FOLIAGE AND ROOT PRODUCTION OF FIELD–GROWN CASSAVA CULTIVARS AS AFFECTED BY PLANT AGE[1] /

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Resumen

Tres cultivares de yuca (M Col 22, M Col 1684 y el híbrido CM 342-170) fueron evaluados por su producción de follaje (hojas, pecíolos y tallos verdes) y raíces, así como de tallos, a través del período comprendido entre los 6 y los 12 meses de edad de las plantas. El rendimiento del follaje fue afectado por las condiciones climáticas y por la edad de la planta, disminuyó progresivamente en todos los cultivares desde el 6° hasta el 10° mes de edad de la planta, período en el cual la precipitación disminuyó y la temperatura ambiental aumentó. El rendimiento de follaje del cultivar M Col 1684 fue menor que el de los otros dos cultivares; a los 10 meses de edad de la planta, el peso fresco del follaje de M Col 1684 fue de 1.3 t/ha comparado con 4 t/ha para los otros dos cultivares. La producción de raíces mostró una tendencia a aumentar con la edad de la planta. Se presenta información sobre las proporciones relativas de los rendimientos de follaje, tallos y raíces en relación al peso fresco total de la planta, así como los cambios en el contenido de materia seca de estas partes de la planta.

Introduction

Cassava (*Manihot esculenta* Crantz) is the most important tropical root crop, cultivated mainly for its roots, which are consumed in a wide variety of food products (16). However, the potential use of cassava leaves as a protein-rich vegetable for human nutrition has attracted a great deal of attention (1, 2, 3, 13, 20, 21, 24) while both the leaves and the foliage have been suggested as animal feeds (6, 8, 18, 22).

Leaf (4, 9) and foliage (leaf blades and petioles as well as green stems) (14) yields differ among cassava cultivars and are also affected by plant age (4, 9) and climatic conditions, especially temperature and rainfall (5). In a previous trial (9), fresh leaf production of two cassava cultivars varied with plant age and climatic conditions but, in general, it represented around 4% to 11% of total plant fresh weight. Little information is available on foliage production in cassava cultivars and on the effect of plant age on foliage yield of field-grown cassava.

The effect of plant age on dry matter distribution and root yield has been reported (5, 19, 25) and reviewed (12), but in most cases yields have been estimated from a limited number of plants (19, 25). Although accessions from the cassava germplasm collection at CIAT differ greatly in yielding ability, several promising cultivars outyielded local cultivars (7).

The present study evaluates foliage (leaves, petioles and green stems), lignified stem and root yield of three field-grown cassava cultivars, from the 6th to the 12th month of plant age.

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Materials and methods

1. Cassava growth conditions

Three cassava cultivars (cv. M Col 22, M Col 1684 and the hybrid CM 342-170) were planted at 1 x 1 m spacing in adjacent fields, each of about 0.4 ha, at CIAT, in October 1981. M Col 1684 is a high-cyanide-containing cultivar whereas the other two are either low or intermediate in cyanide (7). Although a local cultivar (M Col 113) was also planted as a control, a frequent high incidence of rotten roots at the 8th and 10th months of plant age reduced root yields considerably. Therefore, a complete set of yield data for the local cultivar could not be collected. The information on foliage chemical composition of the local cultivar was used for comparison with the three cultivars of this study in another paper (10).

The soil had a pH range of 6.2 to 6.8, an available phosphorus level of approximately 72 mg/kg (Bray II) and, in general, good characteristics for cassava production (15). The mean temperature during the study period (October 1981-October 1982) was 23.7°C and the total rainfall during 12 months was 1196 mm with two dry periods (December-February and June-August).

Before planting, cassava stakes were treated with fungicides and insecticides to insure good germination and healthy growth (17). Fields were kept weed free and two applications, one of Dipterex and the other of Sistemin, were performed at two and three months of plant age to control cassava hornworms (*Erynnys ello*) and thrips, respectively (17).

2. Measurements

Every two months, starting in April 1982 (6 months of plant age) and ending in October 1982 (12 months), five areas of 130 m^2 each, of each cultivar, were harvested. Foliage (leaves, petioles and green stems), older lignified stems as well as stumps (original planting piece) and roots were separately weighed in the field. The stump comprised the lower portion of the lignified stem, up to a height of approximately 30 cm above ground level, and the underground portion to which roots were attached. The dry matter (DM) content of foliage, stem and stump was determined by drying a known quantity of each milled plant part to constant weight at 60°C. Samples of whole roots were also taken for DM determination by the specific gravity method (11). The analysis of variance method was used for statistical analysis of the data (23).

Results

Figure 1 shows the yield of fresh foliage of the three cassava cultivars between plant ages 6 to 12 months as well as the monthly rainfall distribution and mean ambient temperature recorded throughout the study period. In all three cultivars, foliage weight declined progressively from the 6th to the 10th month of plant age, during which time a decrease in rainfall and an increase in ambient temperature were recorded. Although foliage yield at the 12th month of plant age was similar ($P > 0.05$) for all three cultivars, M Col 1684 produced less foliage ($P < 0.05$) than the other two cultivars at other ages; at 10 months it had a significantly lower ($P < 0.05$) foliage yield of 1.3 t/ha compared to 4 t/ha produced by the other two cultivars.

Production of lignified stems, including the stumps, did not follow a consistent trend (Figure 2) but cv. M Col 1684 produced the lowest ($P < 0.05$) stem yields at 6 and 8 months of plant age; part of these differences could be due to the cultivar's branching habit (19). Root production, on the other

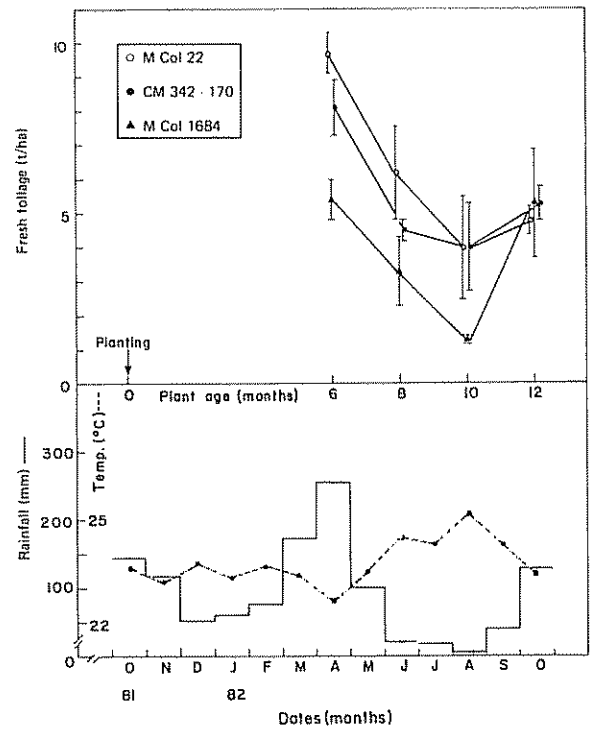

Fig. 1. Meteorological conditions (monthly rainfall _____ and mean air temperature – – – – –) and fresh foliage yield of three cassava cultivars between plant ages 6 to 12 months. Shaded columns represent the planting and the four sampling periods. Each value in this and the other figures is the mean of five samples (total number of plants grown in 130 m^2 plots each) ± SEM.

hand, tended to increase with plant age. Root production of M Col 22 and CM 342-170 outyielded ($P < 0.05$) that of M Col 1684 throughout the entire study period except at 12 months when all three cultivars yielded similarly ($P > 0.05$) (Figure 2).

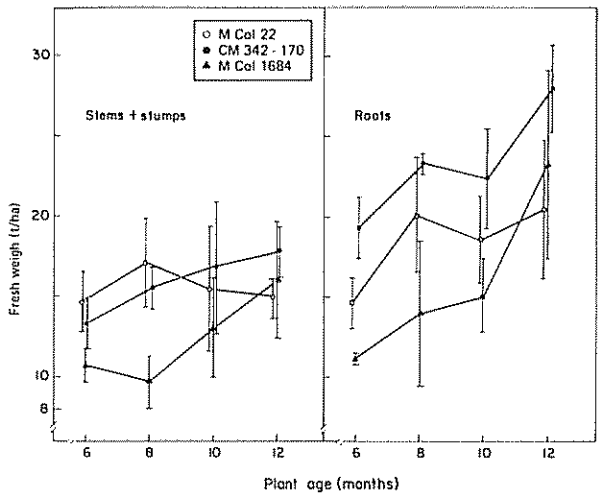

Fig 2 Stem + stumps and root production of three cassava cultivars at four plant ages

Considerable variations, as evidenced by the large standard error of the means (Figures 1 and 2), were observed among the measure areas at each sampling date. The relative proportions of harvested plants to the initial number of planted stakes was slightly lower for cv. M Col 1684 than for the other cultivars (95 ± 3% vs. 97 ± 2% , respectively). Yield data are expressed as the production per planted area and therefore, were not corrected for the slight differences among the number of harvested plants at each sampling date.

Conversion of the absolute fresh weight of foliage, stems and roots to their relative proportions in the total plant weight allows a construction of more consistent trends of growth changes of those plant parts as affected by cultivar and plant age (Figure 3). Foliage weight at 6 months represented at least 20% (25% for M Col 22) of total fresh plant weight and decreased progressively to around 10% for M Col 22 and CM 342-170 and 4% for M Col 1684 by the 10th month of plant age. Due to the onset of rains after the 10th month, foliage yield at 12 months represented from 10 to 12% of total plant weight in the three cultivars. Total stem yield was in the range of 35 to 40% of plant weight, whereas the relative

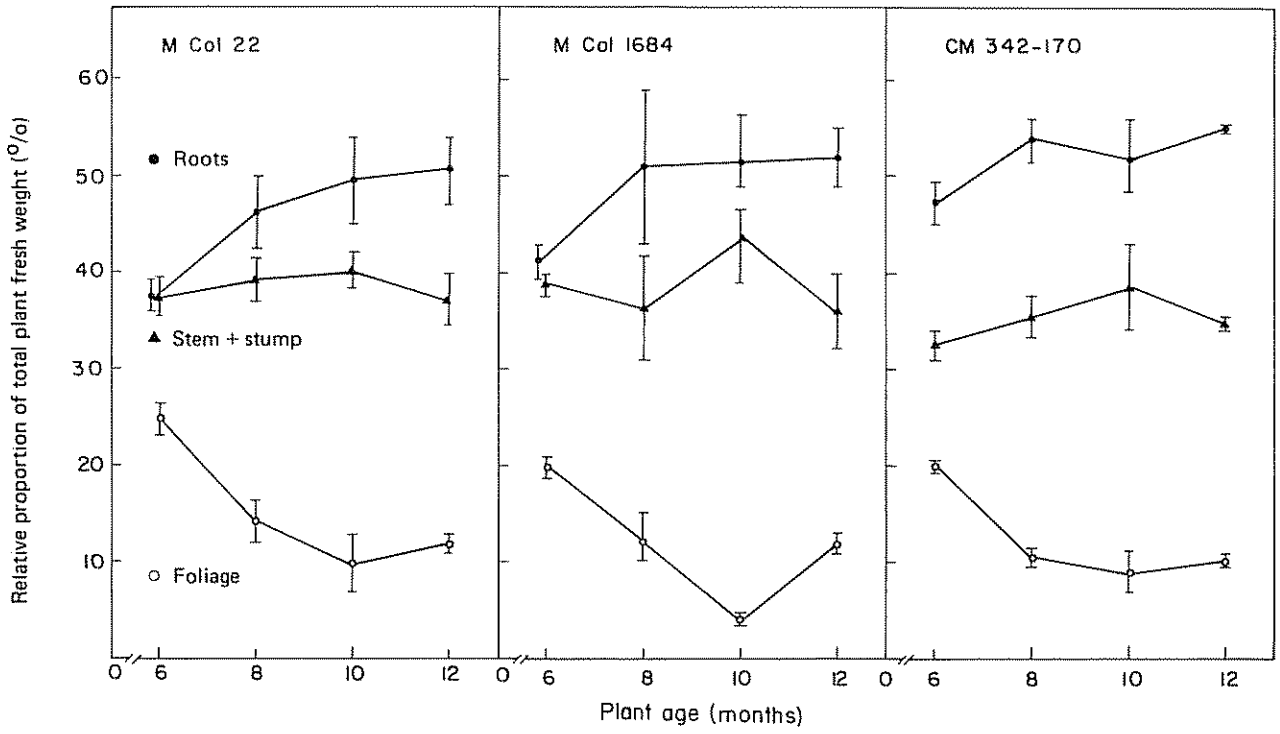

Fig 3 Relative proportions, on fresh weight basis, of foliage; stem + stumps; and roots to total plant weight of three cassava cultivars as affected by plant age.

proportion of fresh root weight increased from 6 to 8 months and thereafter it remained at around 50% of total fresh plant weight (Figure 3).

Figure 4 presents the DM content of foliage, stems, stumps and roots of the three cassava cultivars from 6 to 12 months of plant age. The DM content in cassava foliage increased as foliage production decreased, thus at 10 months foliage of M Col 1684 had the highest ($P < 0.05$) DM of around 34%. Most of the DM values in foliage were in the range of 25 to 30% (Figure 4a). The stems of M Col 22 and CM 342-170, which had similar ($P > 0.05$) DM contents (range: 20-30%), were consistently lower ($P < 0.05$) than that of M Col 1684 stems (25-35%) throughout the entire period (Figure 4b). The DM content of stumps were in the range of 35 to 40% (Figure 4c) and the differences among the three cultivars were not significant ($P > 0.05$).

The DM content of whole roots of M Col 1684 was consistently lower ($P < 0.05$) than those of the other two cultivars (Figure 4d). The DM content of roots increased from the 6th to the 8th month of plant age to remain almost constant until the 10th month in cv. M Col 22 and M Col 1684 and decreased thereafter: the root DM content of the hybrid CM 342-170 declined progressively from the 8th to the 12 month of plant age, at levels between those of the other two cultivars (Figure 4d).

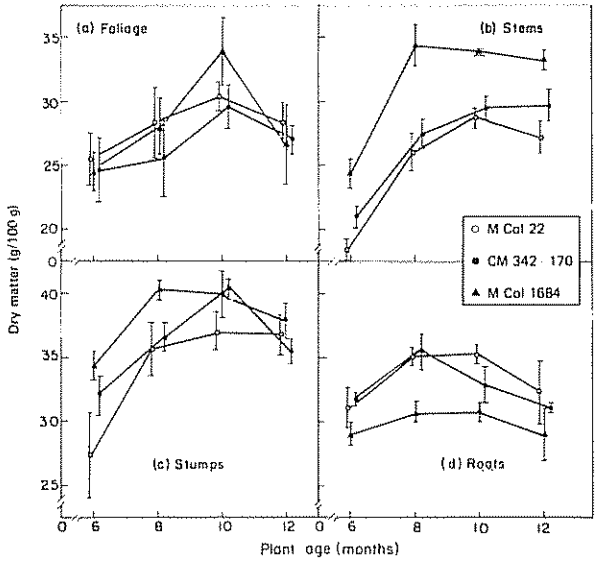

Fig 4 Dry matter content of foliage (a), stems (b), stumps (c) and roots (d) of three cassava cultivars at four plant ages.

Discussion

The results obtained in this study showed that cassava foliage (leaves, petioles and green stems) production was similarly affected by climatic conditions and by plant age in each cassava cultivar evaluated, but remarkable differences in actual foliage yield were found among the three cultivars; the results confirm those previously reported when leaves (4, 5), rather than foliage, were measured. The examination of foliage and root yields suggests that a cultivar, such as the hybrid CM 342-170, having a persistent foliage production that could resist drought periods (low rainfall and high ambient temperature) supports an almost continuously increasing root production.

Under the experimental conditions of this study, the optimum harvest time for both root and foliage yield appears to be as early as 8 months of plant age for M Col 22 and CM 342-170 and as late as one year for M Col 1684.

The potential use of cassava foliage is becoming increasingly important due to the development of agroindustrial cassava production, especially for the animal feed market. This scale of production normally implies an expansion in the area planted with cassava, thus increasing the amount of foliage produced as a crop byproduct. Fresh foliage production of around 4 to 5 t/ha, with a DM content in the range of 25% to 30% , could be obtained. Another paper (10) describes several parameters related to the nutritional value of cassava foliage.

Summary

Three cassava cultivars (M Col 22, M Col 1684 and the hybrid CM 342-170) were evaluated for foliage (leaves, petioles and green stems) and root production, as well as stem yield, throughout the period from the 6th to the 12th month of plant age. Foliage yield was affected by climatic conditions and by plant age; it declined progressively in all cultivars from the 6th to the 10th month of plant age, during which time a decrease in rainfall and an increase in ambient temperature were recorded. Foliage yield of cv. M Col 1684 was lower than that of the other two cultivars; at 10 months of plant age, the fresh foliage yield of M Col 1684 was 1.3 t/ha as compared to 4 t/ha for the other two cultivars. Stem yield of M Col 1684 was also the lowest at 6 and 8 months of plant age. Root production tended to increase with plant age. Data are presented on the relative proportions of foliage, stems and root yield to the total fresh plant weight as well as changes in the DM content of these parts of the plant.

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Notas y comentarios

Ricardo Bressani, Premio Mundial "Albert Einstein"

El Dr. Ricardo Bressani, ilustre científico guatemalteco, y prominente funcionario del Instituto de Nutrición de Centro América y Panamá (INCAP), fue honrado en 1984 con el Premio Mundial de Ciencias "Albert Einstein", otorgado por el Consejo Cultural Mundial, con sede en Monterrey, México. Se reconoce así su valiosa labor en el estudio del valor nutritivo de los alimentos de este continente, que iniciara hace unos 30 años con la publicación de las tablas de valor nutritivo de los alimentos de la región y dirigiendo y colaborando en investigaciones en torno a la nutrición de la población de los trópicos.

Su labor contribuyó al sólido prestigio del INCAP, junto con la desarrollada por los fundadores de ese instituto. Colaborador de la revista **Turrialba**, en la que ha publicado varias de sus investigaciones, el Dr. Bressani es autor y co-autor de más de 450 publicaciones y ha escrito capítulos enteros de libros científicos. Ha sido honrado con otros galardones y con nombramientos a comisiones, paneles, cuerpos editoriales y programas internacionales sobre nutrición humana, animal, y tecnología de alimentos. **Turrialba** se complace en felicitarlo y en compartir la satisfacción que hoy sienten sus colegas y amigos. Adalberto Gorbitz.