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CASSAVA CULTURAL PRACTICES

Proceedings of a workshop held in Salvador, Bahia, Brazil, 18-21 March 1980

Editors:
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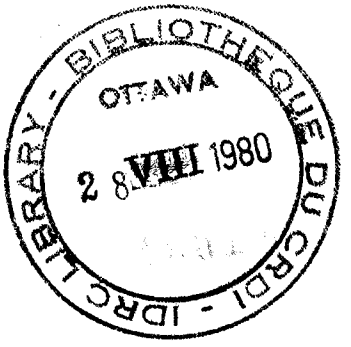

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Influence of Period and Conditions of Storage on Growth and Yield of Cassava

Antonio M. Sales Andrade and Dietrich E. Leihner[1]

Cassava planting often takes place during the rainy season, but harvesting is carried out during the dry season, thus there may be considerable periods of time between harvest and subsequent planting. As a result, storage of planting material for up to several months is necessary.

A great number of storage methods are used to preserve the stakes and protect them against physical damage, dehydration, and extreme temperatures. Chemical treatment is highly efficient in preventing pathogenic infestation, which is an important factor causing germination losses. In adequate storage conditions, chemically treated stakes can be preserved for 6 months under CIAT's conditions. Although there may be no losses in final stand, vigour of planting material is reduced and the number of thick roots tends to decrease. This translates into lower yields coming from stored stakes.

Practices that could reduce the effect of storage on the initial vigour and formation of thick roots could contribute to minimizing yield losses.

Cassava in Brazil is usually harvested in the so-called dormant periods between two rainy seasons because the product reaches a better commercial quality, with a maximum of root production and starch content (Conceição 1976; Normanha and Pereira 1964). When stakes are harvested during this season and are kept for the following planting, storage for up to 6 or 7 months may become necessary, as is the case in the northeastern part of Brazil (Correa and Vieira Neto 1978).

Cassava propagation material is susceptible to adverse climatic conditions and to pests and diseases. Thus, when exposed to the sun after cutting, it can loose viability in a short time due to dehydration. But excessive moisture may cause bud sprouting. Pathogens and pests are also common causes for bad sprouting after planting. Better sprouting is obtained with stakes harvested shortly before planting if compared to stored stakes (Correa 1970, 1977a, b; Silva 1970). Besides, there are varietal differences in the sprouting vigour of stakes, which are emphasized with extension of the storage period (CIAT 1977; Lozano et al. 1977).

[1]Monitor of the Cassava Project, EPAMIG and Specialist in Cassava Cultural Practices, CIAT, respectively.

Storage Period and Conditions

When storage is necessary, it is advisable to protect stakes against external agents and dehydration by using chemical products. Another possibility would be to inhibit early sprouting of buds and stimulate them when necessary. Theoretically this is possible and studies are being done in this field using hormones (CIAT 1978). However, hormone use is complex because slight mistakes in dosages can produce contrary effects, making application under farm conditions difficult.

The literature shows discrepancies in relation to the maximum possible period of stake storage. If no fixed period of time is given, expressions like "reasonable period," "several months," or "some time" are mentioned. Lozano et al. (1977) observed good sprouting after a storage period of 30 days, reference has also been made to 8 weeks (Krochmal 1969), to periods longer than 30 days (EMBRAPA 1976), and to a possible period of from 3 to 5 months (Mendes 1949).

The different opinions among researchers in relation to adequate storage conditions are due, at least partially, to the different environments in which they work, as well as to methodological and varietal differences. According to

Kiernowski (1950) cassava varieties have different storage performance depending on the conservation method used. Lozano et al. (1977) mentioned that there are sprouting differences between varieties that are stressed by extension of the storage period.

However, in spite of the different points of view, some aspects are common to all investigations.

(1) Stake storage. Storage should be avoided, if possible. Silva (1970) and Correa and Vieira Neto (1978) mention a trial in which a high percentage of sprouting was obtained with stakes planted shortly after harvest (100%) as compared to stakes kept vertically under tree shade (70%), in the field in a horizontal position (50%), under partial shade (80%), and in a cold room used for seed potatoes (20%).

(2) Stake position and storage environment. Horizontal and vertical positions are equally recommended and produce good results when storage is carried out in cool and shady environments avoiding direct sun, hot or cold winds, and dehydration.

(3) Position. When stakes are stored vertically, the buds should be facing up to obtain better sprouting.

(4) Stake length. Long stakes are better preserved than short ones (Castellar and Mogollón 1972; CIAT 1973, 1974).

(5) Stake quality. Stakes should have the right maturity and come from healthy cassava plantations. Material attacked by pathogens and/or pests should be avoided. In areas subject to frosts, stakes should not be stored above ground under field conditions.

Lozano et al. (1977) suggest the use of varieties tolerant to storage because they usually have a better sprouting potential. Stephens (1965) recommends stakes with the right maturity. These should not be wet when stored nor should they be exposed later to humidity.

Chemical Treatment

Stake spraying with a solution of Bordeaux mixture at 0.25% (Normanha 1946) or at 0.50% (Normanha and Pereira 1950) before storage prevents fungal attack. Mercury products used before storage also help to obtain good conservation (Viegas 1976). For CIAT (1974), stake treatment with the commercial product CIPC delayed bud sprouting 4 weeks, and according to CIAT (1979) the use of sodium alginate prevents dehydration during storage.

Lozano et al. (1977) mentioned that fungicide treatment before storage results in more than 90% sprouting after a month and a yield increase of more than 25%. A mixture of fungicide, insecticide, and/or miticide should be used. Among other products, a mixture of Orthocide and Bavistin (BCM and Captan) at a rate of 3000 ppm each is recommended. The advantages are their disinfective and protective action, the increase of conservation time, and the speed of sprouting and rooting.

In a 4-week conservation test using a variety with high sprouting potential (M Col 946), and another with low potential (M Col 803), and previous stake treatment with a mixture of BCM and Captam, the following yields were obtained: M Col 946 treated 28.0 t/ha, untreated 18.0 t/ha; M Col 803 treated 25 t/ha, untreated 0 t/ha (CIAT 1977).

Yield Trials

To evaluate this technology in longer storage periods under different conditions, a trial was carried out using planting material of the good sprouting variety CMC 76. Storage periods were 0, 30, 60, and 90 days. Storage conditions were a dry room on a wooden base (horizontally) or placed on the ground (vertically, with buds facing up) under a bamboo canopy, and covered with plastic in earth silos. The material was previously immersed in a solution of BCM and Captam (Bavistin and Othoxide) at 3000 ppm each.

When storage periods ended, the 1-m long bars were cut into 20 cm stakes and treated with a mixture of fungicides, insecticides, and micronutrients, in a preplanting treatment, and were ridge planted at 1.0 × 1.0 m. The field was previously irrigated to ensure good humidity conditions.

Sprouting

The final sprouting percentage as well as the sprouting rate (number of plants/day/plot) was determined. In adequate storage conditions (dry room or bamboo shade), the sprouting rate was greater in stored material than in fresh material, independent of storage period. Even with inadequate storage conditions (earth silos, 1.0 m or 20 cm stakes) the sprouting rate with 30 days of storage was higher than the rate obtained with fresh material.

The final sprouting percentage was almost not affected by storage duration under adequate

Table 1. Cassava fresh root yield as influenced by condition and time of storage of planting material (CIAT 1979).

Condition of storage	Time of storage (days)	Stand at harvest (%)	Root yield (t/ha)
Dry room, 1 m stake, vertical	0	100	35.5
	30	100	29.7
	60	98	26.9
	90	98	24.0
Open air, shade, wooden base, 1 m stake, horizontal	0	100	35.5
	30	100	24.5
	60	100	24.0
	90	94	25.5
Open air, shade, 1 m stake, vertical, on soil	0	100	35.5
	30	100	31.9
	60	100	27.8
	90	96	23.9
Earth silo, 1 m stake, plastic wrap, horizontal	0	100	35.5
	30	73	20.3
	60	65	19.6
	90	0	0.0
Earth silo, 20 cm stake, plastic wrap, horizontal	0	100	35.5
	30	96	31.5
	60	79	21.8
	90	0	0.0
C.V.%		8.7	16.0
SD		7.26	3.9

Table 2. Effect of storage duration of planting material on root characteristics of cassava plants harvested 11 months after planting. Variety CMC-76, chemical treatment: BCM and Captan at a rate of 3000 ppm each. Means of five storage conditions (CIAT 1979).

Storage duration (days)	No. roots per plant	No. marketable roots per plant	Mean root length (cm)	Mean root perimeter (cm)
0	12.2a[a]	7.5a	26.3	19.8ab
30	11.5a	6.2ab	26.1a	19.3b
60	9.4b	5.1b	27.2a	21.1a
90	10.7ab	5.8b	26.7a	21.0a

[a]Figures followed by the same letter are not significantly different at the 5% level (Duncan's Multiple Range Test).

storage conditions, reaching 95–100% in all periods. On the other hand, the final sprouting percentage was drastically reduced with longer storage periods, when conditions were inadequate.

Cassava Yield

Both duration and condition of storage affected fresh root yield (Tables 1 and 2). Yield decreased as a consequence of longer periods of storage under any condition, but the decrease was more drastic under inadequate conservation conditions. The effect of length and storage conditions as well as their interaction were highly significant ($P = 0.001$). The significant interaction effect indicated that with longer storage periods, the conditions under which planting material is stored become more critical. Fresh root yields proved that the best storage condition in this trial was under a bamboo canopy with 1 m stakes stored vertically and buds facing up. Rooting and partial sprouting did

not seriously affect conservation or establishment of the crop. On the other hand, stakes (1.0 m or 20 cm) wrapped in plastic and buried in silos of about 80 cm depth produced excessive humidity and suffered premature sprouting. This caused great reductions in sprouting after planting.

Under these conditions, the difference in yield due to different storage periods was explained by final stand percentage ($r^2 = 0.90^{***}$). In contrast, under adequate conditions (under bamboo canopy, on a wooden base, or on the soil) a great part of the variation of fresh root yield due to the different storage periods could not be explained by the final stand percentage ($r^2 = 0.42^{n.s.}$). This showed that besides plant population, other factors related to duration and condition of storage influenced root yields (Figure 1).

Size and Number of Roots

Plants from stored stakes produced less total and commercial roots per plant, than those originated from fresh material. Plants with less roots had a tendency to compensate for lower root numbers by increasing root size, however, this was not enough to balance production. The decrease in number of roots per plant was significant, and partially explains the reduction in yield ($r^2 = 0.80^{****}$) even under adequate storage conditions.

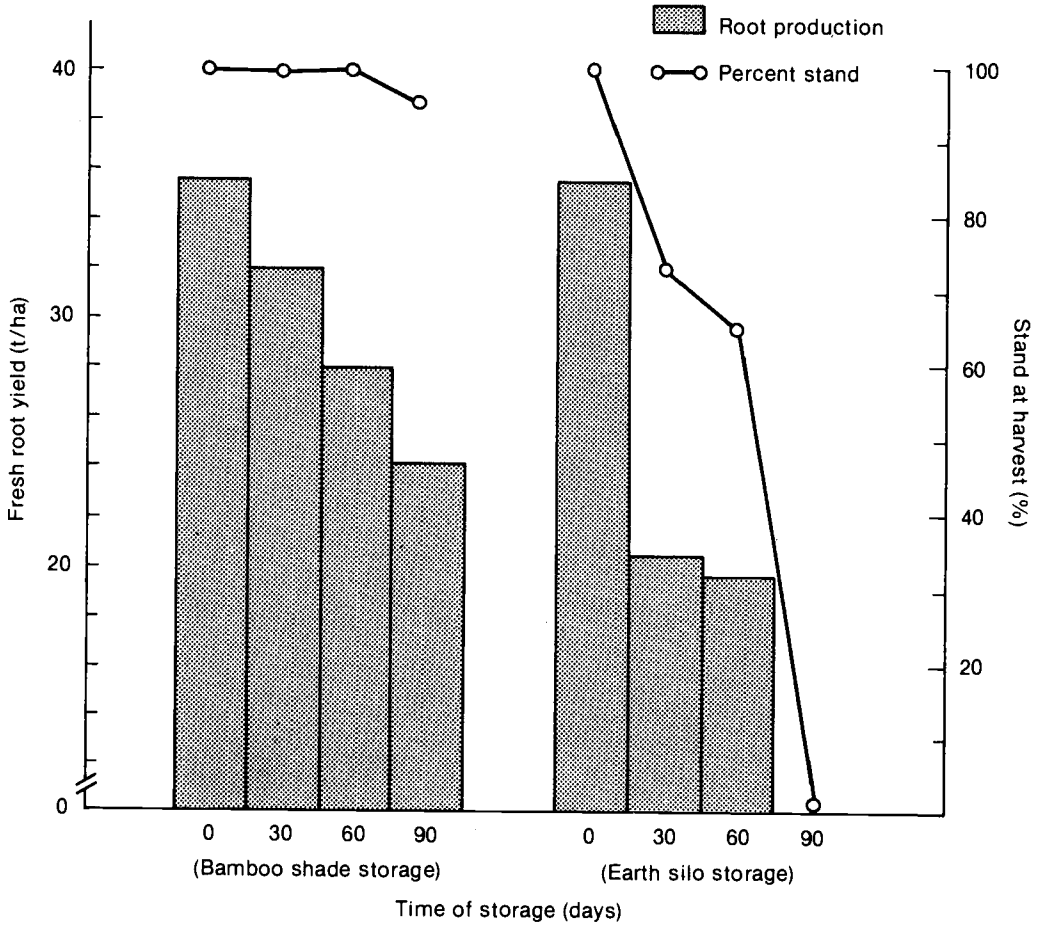

Fig. 1. Percent stand at harvest and cassava fresh root yield as influenced by time of storage under two different storage conditions at CIAT/Palmira, 1979.

Table 3. Effect of storage duration on growth parameters of stakes of variety CMC-40, kept under a bamboo canopy and treated with BCM and Captan (3000 ppm each).

Storage duration (days)	Sprouting 31 DAP[a] (%)	Sprouting rate (plants/day/plot)	Plant height 45 DAP (cm)	Leaf size 60 DAP (cm)	Avg. no. stems per plant 60 DAP	LTR[b] 76 DAP (%)
0	100a[c]	1.73a	26a	278ab	2.66a	23a
60	100a	1.83a	27a	282ab	2.73a	22a
120	100a	1.59ab	23b	253b	2.36b	28a
180	98b	1.40b	25ab	296a	2.23b	25a

[a]DAP = Days after planting.
[b]Light transmission ratio.
[c]Figures followed by the same letter are not significantly different at the 5% level (Duncan's Multiple Range Test).

Initial Growth and Storage Duration

In a recently planted trial with stakes stored for up to 180 days, the influence of storage duration on initial growth was studied in greater detail. Because the material was treated with fungicides and was adequately stored (under bamboo canopy, vertically, on the soil) no effect of the storage period on final sprouting percentage was observed, sprouting 1 month after planting being almost 100% even with 4 and 6 months of storage. However, there was a reaction in relation to other parameters (Table 3). A lower germination rate with storage periods above 60 days and shorter plants could be due to less vigour of the stored material. Also, smaller leaves (with the exception of 180 days storage) and the significant reduction of number of stems per plant as well as a higher light transmission ratio (LTR) may be an expression of this reduced vigour. It is interesting to note that there was no significant decrease in growth parameters with 60 days of storage.

Final harvest data should indicate how the reduced germination rate and slower initial growth, will affect the development of the root system and the formation of thick roots. Identification of factors that make plants from stored stakes less efficient in terms of early growth and thick root formation could allow the development of even better practices to preserve vigour of planting material and minimize yield losses.

Conclusions

The results and observations obtained up to the present are:

(1) The most important factor in cassava yield decrease due to stake storage is reduction of sprouting produced by pathogenic infestation or unfavourable environmental conditions during storage. Poor sprouting results in a deficient population at harvest.

(2) Under adequate storage conditions and chemical treatment, cassava stakes can be preserved for several months, keeping high sprouting percentages.

(3) In tropical climates, storage of planting material under tree shade, eliminates the need for special and expensive facilities.

(4) Storage conditions will be more critical the longer the duration of storage.

(5) When sprouting potential of stakes is preserved by chemical treatment and adequate storage conditions, yield reduction can no longer be explained by final stand percentage. In this case, it seems that other factors affecting top and root growth are responsible for yield variations.

(6) Identification of these factors will allow the identification of management practices for stored planting material, not only to ensure a high sprouting percentage but also to minimize yield losses.