (g) also followed the same trend as pods plant$^{-1}$ under the various treatments (Table 3). The interactions between planting pattern and pruning methods were significant for pods/plant in 1996 and weight of 1000 seeds (g) in both years. Grain yield of cowpea was higher under triangular than regular planting pattern. The general trend of

TABLE 1. Paired sample t-test showing the effects of cassava planting patterns on yield of maize and melon intercropped with cassava

| Source of variation | Triangular vs regular (maize) | Triangular vs regular (melon) |
|---|---|---|
| 1995 | -10.583 | -7.011 |
| 1996 | -0.736 | -1.51 |

Student t $^{(0.05, 2)}$ = 2.772

TABLE 2. Effect of cassava planting patterns and pruning methods on emergence (%) of cowpea relayed into cassava

| Treatments | 1995 | 1996 |
|---|---|---|
| **Planting patterns** | | |
| Regular | 80.6b | 82.9a |
| Triangular | 83.1a | 83.1a |
| **Pruning methods** | | |
| Cutback | 81.9a | 87.7a |
| Debranching | 82.5a | 81.7b |
| No pruning | 81.2a | 79.7b |

Means followed by the same letter in the same column under each treatment are not significantly different ($P<0.05$)

TABLE 3. Effect of cassava planting patterns and pruning methods on yield components and yield (t ha$^{-1}$) of cowpea relayed into cassava

| Treatments | Pods/plant | | 1000 seeds weight (g) | | Yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 |
| **Planting patterns** | | | | | | |
| Regular | 19.4a | 17.8b | 61.1b | 80.6b | 0.33b | 0.37b |
| Triangular | 19.2a | 20.7a | 71.3a | 86.3a | 0.38a | 0.43a |
| **Pruning methods** | | | | | | |
| No pruning | 20.0a | 21.8a | 73.9a | 91.7a | 0.41a | 0.46a |
| Cutback | 20.0a | 18.6b | 71.8a | 90.3a | 0.37b | 0.45a |
| Debranching | 18.1b | 17.4c | 53.1b | 68.5b | 0.28c | 0.29b |
| Interaction | ** | ns | ** | ** | ns | ns |

Means followed by the same letter in the same column under each treatment are not significantly different ($P<0.05$)
ns = not significant ($P>0.05$); **= highly significant ($P<0.01$)

cowpea grain yield was cutback > debranching > no pruning (Table 3).

More tubers plant$^{-1}$ were recorded under regular than triangular planting pattern, but bigger tubers were produced under triangular than regular planting pattern as shown by tuber weight (Table 4). The highest average number of tuber plant$^{-1}$ were obtained from the unpruned plants, while no definite trend was observed under the two pruning methods in both years.

Bigger tubers were produced under cassava plants cutback above 60 cm ground level than the debranching treatment; but the biggest tubers were from the control plots (Table 4). The root yield of cassava was significantly ($P<0.05$) higher under regular than triangular in both years (Table 5). Unpruned cassava had significantly ($P<0.05$) higher root yield than either cutback or debranching treatments in both years.

The partial budget analyses for different treatment combinations showed that the regular planting pattern was more costly, and the net benefit was lower than that of triangular planting pattern. The highest returns under the various pruning methods was from cassava cutback at 60 cm above ground level (Table 6).

TABLE 4. Effect of planting patterns and pruning methods on average number of tubers plant$^{-1}$ and tuber weight of cassava

| Treatments | Number of tubers plant$^{-1}$ | | Tuber weight (g) | |
|---|---|---|---|---|
| | 1995 | 1996 | 1995 | 1996 |
| **Patterns planting** | | | | |
| Regular | 6.1b | 6.9a | 381.2b | 400.4b |
| Triangular | 5.4a | 5.1a | 557.2a | 1010.6a |
| **Pruning methods** | | | | |
| Cutback | 5.2b | 5.9a | 458.2b | 730.3a |
| Debranching | 5.9a | 6.0a | 363.4c | 557.4b |
| No pruning | 6.3a | 6.2a | 586.1a | 828.8a |
| Interaction | ** | ** | ** | ** |

Means followed by the same letter in the same column under each treatment are not significantly different ($P<0.05$)
ns = not significant ($P>0.05$); ** = ($P<0.01$)

TABLE 5. Effect of planting patterns and pruning methods on root yield (t ha$^{-1}$) of cassava

| Treatments | Root yield (t ha$^{-1}$) | |
|---|---|---|
| | 1995 | 1996 |
| ***Planting patterns*** | | |
| Regular | 8.68a | 11.88a |
| Triangular | 6.98b | 10.53b |
| **Pruning methods** | | |
| Cutback | 6.52c | 8.31c |
| Debranching | 7.43b | 11.34b |
| Control | 9.55a | 13.98a |
| Interaction | ** | ns |

Means followed by the same letter in the same column under each treatment are not significantly different by LSD test at 5 percent probability level

## DISCUSSION

Cassava planting pattern had significant ($t_{0.05}$) effects on yield of maize and melon in 1995 alone. This could be attributed to little or no above ground competition for light from cassava, which has a slow initial growth rate, further showing its suitability for intercropping by farmers in humit tropis (Edje, 1982; Jerome *et al.*, 1989). The slight difference in the yield of maize and melon under the two planting patterns could be due to competition for soil resources (nutrients and moisture). Plant population was higher under regular planting pattern, where cassava was planted at 10,000 plants $ha^{-1}$. This was double the plant population in the triangular planting pattern. Competition for nutrients and water could, therefore, be higher under regular planting pattern. Ambe *et al.* (1988) observed that competition exists among crops planted in mixtures for soil resources. The generally higher crop yield in the second year of experimentation could be due to the use of residual nutrient from the previous year fertilisation, and the fact that crop residue from the first year was not removed from the field.

Cassava planting pattern had little effect on the emergence of cowpea because the canopy formed by cassava was just about 50% even under regular planting pattern in the control (unpruned) plots, at the time of planting cowpea. Yield components, i.e., pods $plant^{-1}$ and weight of 1000 cowpea seeds differed only slightly under the two planting patterns. Seed quality as indicated by weight of 1000 seeds, was better under triangular than regular planting pattern. This could be attributed to shading of cassava plants whose canopy had started closing up after maize and melon harvest.

Cassava plants were taller under regular than triangular planting pattern probably because of the higher population density in that treatment. Cock *et al.* (1977) reported that cassava responded to increased competition by diverting more dry matter to stem. Overall, yield of cassava also followed the same trend. Yield components, such as tubers $plant^{-1}$ and tuber weight, however, suggested that the quality of tuber under triangular planting pattern was superior to that of regular planting pattern. More space was available for the development of bigger tubers under the triangular than regular planting pattern. Cock *et al.* (1977) also reported that increased yield resulting from higher population density are achieved at the expense of size of tuber, while Jalloh (1995) observed that diversion of assimilates from the roots to the stem occurred at higher cassava population.

Cowpea grain yield and yield components were affected by cassava pruning methods. The least yield and yield component were recorded under unpruned cassava, which had started forming canopy after the harvest of maize and melon. Eriksen (1977) and Wahua *et al.* (1981) reported a decrease in cowpea yield when light intensity was reduced. Agboh-Noameshie (1990) observed that the growth and yield of cowpea intercropped with cassava were not affected only when cassava did not produce enough vegetative growth. It was also noted that cowpea could be successfully grown under pruned cassava if the cassava cultivar recovered slowly after pruning.

Cutback cassava plants produced taller plants than debranched ones, showing that cassava plants recovered at a faster rate when cutback at 60 cm above ground level than when debranched. Agboh-

TABLE 6. Cost/benefit analysis of different treatment combinations

| | | Total cost (N) | Total benefit (N) | Net benefit (N) | MRR |
|---|---|---|---|---|---|
| Regular | Cutback | 20,020 | 62080 | 421060 | 210.1 |
| | Debranching | 20,020 | 61568 | 41548 | 207.5 |
| | Control | 19,660 | 59588 | 39928 | 203.1 |
| Triangular | Cutback | 18,960 | 65622 | 46662 | 246.1 |
| | Debranching | 18,960 | 62802 | 43842 | 231.2 |
| | Control | 18,780 | 61770 | 42990 | 228.9 |

Noameshie (1990), in a similar experiment observed that cassava cutback from which stems, branches and leaves were removed was capable of recovering better than in the total defoliation. This was attributed to rapid regrowth of branches and leaves after cutback. Yield and yield components of cassava reduced when it was pruned irrespective of pruning method. This shows that reduction in foliage by pruning, cutback or defoliation affects tuber yield in cassava. Hunt *et al.* (1977) reported that the deposition of starch in storage root can be reduced if the supply from the top is curtailed as occurs when much of the leaf and stem materials are removed. The growth of unpruned cassava was never disturbed, whereas the pruned ones had to recover by producing new stems and leaves. This reduced the carbohydrate available for storage roots.

The cost of cassava cuttings as well as higher labour for planting and pruning under regular planting pattern accounted for the higher cost incurred with this treatment compared to what was obtained for the triangular planting pattern. The highest returns from plots where cassava was cutback at 60 cm above ground level was due to the proceed from cowpea, whose yield was highest under that treatment.

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