THE EFFECTS OF PROPAGATION TECHNIQUES ON THE YIELD OF CASSAVA

V. Vichukit and J.C. Toro

Centro Internacional de Agricultura Tropical,
Apartado Aéreo 67-13, Cali, Colombia, S.A.

INTRODUCTION

Cassava (Manihot esculenta Crantz) is usually propagated by stem cuttings. Such cuttings are used as planting material to establish commercial crops. Cuttings are normally made from stems of plants older than 9 months (Wholey, 1974). Molinyawe (1968) and Stuart (1972) recommended the age of the planting material to be at least 10 months old, and the use of the lower two-thirds of the stem. However, Chan (1969) found no significant differences in yield from basal, middle and apical cuttings. Research recommendations at different locations show that the optimum length of cuttings used by farmers ranges from 15 to 30 cm (Filho, 1946; Ekandem, 1962; Molegode, 1924; Molinyawe, 1968; Stuart, 1972).

Although the vegetative method of propagation is used in commercial plantings, it gives a slow rate of plant multiplication. Cassava research is, therefore, repeatedly hampered by the lack of sufficient promising planting material (CIAT, 1972), hence the importance of developing rapid propagation methods. Single-node woody cuttings have been successfully used for rapid propagation in Venezuela and Brazil (Wholey, 1974). Chant and Marden (1958) have developed techniques that use young green shoots produced from stem cuttings. Similarly, rooted single-node and single-bud eye cuttings from stems have been successfully used in an attempt to produce plants free from cassava bacterial blight (Lozano & Sequeira, 1974).

Development of techniques for rapid propagation of cassava was initiated at CIAT in 1971. Cock et al. (1976) compared the rate of commercial methods and rapid propagation methods showing that starting from one mature plant with 30 normal cuttings, it was possible to produce 900 and 36,000 normal planting pieces, respectively, after one year. However, it was pointed out that this rapid propagation method was only suitable for use at research stations in the lowland tropics because of the requirement for sophisticated and expensive equipment (CIAT, 1973; Wholey, 1974).

The objective of this study was to determine whether in fact root yield from rapid propagation techniques were comparable to those obtained from planted stakes after a similar period of growth.

MATERIALS & METHODS

Propagation frames and rooting chambers of the type described by Cock et al. (1976) were filled with clay loam soil. The soil was sterilized before use by fumigation with methyl bromide at the rate of 1 lb/cu yd. Two-node stem cuttings were taken from plants which were 11 months old. The variety MCol 673 was used. The cuttings were treated with a 5% arazan water solution for five minutes to prevent attack from soil fungi. After drying these cuttings for 2 hours, they were planted horizontally at 1 cm below the soil surface in the propagation frames. Daily watering was done to maintain soil moisture at field capacity. Shoots appeared 2-3 weeks after planting, and these green shoots when 8 cm tall were excised with a razor blade sterilized in 1% potassium hypochlorite. The shoots were rooted either in peat pots and waxed paper cups filled with clay loam soil in a propagation frame, or in flasks filled with sterile water in a rooting chamber depending on the treatment. In the preparation of the cuttings, care was taken to sterilize all equipment before use.

Five different cassava propagation techniques were tested:

1. Rooting in peat pots (8 cm in diameter) filled with clay loam soil for 18 days and subsequent transplanting to the field

without removal of the pots (Fig. 4).

2. Rooting in waxed paper cups (5 cm in diameter) filled with clay loam soil for 18 days and subsequent transplanting to the field after careful removal of the cups (Fig. 5).
3. Rooting in flasks (25-ml glass flasks) filled with sterile water for 18 days and subsequent transplanting to the field at the long root stage (1 cm long) (Fig. 6).
4. Rooting in flasks (25-ml glass flasks) filled with sterile water for 8-10 days and subsequent transplanting to the field at the callus formation stage (Fig. 7).
5. Planting 20-cm long stem cuttings directly to the field as a control treatment (Fig. 8).

The plants were grown in deep holes on ridges at a spacing of 1m x 1m, and the stakes were planted in a vertical position at the same spacing. The depth of planting was such that the plants were buried to the base of the lowest leaf (5 cm approximately), taking care not to damage the roots (Cock et al, 1976). Plants were watered daily for the first 27 days. Weed control was carried out by spraying with gramoxone at the rate of 2 litres/ha before planting, and by three hand weedings at 60, 120 and 180 days after planting.

The above five treatments were used in two experiments laid out in a randomized complete block design, replicated 4 and 3 times, respectively.

Experiment 1: Twenty-five plants of each treatment were planted per plot, and nine central plants were harvested at 10 months after planting.

Experiment 2: One hundred and twenty-six plants of each treatment were planted in 21 rows per plot. Due to insufficient material for a single planting, each replicate of the complete five treatments were planted at a slightly different time. Four plants were harvested from alternate rows at monthly intervals, starting from the first month up to the tenth month. At each harvest, the plants were carefully lifted to prevent damage to the root systems. Root fresh weight, total plant fresh weight, number of thickened roots and number of total roots were recorded.

RESULTS

Experiment I

Yields and yield components of 10-month old plants harvested from experiment I are shown in Table 1. There were no significant differences at the 5% level between treatments in fresh root yield and in total plant fresh weight. The fresh root yield of the treatments 1, 2, 3, 4 and 5 were 29.2, 26.3, 20.8, 22.7 and 21.1 tons/ha, respectively. Total plant fresh weight of treatment 5 was 81.2 tons/ha, whereas that of treatment 4 was 57.5 tons/ha.

Treatment 5 had a significantly lower harvest index than the others which showed no statistical difference at the 5% level amongst themselves.

Significant differences were found between treatments for total and thickened root numbers per plant at the 5% level. Total root number per plant varied from 13.6 in treatment 5 to 9.8 in treatment 4, while thickened roots per plant varied from 7.4 in treatment 5 to 5.8 in treatment 3.

Experiment II

Fresh root yields per plant of the five treatments over the period of 10 months are shown in Fig. 1. The yields of the treatments 1, 3 and 4 increased throughout the period. In treatments 2 and 5, the yield increased from one month, reaching a peak at nine months and falling in the tenth month. The average yields of the treatments in a descending order were 36.4, 35.9, 28.4, 26.7 and 16.8 tons/ha (Table 2). There were no siginificant differences in yield among the treatments throughout the period of growth. Total plant fresh weight increased with time in all treatments except in treatment 2 (Fig. 2). Table 3 shows that at the tenth month the total plant fresh weight of treatment 4 was 86.4 tons/ha, whereas treatment 2 gave 63.9 tons/ha.

In terms of total number of roots per plant, treatment 5 produced more roots on the average than the other treatments over the 10 months because of its greater vigour (Table 4). The number of thickened roots per plant remained constant in all treatments (Fig. 3) from the third month up the tenth month, and there were no differences between treatments (Table 5). At the tenth month, all treatments possessed 7 to 8 thickened roots per plant.

Harvest indices obtained in the tenth month confirmed those from experiment I in being significantly lower in the treatment 5 (Table 6).

DISCUSSION

From the data presented of the both experiments, it appears that the production of fresh root yield of all the five treatments at ten months were not significantly different (5% level). This suggests that this method of rapid propagation not only provides planting materials but also gives yields, comparable to normal cuttings over the same period of growth. Although the data did not indicate significant statistical differences between root yields, it would seem from the trends in Fig. 1 that root yields of the treatments from rapid propagation techniques were higher than from stakes. The increase in yields of the five treatments from three months to ten months was not due to a large increase in the number of swollen roots but rather to an increase in their size (Table 5).

Callus and pot treatments suffered less in transplanting; this may explain the superior yields of these treatments in both the experiments. In addition, the use of the callus treatment saved time when compared to the long root treatment which were transplanted at least 10 days later. Since in the transplanting process long roots were apt to suffer more, this could retard growth and explain why the long root treatment was always inferior in yield.

The favourable yields of plants from rapid propagation techniques would therefore enable such plants to be utilized under the following circumstances:

1. For the establishment of new farms where one usually encounters problems of insufficient planting material in the form of stakes.

2. When a disease outbreak occurs and there is a need for destruction and elimination of diseased plants, and the replanting with disease-free material.

3. For the release of new varieties or the evaluation of new varieties in regional trials; rapid propagation techniques save the time required in the multiplication of plants to be used as stakes.

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FIG. 1. MEAN ROOT FRESH WEIGHTS PER PLANT OVER 10 MONTHS

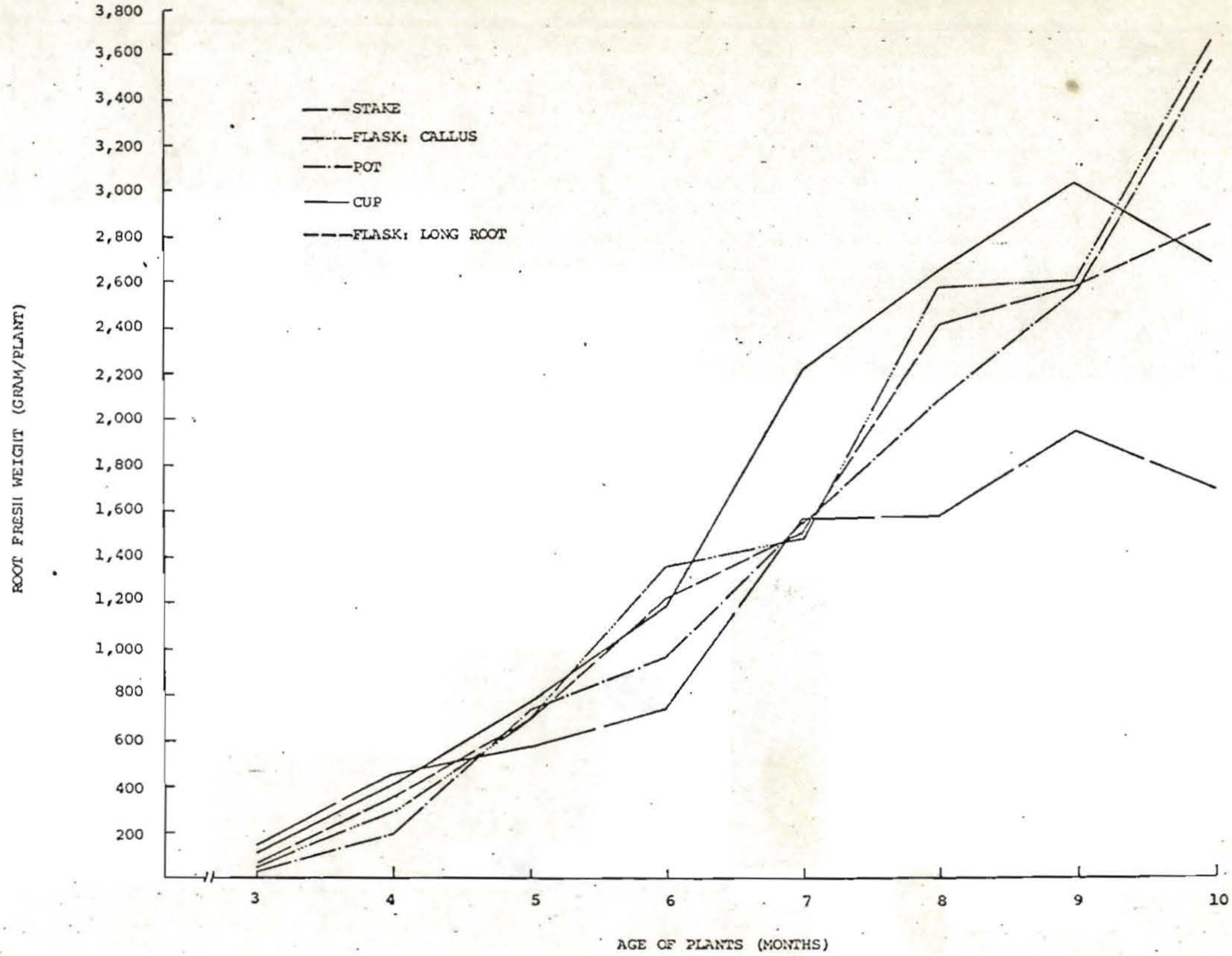

FIG. 2. MEAN TOTAL PLANT FRESH WEIGHTS OVER 10 MONTHS

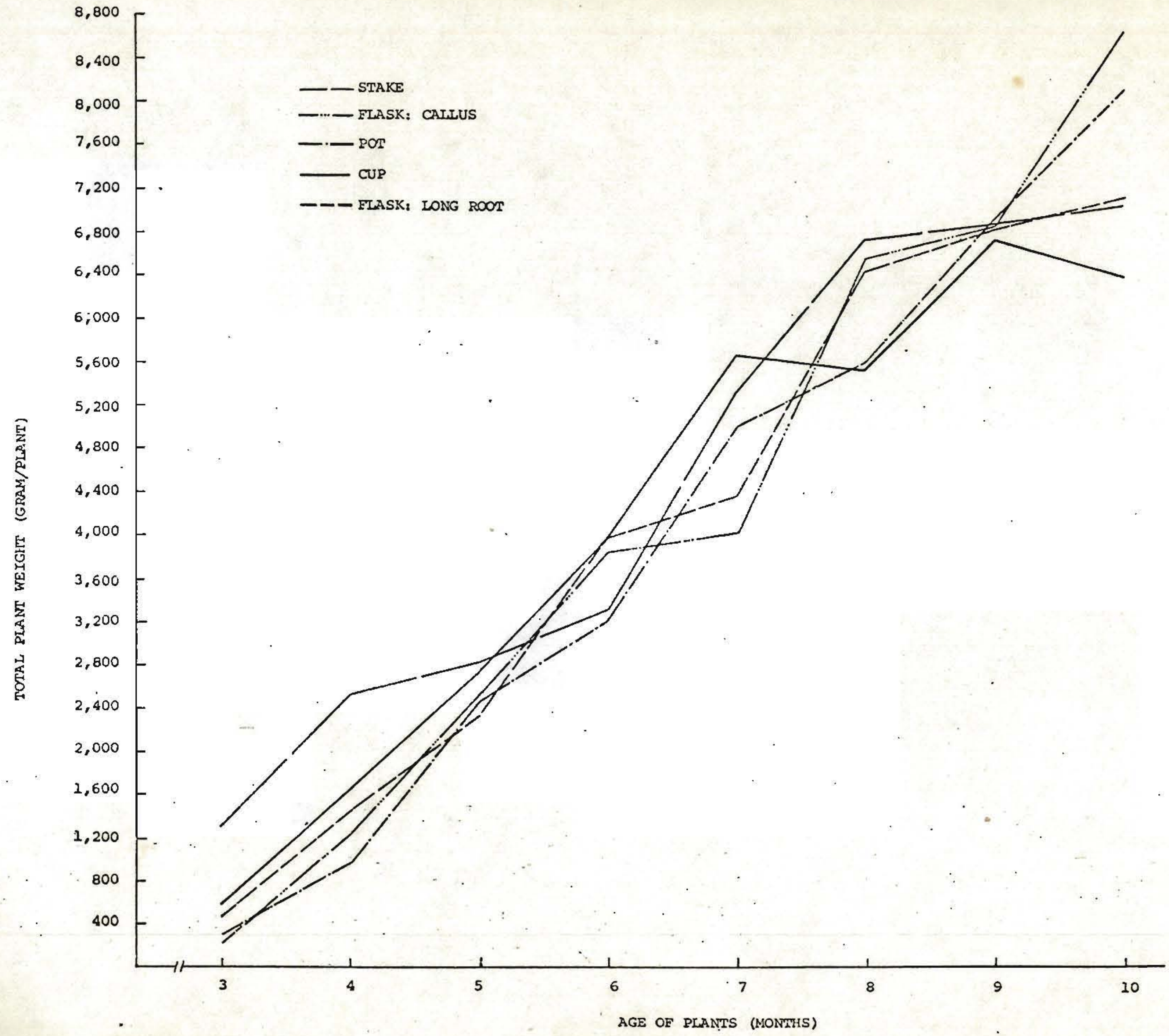

FIG. 3. MEAN NUMBERS OF THICKENED ROOTS PER PLANT OVER 10 MONTHS

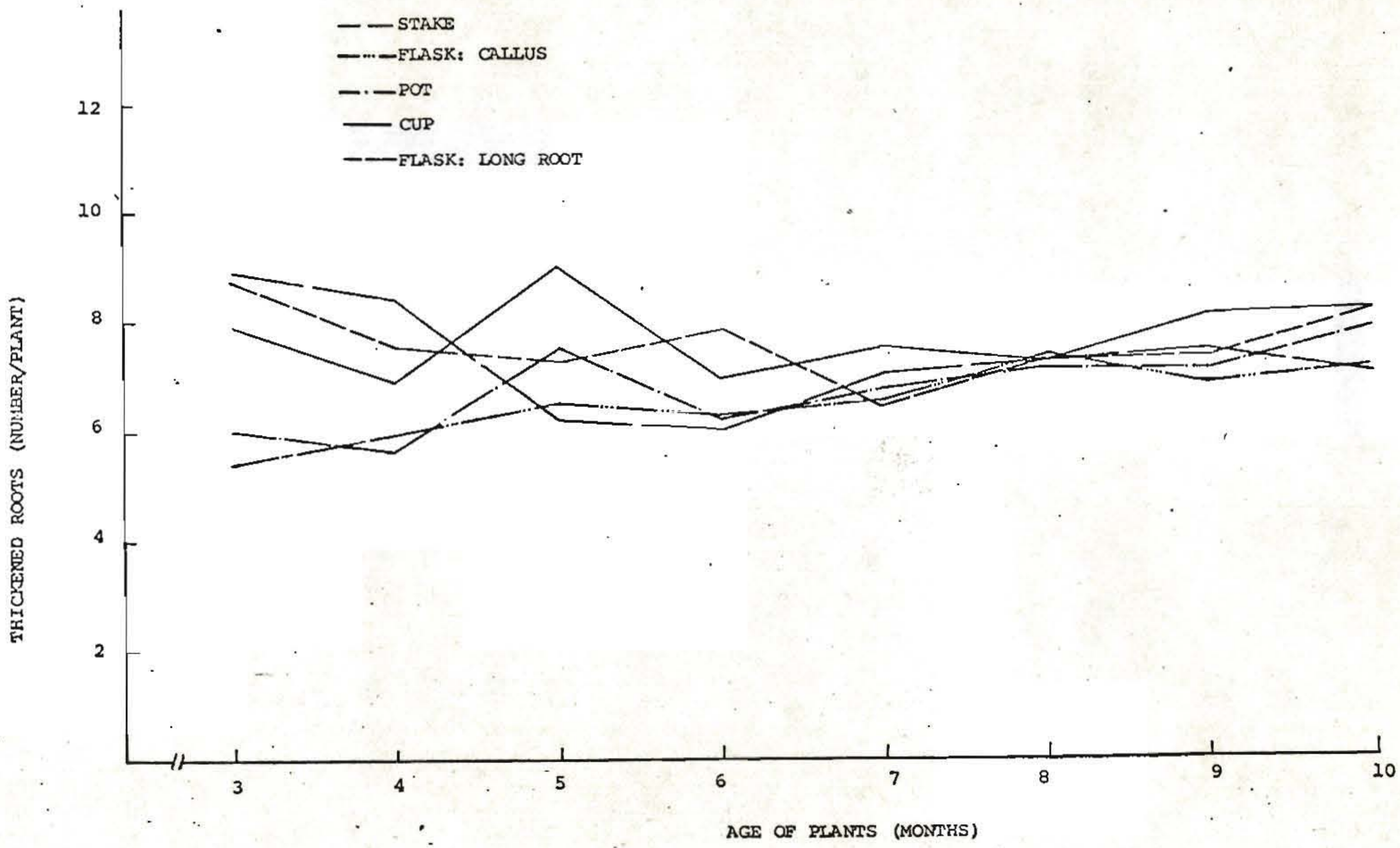

Figure 4. Treatment 1: Rooted shoots in peat pots filled with clay loam soil ready for planting.

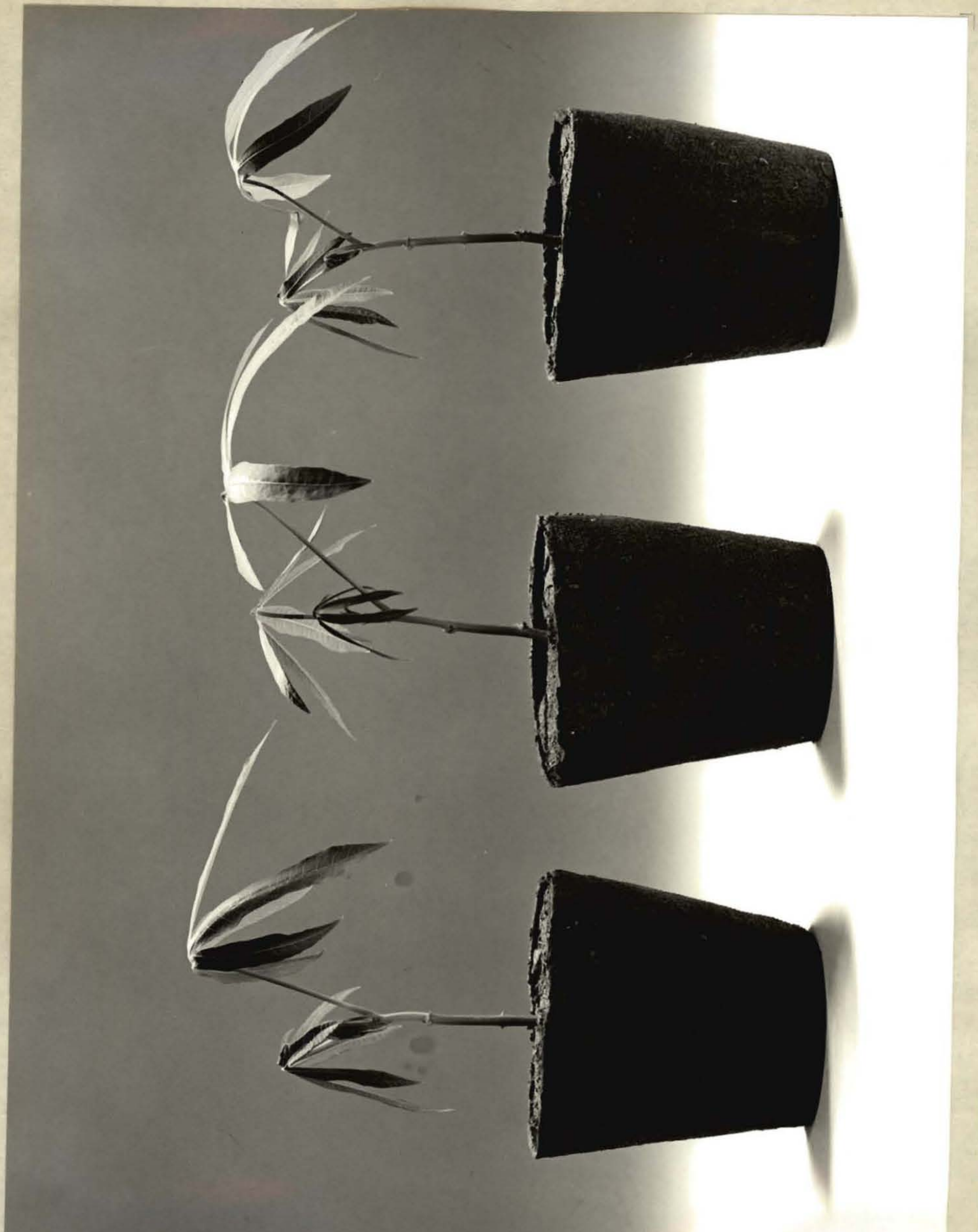

Figure 5. Treatment 2: Rooted shoots in waxed paper cups filled with clay loam soil ready for planting.


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Figure 6: Treatment 3: Rooted shoots in flasks filled with sterile water ready for planting at the long roots stage.

Figure 7. Treatment 4; Shoot in the callus formation stage ready for planting, having been rooted in a flask filled with sterile water.

Figure 8. Treatment 5: Stake cuttings of 20 cm length ready for planting.

TABLE 1. YIELDS AND YIELD COMPONENTS OF CASSAVA PLANTS HARVESTED AT TEN MONTHS (EXPERIMENT I)

TREATMENT	Root yield (tons/ha)	Total plant fresh wt. (tons/ha)	Harvest Index	Total root number per plant	Thickened roots per plant
1*	29.2 a	73.7 a	0.40 a	10.5 c	7.3 ab
2	26.3 a	63.9 a	0.41 a	11.2 bc	7.1 abc
3	20.8 a	59.6 a	0.34 a	12.8 ab	5.8 c
4	22.7 a	57.5 a	0.40 a	9.5 c	6.1 bc
5	21.1 a	81.2 a	0.26 b	13.6 a	7.4 a
C.V. (%)	25.0	18.0	13.0	11.4	8.0

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

*
1 - Peat pots
2 - Waxed paper cups
3 - Long roots
4 - Callus
5 - Stakes

TABLE 2. WEIGHTS OF FRESH ROOTS PER PLANT (TONS/HA) (EXPERIMENT II)

	Age (months)									
Treatments	1	2	3	4	5	6	7	8	9	10
1	-	-	2.2 a	2.0 a	7.3 a	10.0 a	17.8 a	20.8 a	25.4 a	35.8 a
2	-	-	1.1 a	4.2 a	7.4 a	13.2 a	21.1 a	19.3 a	30.2 a	26.6 a
3	-	-	0.7 a	3.6 a	6.7 a	14.2 a	15.1 a	24.0 a	25.7 a	28.4 a
4	-	-	0.6 a	3.8 a	7.0 a	14.3 a	14.9 a	25.7 a	25.9 a	36.3 a
5	-	-	1.4 a	4.4 a	5.7 a	7.4 a	15.3 a	15.6 a	20.3 a	16.7 a
Mean	-	-	1.0	3.6	6.8	10.1	17.0	21.0	25.5	28.8
C.V. (%)	-	-	15.0	28.0	29.0	28.0	29.0	37.0	29.0	38.0

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

TABLE 3. TOTAL PLANT FRESH WEIGHTS (TONS/HA) (EXPERIMENT II)

	Age (months)									
Treatments	1	2	3	4	5	6	7	8	9	10
1	-	-	3.0 a	9.7 a	24.6 a	32.3 a	49.9 a	55.9 a	68.8 a	81.7 a
2	-	-	5.9 a	16.3 a	27.8 a	39.6 a	56.5 a	55.3 a	67.3 a	63.9 a
3	-	-	4.7 a	14.9 a	23.3 a	39.7 a	43.5 a	64.7 a	68.1 a	71.4 a
4	-	-	2.7 a	12.5 a	25.2 a	39.0 a	30.3 a	65.0 a	68.5 a	86.4 a
5	-	-	13.2 a	25.7 b	28.1 a	33.1 a	53.3 a	67.5 a	68.7 a	71.2 a
Mean	-	-	5.9	21.0	25.6	36.7	48.7	61.7	68.2	77.6
C.V. (%)	-	-	23.0	22.6	19.8	16.9	12.7	22.4	15.3	23.1

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

TABLE 4. TOTAL ROOT NUMBERS PER PLANT (EXPERIMENT II)

	Age (months)									
Treatments	1	2	3	4	5	6	7	8	9	10
1	-	-	12.1ab	11.7b	13.0a	10.3a	11.0a	12.6a	11.2a	10.6a
2	-	-	15.3c	11.5b	13.5a	11.4a	12.3a	11.5a	12.2a	13.0a
3	-	-	15.1bc	15.2a	13.3a	13.3a	12.3a	27.5a	13.9ab	14.8a
4	-	-	9.9a	11.3b	11.8a	10.8a	10.7a	12.1a	12.4a	12.3a
5	-	-	15.1c	16.6a	17.9a	13.0a	14.9a	13.8a	16.2b	15.3a
Mean	-	-	13.5	13.3	13.9	11.8	12.3	12.8	13.2	13.2
C.V. (%)	-	-	11.0	13.0	18.0	15.0	18.0	13.0	12.0	19.0

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

TABLE 5. THICKENED ROOT NUMBERS PER PLANT (EXPERIMENT II)

	Age (months)									
Treatments	1	2	3	4	5	6	7	8	9	10
1	-	-	6.0 a	5.7 a	7.5 a	6.3 a	6.8 a	7.2 a	7.1 a	7.8 a
2	-	-	7.9 a	3.0 a	9.0 a	6.9 a	7.4 a	7.3 a	8.1 a	8.2 a
3	-	-	8.8 a	7.6 a	7.3 a	7.8 a	6.4 a	7.3 a	7.3 a	8.2 a
4	-	-	5.4 a	5.9 a	6.5 a	6.3 a	6.5 a	7.3 a	6.8 a	7.1 a
5	-	-	8.9 a	8.4 a	6.3 a	6.0 a	7.0 a	7.3 a	7.4 a	7.0 a
Mean	-	-	7.4	6.9	7.3	6.6	6.8	7.3	7.4	7.7
C.V. (%)	-	-	26.0	14.0	19.0	18.0	26.0	19.0	18.0	23.0

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.

TABLE 6. HARVEST INDICES (EXPERIMENT II)

	Age (months)									
Treatments	1	2	3	4	5	6	7	8	9	10
1	-	-	0.16a	0.20a	0.30a	0.31a	0.36a	0.34a	0.36a	0.44a
2	-	-	0.18a	0.26a	0.27a	0.34a	0.38a	0.35a	0.45a	0.42a
3	-	-	0.16a	0.24a	0.29a	0.35a	0.34a	0.36a	0.37a	0.38a
4	-	-	0.21a	0.21a	0.29a	0.37a	0.38a	0.40a	0.38a	0.42a
5	-	-	0.11a	0.17a	0.20a	0.22b	0.27a	0.25a	0.28a	0.22b
Mean	-	-	0.16	0.22	0.27	0.32	0.35	0.34	0.37	0.37
C.V. (%)	-	-	27.0	19.8	16.0	14.0	22.0	25.7	19.0	20.0

Note: Values in the same column having the same letter are not significantly different at the 5% level according to Duncan's new multiple range test.