Effect of Cutting Quality on Cassava

Authors: J.C. Lozano, B. Pineda and U. Jayasinghe, Plant Pathologists, Cassava Program, CIAT, Apartado Aéreo 67-13, Cali, Colombia.

ABSTRACT

Cassava is normally propagated by planting 20 cm long stem cuttings. The general performance as measured by root, starch and cutting yield; plant height; root rot resistance; and root and cutting quality of a native cultivar of long standing use and a recently selected hybrid was investigated to planting material source. Results showed that by using cuttings from plants regenerated after meristem culture, the root and starch yield increased by 69.5% and 70.3%, respectively, compared to traditional planting material. The plant height and the production of good quality planting material were significantly (5% level) higher. When comparing the native cultivar with the selected hybrid, there were no differences in yield (fresh roots) if "clean cuttings" were used. However, significant differences between the native and the hybrid genotypes were found on cutting production and root rot resistance. When using traditional planting material for the native cultivar the hybrid produced around 3.2 times more than the native cultivar. These findings appear to indicate a continuous decrease in the performance of cassava cultivars with time due to the effect of biotic stresses asserted during each cycle. These bring out the need for: a) a careful evaluation of the genotypes during selection by using planting material of equal quality and b) use of clean planting material for a high performance.

In any vegetatively propagated crop yield is related to quality of the planting material used. Cassava (*Manihot esculenta* Crantz) is propagated by planting stem cuttings approximately 20 cm in length. The quality of this planting material is usually visually judged, but selection only occurs if sufficient stem material is available. Due to the long growing cycle of the crop, plants are continuously subjected to pressures from biotic (diseases and pests) and abiotic (climate, soil pH, nutrient deficiency or toxicity) factors which may decrease the quality of the planting material. The general performance of a genotype in a given ecosystem is related to the quality of the planting material which in turn is related to the resistance to biotic or abiotic stresses present.

Most endemic biotic problems are generally eliminated by true seed production (of about 26 viral diseases of potato only three have been reported as seedborn; Salazar, 1980). So far none of the viral problems in cassava have been reported to be seedborn; according to literature only cassava bacterial blight (Elango and Lozano, 1980) anthracnose (CIAT, 1981) and a *Fusarium* sp. (CIAT, 1982) are seedborn pathogens of the crop, but they can be eliminated by heat and fungicide treatments (CIAT, 1981-1982). However, the sexual propagation of cassava is scattered and rare in traditional systems and is mostly used by scientists in the process of genetic improvement (Hershey and Amaya, 1982). As native or parental genotypes obviously evolved in traditional systems, they have been under biotic and abiotic stresses for a considerable period of time. The effect of such stresses over time on genotypes could have been cumulative decreasing the quality of the planting material after several or many cycles of vegetative propagations. Evaluation of the progeny by comparison with native or parental genotypes without considering the quality of the planting material may give unreliable results.

The effect of cutting quality on cassava performance is preliminarly reported here after comparing results of a year-cycle trials with planting material of a traditional genotype generated from meristem culture with other sources of planting material and with a selected hybrid.

Materials and Methods

Twenty centimeter long stem cuttings of the cultivar Secundina, a widely grown clone from the north coast of Colombia, from the following sources were used: (1) cuttings from plants generated by meristem culture and indexed for the absence of Frog Skin Disease, Caribbean and Common mosaics (CIAT, 1981 and 1982); (2) cuttings from farms, but selected from plants which were apparently healthy (without mosaic symptoms) and from the mature stems, free from injuries and any signs of cassava pathogens or pests; (3) planting material from farms taken from the mature stem portions of unselected plants, free from injuries and signs of cassava pathogens and pests; (4) planting material selected from mature stem portions of plants showing mosaic, but free from necrotic signs of cassava pathogens and pests; (5) planting material taken from farmer's fields following the farmer's criteria of selection (selection of stem pieces without considering maturity and/or sanitary condition of the cuttings); (6) cuttings from the hybrid CM 342-170 produced at the CIAT-Palmira Experimental Station; and (7) cuttings from the hybrid CM 342-170 selected after a year growth-cycle on a farm near the trials. Two different trials were performed in the north coast (Media Luna region) using the above treatments: One to compare the effect of cutting sources with the local native genotype, and the other to compare the native genotype with the hybrid which was previously selected as promising on the north coast (CIAT, 1980 and 1982). The Media Luna area of Colombia has an average temperature of 27°C and average rainfall 1100 mm/year with a 4-month dry season with essentially no rain. The soil of the locality is sandy with a pH of about 6.3.

All cuttings were treated with a solution mixture containing Captan/BCM (3000 ppm a.i. each) for 5 min before planting in a randomized block design of 30 plants/plot with 4 replicated. Experimental plots were separated by 2 m rows and plants planted 1x1 m apart in flat seedbeds.

The following parameters were evaluated during the 12 month cycle of the trials: percent germination of cuttings, plant height, mosaic symptoms, yields (ton/ha) of fresh roots, starch content and number of cuttings/plant. Starch was estimated by the specific gravity method (CIAT, 1980) and cutting production by counting the number of cuttings produced from the mature stem portion of each plant. Cuttings were also selected visually according to their sanitary state (absence of necrotic lesions caused by pathogens and pests), thickness and weight (Lozano et al, 1977).

As Caribbean mosaic was the most prevalent disease of the area, the presence of this disease in each cutting source was recorded every two months. Readings for all parameters were taken from all plants, except for yield (fresh root and starch) where data were taken only from the 12 central plants, to eliminate the border effect (CIAT, 1979).

Results and Discussion

The percentage germination of cuttings from farms where no selection criteria were used (Treatment 5) were 20% less than those of the cuttings obtained from other sources in both native and hybrid genotypes and showed significant (5% level) differences. However, percentage germination of cuttings from both the native and the hybrid used from other source were not significantly different.

Plants developed from cuttings obtained from plants generated from meristem cultures averaged 51 cm higher than the plants developed from cuttings obtained from other sources. The height of plants developed from selected (Treatment 2, 3 and 4) or non-selected (Treatment 5) cuttings with or without mosaic was not significantly different, but in general plants with mosaic were shorter than symptomless plants.

Mosaic symptoms were most striking during the rainy seasons, the coolest (21.8°C, maximum; 30.3°C, minimum) periods in the region. During the dry, hot periods (19.3°C, min.; 34°C, maximum) mosaic symptoms decreased and they were barely noticeable at the end of the dry season. This agrees with the results obtained under controlled conditions (Table 1), suggesting that mosaic symptoms are highly heat sensitive. However, when plants were transferred back to a cool environment (20-21°C), severe symptoms reappeared. This was also observed in field trials at the onset of the second rainy season of the growth cycle when plants were 10 months old.

Table 1. Effect of temperature on the expression of mosaic symptoms on variety Secundina (MCol 2063) under controlled conditions.

Temperature Range*	Severity of Symptoms
21-22°C	Severe†
23-24	Severe
25-26	Severe
27-28	Moderate
28-29	Moderate
31-32	Absent

*Light intensity 4,800-6,400 lux/12 hrs.

†Symptom expression of cassava Caribbean Mosaic on Secundina: severe=leaf distortion and curling, plant stunting; moderate=light leaf distortion, vein clearing; absent=no mosaic symptom expression.

Undoubtedly, visual selection of cuttings has a significant positive effect on yield. This increase also appears to be related to the absence of mosaic symptoms on plants. The highest yield produced by plants produced by cuttings regenerated from meristem cultures suggest that accumulative unnoticeable factor(s) were present in cuttings from other sources and that they were able to decrease the yield significantly. Similar results were also obtained in relation to the total cutting production (Table 2). The ratio of the quality of the cuttings (good: poor = 2:1) obtained with cuttings produced from meristem culture plants gives the growers a higher possibility of selecting good quality cuttings than when they use other sources of planting material. When planting material is unselected the quality ratio (1:2) tends to decrease the probability of farmers selecting good material for next growing cycle. This may partially explain the gradual but constant decrease in cassava genotype performance as well as the great variability of plant-to-plant yield and general performance often reported in the literature (CIAT, 1979). However, other abiotic or biotic factors for such variability could also be responsible.

The yields (fresh roots or starch content) of the hybrid and the native Secundina were similar, reflecting the similarities in genetic yielding ability of these two genotypes under the environmental conditions where they were tested. However, when unselected Secundina planting material (i.e. farmers usual practice, Treatment 5) was used the hybrid yielded 2.5 times more than the native genotype. Similarly, the yield of the hybrid itself with planting material selected from the farmers' field after the first growing cycle was 32% less than the yield of the plants whose planting material originated from the CIAT's Experimental Station (Table 3). This indicates the great influence of environmental factors (diseases, pests, cultural practices, climate, soil, etc.) in determining the final quality of cassava planting material after each growing cycle. Results also indicate that an accurate evaluation of genotypes can only be made if evaluated material is planted with cuttings which are similar in agronomic (maturity, size, weight, number of nodes) and sanitary (absence of pests, diseases, insects, spider mites) conditions.

From the above results it can be concluded that the performance of a cassava genotype may decrease with time because the biotic and abiotic pressures of the ecosystem on the genotype may act continuously to reduce the quality of its planting material. The yield stability of a good performing genotype is related to the genetic capacity of the genotype to overcome such pressures. The potential performance of a native genotype can be measured only by using high quality planting material obtained through meristem culture and good cultural practices, a fact that has a great influence on final yield and which should be considered when comparing improved genotypes with the native ones during evaluation.

Results also show the great effect that the sanitary condition of the cuttings has on yield. Yields could be increased by visual selection of the most vigorous and healthy plants of plantations, a careful selection of mature-lignified stem portions, free from cankers and mechanical damages, and treatments with appropriate fungicide-insecticides (Lozano et al, 1977). Devoting a plot of each farm exclusively to the production of planting material will greatly help the growers to obtain high quality cuttings if appropriate cultural practices related to soil preparation, fertilization, weed control, insect-disease control, are given to these plantations.

Table 2. Yield (ton/ha), percentage of yield reduction and number of cuttings per plant in the native clone 'Secundina' in relation to cutting source and type of selection.

		Yield (ton/ha)			Number of cuttings per plant / quality	
Treatment	Cutting Source	Fresh root weight	Starch	Yield reduction (%)	Good	Poor
1	Secundina from meristem culture.	24.0 a*	7.9 a	0	6.2 a	2.8 ab
2	Secundina from farms without symptoms of mosaic; selected cuttings.	19.6 b	6.2 b	18.3	3.6 bc	4.9 ab
3	Secundina from farms without regard to mosaic symptoms; selected cuttings.	18.2 b	5.8 b	24.2	3.8 b	4.4 ab
4	Secundina from farms with mosaic; selected cuttings	14.7 c	4.5 c	38.7	3.2 bcd	3.5 b
5	Secundina from farms without regard to mosaic symptoms and without selection of cuttings	7.3 d	2.4 d	69.5	3.4 bcd	5.5 a

*Values with same letter are not significantly different by Ducan's multiple range test (P=0.05).

Table 3. Yield and number of stakes per plant in the native clone 'Secundina' and the hybrid CM 342-170 in relation to cutting source and type of selection.

		Yield (ton/ha)		Number of cuttings per plant / quality	
Treatment	Cutting source	Fresh root weight	Starch	Good	Poor
1	Secundina from meristem culture.	26.0 a*	7.6 a	6.7 a	3.6 a
5	Secundina from farms without regard to mosaic symptoms and without selection of cuttings.	8.2 b	2.6 b	3.3 b	5.4 b
6	CM 342-170 from CIAT; selected cuttings.	26.1 a	7.0 a	6.3 a	9.6 b
7	CM 342-170 from farms; selected cuttings.	17.8 c	4.3 c	6.0 a	9.1 b

*Values with same letter are not significantly different by Ducan's multiple range test (P=0.05).

Bibliography

Centro Internacional de Agricultura Tropical. 1979. CIAT Annual Report 1978. CIAT, Cali, Colombia. GI-G25.

Centro Internacional de Agricultura Tropical. 1982. CIAT Annual Report 1981. CIAT, Cali, Colombia.

Centro Internacional de Agricultura Tropical. 1983. CIAT Annual Report 1982. CIAT, Cali, Colombia (In press).

Elango, F. and Lozano, J.C. 1980. Transmission of Xanthomonas manihotis in seed of cassava (Manihot esculenta). Plant Disease 64:784-786.

Hershey, C. and Amaya, A. 1982. Genética, citogenética, estructura floral y técnicas de hibridación de la yuca. In Yuca: Investigación, Producción y Utilización. PNUD/CIAT, Programa de Yuca, Cali, Colombia, 660 pp.

Lozano, J.C., Toro, J.C., Castro, A., and Bellotti, A.C. 1977. Production of Cassava Planting Material. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. Series GE-17, 28 pp.

Salazar, L.F. 1980. Enfermedades causadas por virus en papa. Manual Introductorio. Centro Internacional de la Papa, Apto. 5969, Lima, Perú. 50 pp.