The Production of Planting Material in Cassava: Some Agronomic Implications

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ABSTRACT

In traditional cultivation systems obtaining cassava planting material is an integral part of the production process. With advent of new technology and larger plantations, however, root and stake production may occur separately. Identification of agronomic practices specifically suited for stake production is therefore desirable.

Stakes of different ages are usually obtained within the same plant, more mature stakes showing more vigorous sprouting but young stakes frequently giving higher yields. High planting densities increase total number of primary and secondary stems/ha thus increasing total stakes number/ha although average stake weight may decrease. High natural soil fertility or fertilization on poor soils can increase stake production significantly. In early growth stages, cassava is highly sensitive to weed competition which can reduce top growth drastically. Good, timely weed control is therefore essential to produce large numbers of good quality stakes per plant.

Introduction

In traditional cropping systems, obtaining vegetative material for planting cassava has been an integral part of the production process. The relative ease with which cassava is propagated from stem cuttings has probably been one of the reasons why no specific cassava stake production technology has yet been developed. On the other hand, poor stake production practices and the resulting low-quality planting material are frequent reasons for low productivity in cassava. While application of sound stake production practices is important for both small and large producer, it may become necessary for the latter to separate more and more stake from root production in response to specific requirements of large plantations where quantity, uniformity, quality and continuity of supply must be assured. In this paper, several agronomic practices are discussed in relation to production of cassava planting material, providing a starting point for the development of a specific stake production technology.

Materials and Methods

Characteristics of the experimental sites. Trials were at CIAT-Palmira and Quilichao stations in the Cauca Valley of Colombia, South America, at ICA (Instituto Colombiano Agropecuario) - Carimagua in the eastern plains and at ICA-Caribia and "La Idea" farm on the Colombian north coast. The CIAT-Palmira Station, located at 1,000 m.a.s.l., has annual rainfall of 1,025 mm in bimodal distribution, 23.7°C annual temperature and 72% mean annual relative humidity. The soil is a vertic calcustoll (mollisol) with a silty clay texture, pH 6.0, organic matter 4.2% and a generally high base status and fertility. Elevation of Quilichao is 1,035 m.a.s.l., annual precipitation is 1,590 mm, annual mean temperature is 23.6°C and annual mean relative humidity 69%. The soil is a typic dystropept (Inceptisol) with a clayey texture, pH 4.1, organic matter 6.3% and low P and base status but high P fixing capacity and high aluminum and manganese saturation. Carimagua, at 200 m.a.s.l., has annual rainfall of 2,094 mm and an annual mean temperature of 26.5°C. The soil is a typic haplustox (oxisol) with clayey texture, pH 4.5, organic matter 2.5% and very low P and base status, but high aluminum saturation. Climatic characteristics of the north coast sites Caribia and La Idea are an elevation of 30 and 10 m.a.s.l., and respective annual mean temperatures of 27.5°C and 27.2°C, annual rainfall of 1,393 and 1,606 mm, and mean annual relative humidity of 84% and 86%. The soil at Caribia is an unclassified entisol with sandy loam texture, pH 6.0, organic matter 1.6%, high available P but intermediate to low base status. At La Idea, the soil is an unclassified entisol of sandy texture, pH 6.3, organic matter 0.9% and low P and base status.

Experiment 1: The effect of the age of stakes within the plant on a subsequent crop.

At CIAT-Palmira, 12-months-old cassava, variety M Mex 11, an erect growing, late branching, medium vigor cultivar, was chosen to harvest stakes of 20 cm length from the lower, middle and upper portion of the primary stem, as well as from the first branches (secondary stem), immediately above the first ramification. Stakes were then planted in a preirrigated field on ridges in a 0.8x1.2 m arrangement. A fertilization of 100, 44 and 166 kg/ha of N, P and K was given at planting. The sprouting process was monitored and final sprouting percentage determined. Root numbers, sizes, and weights were measured at final harvest, 11 months after planting.

Experiment 2: Influence of planting densities on the production of stakes in cassava.

Fresh planting material of variety M Ven 77, an erect growing, late branching, medium vigor variety was produced at CIAT-Palmira and sent to ICA-Carimagua to plant plots with equivalents of 5, 10, 20 and 40 x 10^3 plants/ha on ridges of 0.5 m distance. Before planting, 1 t/ha of dolomitic lime was incorporated with land preparation and 100, 88, 166 and 10 kg/ha of N, P, K and Zn were applied at planting. The number of primary stems per plant as well as the number and fresh weight of stakes was assessed 12 months after planting. To be counted as a stake, cuttings had to fulfill the following requirements: Length approximately 20 cm, a ratio of pith diameter to total diameter between 1:2 and 1:3 (to ensure adequate maturity) and a bud-number not below five.

Experiment 3: The effect of N fertilization on stake production on a soil low in organic matter and available N.

Variety M Col 22 was grown at ICA-Caribia showing an erect growth habit and intermediate vigor under the given temperature conditions. Planting was on ridges in a 1.8x0.6 m arrangement. The trial received a standard fertilization of 83 kg K/ha, and 10 kg Zn/ha together with levels of 0, 50, 100, 150 and 300 kg N/ha.

At the age of 10 months, plants were harvested and total top and root fresh weights as well as stake number and fresh weights were recorded. Stake selection criteria were those given for Experiment 2.

Experiment 4: The effect of weed control efficiency on stake production in cassava.

The local variety "Secundina" and a CIAT hybrid, CM 342-170 were grown at "La Idea" farm on the Colombian north coast. For "Secundina," the traditional spacing of 1.2x1 m was used whereas the hybrid was grown at 1x1 m, both cultivars being grown on the flat. Differential weed control levels during early growth were established by using chemicals and doses differing in their weed control effectiveness. The treatments were manual control as necessary, oxifluorfen at rates of 4, 2 and 1 liter/ha (commercial product), Diuron plus Alachlor in mixture at 1 kg and 2 lt/ha, Oxadiazon at 2 liters/ha and no control (weedy check). Weed control percentage was assesses visually at 10-day intervals. Ten months after planting, plants were harvested and total top and root fresh weight as well as stake number and stake fresh weight was recorded. Stake selection criteria were those given for Experiment 2.

Results

The age of the plant and stems. When the age of a cassava plant in relation to stake production is considered, two aspects are important: the age of the plant *per se* as determined by the number of days from planting and the age of the stems *within* the plant.

Up to the present, no specific research has been conducted with regard to influence of plant age *per se* on stake production but it appears logical that as plant age increases, top growth also increases, and with it the amount of stems from which planting material may be obtained. Furthermore, cassava as a perennial is unlikely to have a clearly defined optimum or maximum age for stake production. Although in plants of advanced age, primary stems may be too lignified to be used as planting material, there will always be stems of a superior order which fulfill the requirements of adequate maturity. The influence of plant age on the relationship between total and useful top growth with regard to planting material is not known nor is there information on "earliness" of varieties to produce stakes in relation to genotypes and edaphoclimatic influences.

On the other hand, some information is available on effect of stakes obtained from stems of different age within the plant. Stems resulting from initial sprouts of the planting piece are called primary stems and represent the oldest tissue of the plant whereas secondary, tertiary, etc., stems resulting from the branching process are formed later and represent younger tissue. In Experiment 1, the effect of stakes from primary and secondary stems on sprouting and yield was compared. There was considerable difference in speed of sprouting among stakes of different ages. Stakes from middle and lower part of the primary stems (i.e. the older stakes) sprouting much faster and more vigorously than stakes from the upper portion of primary stems and from secondary stems, i.e. the younger stakes (Figure 1). While no differences existed between the four groups of stakes with regard to percent final stand at harvest, plant height or total top fresh weight, there was a large difference between commercial root weights, stakes from the secondary stems (the youngest stakes) giving a significantly greater commercial root yield than the oldest stakes (Table 1). The same tendency was observed with regard to total root yield, however, differences among treatments were statistically non-significant.

Table 1. Effect of stake age within the plant on sprouting, growth and root yield of a subsequent crop.

Stake age and origin	Final sprouting (%)	Plant height at harvest (cm)	Total fresh weight: Total tops (t/ha)	Total roots (t/ha)	Commercial roots (t/ha)
Very old lower part primary stem	100 a*	234 a	34.3 a	15.9 a	11.2 b
Old middle part primary stem	100 a	239 a	32.3 a	16.7 a	12.0 ab
Intermediate upper part primary stem	100 a	241 a	32.9 a	17.5 a	12.3 ab
Young lower part secondary stem	100 a	240 a	32.9 a	21.3 a	16.9 a

*Means in the same column followed by the same letter are not significantly different at P = 0.05, according to Duncan's multiple range test.

These data for an erect growing, late branching variety corroborate earlier findings showing that in less erect, earlier branching varieties, younger stakes (middle and upper portion of plant) also give greater yields (CIAT, 1979).

The effect of planting density. During early growth, cassava plants tend to not interfere with each other, even at greater than normal planting densities. The number of sprouts/plant which form the primary stems, is therefore almost not affected by planting density, as results from Experiment 2 show. This, however, leads to a greater number of primary stems per unit area at higher planting densities and to increased competition among these stems at later growth stages. As a result, individual stems stay thinner and a lower production of stakes/plant with adequate size, maturity and bud number is obtained (Figure 2a). On the other hand, higher planting densities increase the total number of plants per unit area sufficiently to more than compensate for the decrease in number of stakes per plant. In the end, higher planting densities do increase the total amount of stakes produced per unit area, mean stake fresh weight being somewhat adversely affected (Figure 2b). Similar experiences with the use of increased planting densities for the production of quality planting material in cassava have been reported from India (Mohankumar et al, 1980).

Influence of N on stake production. In Experiment 3, there was a large influence of N fertilization on total top fresh weight of plants. As expected, increased N levels promoted formation of stems and foliage which almost doubled in weight comparing the 300 with the zero N level (Table 3). However, stake number per plant was only slightly increased up to 150 kg N/ha and showed a decline at 300 kg N/ha.

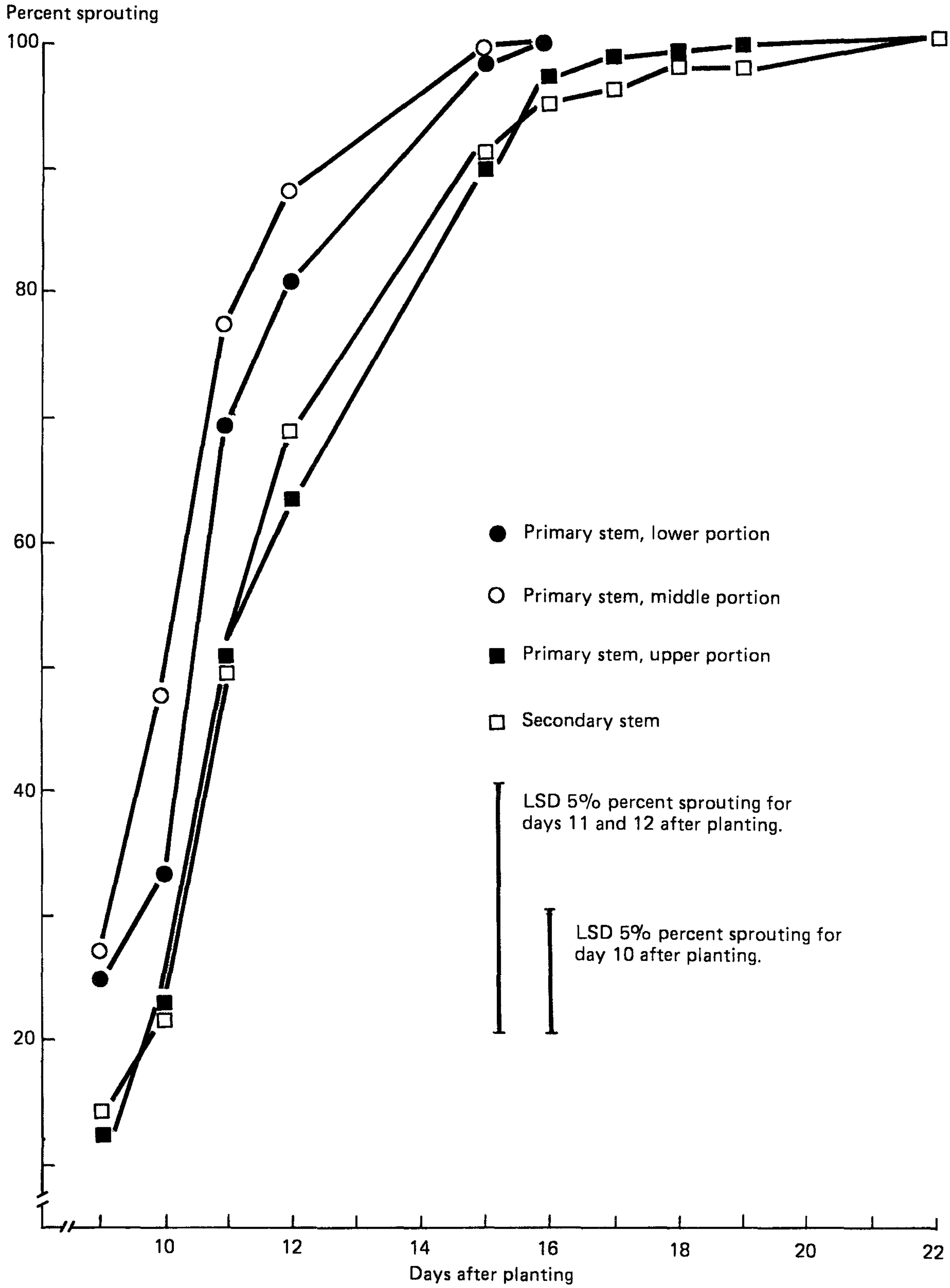

Figure 1. Effect of stake origin within the plant on the sprouting process in cv. M Mex 11. CIAT-Palmira, 1981.

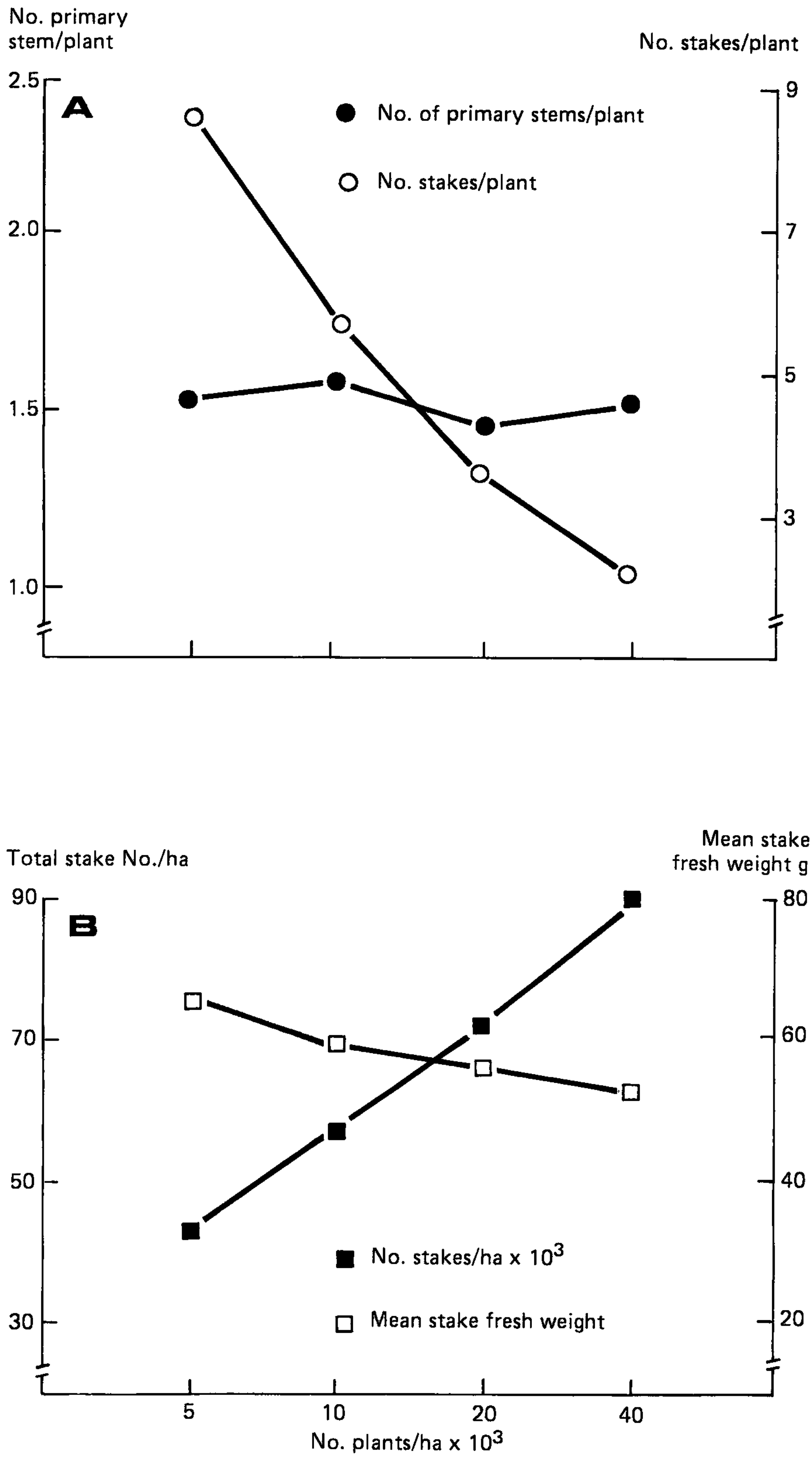

Figure 2. Effect of planting density on number of primary stems, stakes and stake weight in cv. M Ven 77. Carimagua, 1982.

A stake production index (fresh weight of standard size stakes over total plant top fresh weight multiplied by 100) was calculated to demonstrate differences in stake production efficiency of the tops. Similar to stake number per plant, the stake production efficiency increased from 50 to 150 kg N/ha and decreased when more N was applied, the differences being numerically noticeable but statistically nonsignificant. The high stake production efficiency with zero kg N/ha is explained by less elongation of stems without N which allowed selection of a higher proportion of the entire top as planting material with five or more buds per stake whereas with more elongated stems, more stakes had to be discarded due to insufficient bud numbers (Table 2).

Table 2. The influence of N fertilization on quantity and efficiency of stake production and on other growth and yield parameters.

N level (kg/ha)	Stakes/plant	Stake production index (%)	Total fresh weights Tops (t/ha)	Total fresh weights Roots (t/ha)	Harvest index (%)
0	3.9 ab*	8.5 a	26.5 c	28.5 b	52 ab
50	3.1 b	5.6 a	30.1 bc	33.0 ab	52 ab
100	3.3 ab	7.5 a	28.9 bc	39.0 ab	57 a
150	5.3 a	8.0 a	40.1 ab	40.6 a	50 ab
300	2.7 b	4.0 a	46.9 a	41.3 a	47 b

*Means in the same column followed by the same letter are not significantly different at P = 0.05, according to Duncan's multiple range test.

Data from this experiment show that applications of N up to intermediate levels promote a balance between stem and foliage growth favorable to production of planting material whereas excessively large amounts of N fertilizer reduced the efficiency of the plant to produce stakes but promoted branch and foliage growth.

Plant protection. All types of diseases, insects and weeds may be detrimental to production of planting material in cassava. For diseases and insects the concern is twofold since both can not only reduce production of stakes, they can also be transmitted from mother-plants to new crops resulting in a high risk for productivity. Weeds, compete with cassava for light, nutrients and water. Growth depression in cassava is particularly strong when competition occurs at early growth stages.

A direct response of cassava to different weed control levels during the first 2 months of growth was observed in Experiment 4. According to efficiency of different weed control systems, products and doses, there were different levels of competition between weeds and cassava. The lower the control percentage 50 days after applications, the higher was the competitive effect, reflected by a reduction in total top fresh weight as weed control percentage decreases (only data from CM 342-170 reported, Table 3). Stake production per plant was proportional to total top fresh weight. Uncontrolled weeds reduced top growth to a low level and under these conditions, only every third plant produced one stake of acceptable size and quality. On the other hand, without competition in the handweeding treatment, almost six stakes per plant were obtained. The mean stake fresh weight was rather constant, mainly as a result of the uniform selection criteria.

Discussion

Using stakes mainly from primary and secondary stems of the plant, it is apparently not indifferent to productivity of subsequent crop from where stakes originate. Stakes from the lower and middle portion of primary stems sprout faster and more vigorously, probably as a result of the greater amount of carbohydrate reserves they can draw on after planting. This, however, appears to be unrelated to thickened root initiation, as a careful analysis of root yield components would suggest. Plants grown from stakes taken from the lower portion of primary stems had noticeably less thickened roots at harvest than those plants originating from stakes of secondary stems. Also, roots from stakes of the former origin were slightly smaller than those from stakes of the latter. These factors together may account for the lower yield of the "old" stakes but the phenomenon is not open to a simple explanation. The possibility of a more efficient dry matter pertitioning in plants grown from younger stakes should not be discarded.

Table 3. The effect of weed competition on growth and stake production in cassava.

Control systems products - doses***	Weed control 50 DAA** (%)	Stakes/ plant	Mean stake fresh weight (g)	Total fresh weights tops (t/ha)	Total fresh weights roots (t/ha)
Frequent manual control	100	5.9 a*	70 a	18.8 a	28.4 a
Oxifluorfen 4 lt/ha	70	4.1 a	71 a	17.4 ab	24.6 ab
Oxifluorfen 2 lt/ha	67	3.5 ab	64 a	14.3 ab	22.8 ab
Diuron + Alachlor 1 kg + 2 lt/ha	62	4.9 a	63 a	16.7 ab	19.2 b
Oxifluorfen 1 lt/ha	51	3.3 ab	63 a	13.8 ab	21.9 ab
Oxadiazon 2 lt/ha	30	1.1 bc	69 a	9.4 bc	16.9 b
No weed control	0	0.3 c	90 a	2.6 c	3.5 c

*Means in the same column followed by the same letter are not significantly different at P = 0.05, according to Duncan's multiple range test.

**DAA - Days after application.

***Amounts in liters or kilograms of commercial product per hectare.

Information available in this paper and from other workers appears to suggest that the use of high planting densities to increase stake production is uncontroversial, even if as a secondary goal the aim is root production. Plant populations of up to 40×10^3 plants/ha appear reasonable for stake production whereas for an increased, combined stake and root harvest, densities around 20×10^3 plants/ha may be preferable to avoid an overly drastic reduction in root size. No information exists comparing performance of stakes from high density to low density plantings. However, in the light of results discussed in the previous paragraph, the use of somewhat thinner, lower weight stakes coming from high density planting should not be to the detriment of root production of the subsequent crop.

Reviewing the information on the effect of soil fertility presented here, it is evident that plant nutrition interacts with genotypic characteristics in modifying the plant's growth habit and consequently its stake production ability. To evaluate this modification a stake production index was calculated, indicating which proportion of the above-ground part of the plant may be utilized for propagation and thus allowing to quantify the plant's stake production efficiency. Based on this concept which may be called a "harvest index" for stake production, it was seen that the proportion of stems useful for stake production is in a favorable balance with total top growth when growth is only supported by natural soil fertility or stimulated slightly by low to intermediate fertilization. On the other hand, at high rates of applied nutrients, the efficiency of the plant to provide propagative material diminishes due to more foliage production, a higher proportion of thinner branches and longer internodes, leading to 20 cm stakes with less than the minimum of 5 buds per stake required to ensure plant establishment. Under limited soil fertility conditions, this shift in top growth is promoted by N but probably also by other major or minor elements, according to the prevalent soil nutrient conditions. While present data allow assessment of effect of N on stake production of the crop to which they are applied, the influence of N levels in stakes on the subsequent crop is still largely unknown and remains open to future research.

The influence of pests on the production of planting material in cassava is presently receiving much attention. (Byrne, 1982; Bellotti, in press; Lozano, in press). As related to diseases, insects and mites, this is a vast and complex field due to the twofold risk that pathological and entomological problem pose to a vegetatively propagated crop such as cassava. With regard to weeds, the situation is less complex since there is only a direct influence and no transmission of the problem by stakes occurs. Data presented here show that stake and root production is affected by deficient weed control in almost identical proportions. It is therefore of dual interest to maintain a good control level of this pest when both root and stake production are to be optimized.

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