

## **THE PERFORMANCE OF 'MINISTEM' CUTTINGS AS PLANTING MATERIAL IN CASSAVA (*Manihot esculenta* Crantz)**

J.B.D.S. KAHANDAWELA and T.N.A. JAYATILEKA  
*Regional Agricultural Research and Development Centre, Bomбуwela*

### **ABSTRACT**

Cassava is the most widely cultivated tuber crop in Sri Lanka. The high requirement of planting materials leads to certain problems such as low availability and high handling and transport costs. Cuttings become available only at harvest, compelling farmers to wait for long periods of 8 months or more. Thus, a methodology was tested to overcome these problems. Small stem pieces of 5-7.5cm ('ministems') were tested in two experiments carried out in two seasons, using two recommended varieties to evaluate plant height, plant girth, plant fresh weight and tuber fresh weight at 6 and 8 months after planting. Results show that with regard to vegetative growth parameters, there was no difference between the performance of the ministem and the conventional cuttings of 20cm, except in the time of harvesting. The 8-month harvest showed an increase in plant girth in both seasons. Plant height showed an increase in this respect only in one season. Plant fresh weight showed a significant difference only between varieties. The multiplication ratio increased from 1:14 to 1:23 in the first cycle and from 1:196 to 1:576 at the end of the second cycle. It was seen that the multiplication cycle could be reduced to 6 months after planting without incurring a significant yield loss.

**KEY WORDS:** Cassava, Ministem, Multiplication, Stem cuttings.

### **INTRODUCTION**

Cassava (*Manihot esculenta* Crantz), a major crop of the tropical region, is the most important tuber crop in Sri Lanka. It is at present cultivated in an extent of about 30,000ha, giving a total production of around 250,000t per annum. In the current Sri Lankan export market, cassava is the largest in terms of quantity (about 1500t annually) which brings in the highest foreign exchange earnings (Rs 46 million, FOB value) among all agricultural crops (Anon, 2002). It is a crop that is easy to grow, with few pest and disease problems. Cassava can withstand moisture stress and therefore, is a security crop in drought conditions. Being able to fit into many cropping systems, cassava is the bread of the poor and the sound investment of the rich farmer.

Despite all its advantages, cassava cultivation faces one major problem. It has a high planting material requirement of around 10,000 cuttings per hectare at the spacing of 90cm x 90cm (Ezumah and Okigbo, 1980) and a low multiplication ratio. Personal experience has shown this to be less than 1:15 in 8-10 months under well managed conditions. The length of the stem cutting used decides the total bulk required at planting. Long cuttings bring about a higher tuber yield (Krochmal, 1966, 1969; Gurnah, 1974) but they also lead to an inevitable dearth and a long wait for the planting material to become available. Long cuttings also incur a high cost on handling and transport.

Several methods had been tried out in the past to increase the multiplication ratio of cassava. Various tissue culture methods, using root promoting hormones such as IBA on parent cuttings (Chant and Marden, 1958) and a variety of shoot tissues including leaves, leaf buds, non-lignified leafy shoots and very small (2cm) woody stem pieces demonstrated success under mist chamber conditions (Sykes and Harney, 1972; 1974). More recently, 2-node woody stem cuttings had been used in covered black polyethylene bags (12.5 cm diameter; 25cm depth) for rooting, hardening, and transplanting in the field (Anon, 1982).

In view of the above facts, a series of studies were undertaken in 1998 to test various propagation methodologies under the low country wet zone conditions of Sri Lanka at the Regional Agricultural Research and Development Centre (RARDC), Bombuwela. The main objective was to increase the multiplication ratio of cassava using a simple technique that did not involve sophisticated equipment or complicated methodology. Consequently, short woody stem pieces (5-7.5cm with 3-5 nodes) termed 'ministems' were assessed to determine their ability to be used as planting material in establishing cassava successfully.

#### MATERIALS AND METHODS

The performance of ministems was evaluated together with conventional cuttings at two different harvesting times in two popular varieties in a 2x2x2 factorial experiment laid out in a split-split plot design with 3 replicates. The three factors tested were the time of harvest (6 and 8 months after planting), variety (MU51 and 'Kirikawadi') and the type of cuttings (5-7.5cm ministems and 20cm conventional cuttings).

Cuttings were taken from hardwood and semi - hardwood regions of the mother plant and planted at 90 cm x 90 cm in holes of 20cm x 20cm with a depth of 30cm. Holes were filled with soil mixed with 500g dried cowdung and 10g triple super phosphate. Ministems were planted horizontally at a depth of 2.5cm and the conventional cuttings vertically, leaving 1 or 2 buds above the soil. Basal fertilizer mixture (7g urea:7g muriate of potash/hole) was given at 3 weeks after planting as per fertilizer recommendations. The first and second top dressings were given at the latter rate, 2 and 4 months after planting. All plants were supplementary irrigated during the first month. Shade up to 30% was provided only for the ministems, during the first two weeks, using tree loppings.

The total plot size was 2.7m x 2.7m with 16 plants. Four plants in the centre were used in recording the data. Plant height, plant fresh weight, plant girth (one meter from the base) and the number of ministems and conventional cuttings obtainable per plant at harvest were used to assess the vegetative

growth of the plants arising from the two different cutting types. Ministem counts were taken only from plants grown from ministems and conventional cuttings only from plants arising from conventional cuttings. In assessing yield parameters, tuber fresh weight and tuber number per plant, maximum tuber girth and length were recorded at harvest.

This experiment was conducted three times during 1999 and 2001, the first of which was on an observational basis. Results of the other two experiments are presented as Experiments 1 and 2.

## RESULTS AND DISCUSSION

There was no two-way or three-way interaction effect in either of the two experiments. In keeping with the objectives of the study, Table 1 presents the data only on the vegetative growth of the two cutting types in relation to plant height, plant fresh weight and plant girth. Significant effects of other variables have been highlighted and discussed in the text.

The results show that plants arising from ministems performed equally well as the conventional cuttings in both Experiments 1 and 2. This suggests that there is no difference between the plants produced by ministems and conventional cuttings in terms of the recorded parameters. There was however, a significant effect of the time of harvesting on plant girth in both experiments, suggesting that plant thickness increased with delayed harvesting. A variety effect on plant height in Experiment 1 alone was also observed. MU 51 with the erect plant type showed a higher plant height than the other variety (results not included).

**Table 1.** Average plant height (m), plant girth (cm) and plant fresh weight (kg) of cassava arising from ministems and conventional cuttings in two experiments conducted at RARDC, Bomбуwela during 1999-2001.

<i>Treatment</i>	<i>Plant height</i>		<i>Plant girth</i>		<i>Plant fresh weight</i>	
	<i>Exp 1</i>	<i>Exp 2</i>	<i>Exp 1</i>	<i>Exp 2</i>	<i>Exp 1</i>	<i>Exp 2</i>
Mini stem	2.77 a	2.78 a	7.26 a	6.78 a	1.57 a	1.32 a
Conventional	2.71 a	2.79 a	8.14 a	7.03 a	1.71 a	1.65 a
CV (%)	11.19	6.01	12.6	19.8	23.2	30.7

Values followed by the same letter in each column are not significantly different at P=0.05

Table 2 presents data on the number of ministems and conventional cuttings and the tuber fresh weight that can be obtained at harvest.

**Table 2.** Mean number of ministems and conventional cuttings obtained at harvest and estimated mean tuber fresh weight (t/ha) in two experiments conducted at RARDC, Bombuwela during 2000-2001.

<i>Treatment</i>	<i>Number of cuttings</i>		<i>Tuber fresh weight</i>	
	<i>Exp 1</i>	<i>Exp 2</i>	<i>Exp 1</i>	<i>Exp 2</i>
Ministem	23.9 a	22.6 a	1.93 a	1.82 a
Conventional	14.3 b	13.2 b	2.19 a	2.14 a
CV (%)	18.1	35.5	17.9	21.8

Values followed by the same letter in each column are not significantly different at P=0.05

The cutting type had no interaction with either the time of harvesting or the variety in both experiments. This means that a significantly higher number of ministems (around 60%) could be obtained over the conventional cuttings at harvest. There was, however, a variety x time of harvesting interaction in Experiment 1, whereas in Experiment 2, only the variety effect could be seen, with MU 51 producing more number of cuttings because of its greater plant height. Results of Experiment '1 on the above interaction are given in Table 3.

**Table 3.** Mean number of ministems and conventional cuttings obtained from plants of two cassava varieties at 6 and 8 months after planting at RARDC, Bombuwela during 2000.

<i>Time of harvesting</i>	<i>Variety</i>	
	<i>MU 51</i>	<i>'Kirikawadi'</i>
6 months after planting	23.72 a	11.93 a
8 months after planting	21.98 a	18.73 b
CV%	9.8	

Values followed by the same letter in each column are not significantly different at P=0.05

The results show that the interaction was due to the reduction in the number of stem cuttings produced at 8 months after planting over the 6 months in the case of MU 51, which is due to random error and not due to the treatment effect.

Although tuber production has not been a primary objective of this study, all yield parameters were statistically analyzed. Only the time of harvesting effect could be seen in both experiments. Tuber fresh weight produced by both cutting types is given in Table 2. Conventional cuttings gave higher yields compared to ministems but the difference was not significant in either of the experiments. However, a significant cutting type x time of harvesting interaction was seen only in Experiment 2. Results of this experiment show that at 6 months after planting, ministems produced a lower yield than conventional cuttings. However, this drop in the yield has not been statistically significant. The interaction has been due to the decrease in the

yield of conventional cuttings when harvesting was delayed from 6 to 8 months. Such a decrease can be attributed only to random error.

This study shows that ministems cause vegetative growth as measured by plant height, plant fresh weight and plant girth that is as high as conventional cuttings. This means that no retardation of the growth of plants arising from ministems can be expected as compared to those emerging from conventional cuttings, irrespective of the variety and the time of harvesting. This is important, because plant height decides the number of cuttings obtainable from a single plant. On the other hand, plant girth and plant fresh weight indicate the vigour of such cuttings. Keating *et al.* (1988) observed that cuttings of greater diameter (27 and 37mm) gave a higher emergence compared to cuttings of smaller diameter (19mm).

A greater vegetative growth can be expected when harvesting is delayed from 6 to 8 months after planting, particularly in a variety that has a faster growth rate such as MU51. However, such an effect by the time of harvesting was seen only in stem thickness in both experiments and, in Experiment 1, in respect to plant height (data not included). The variety effect was seen in relation to plant height and plant fresh weight only in Experiment 1 (data not included).

There is little direct reference made to the vegetative growth of ministems in literature. However, certain authors suggest that when stem cuttings are small (5-10cm), they tend to bring about a lower number of sprouts per plot and a slower canopy formation, taking about 52 weeks, compared to 16 - 24 weeks taken by longer cuttings (15-30cm) (Garcia and Rodriguez, 1986; Anon, 1982; Forno *et al.*, 1976) observed that 5 to 6 cm cassava cuttings in certain cultivars tended to wilt even under continuous misting.

In the present study, however, there was a high establishment rate of over 90% and a faster canopy cover that took place in 8-12 weeks. This must have been due to the improvised shading supplied by tree loppings that was effective during the first two to four weeks. Supplementary irrigation provided during the first four weeks also would have helped in attaining the above. Forno *et al.* (1976) suggested that light shading (30%) showed a tendency to improve root growth and establishment of cuttings in certain cultivars.

The multiplication ratio that can be obtained from ministems is the most important factor that emerged from this study (Table 2). The increase in the number of ministems produced from a single ministem (23) is significantly higher than the number of conventional cuttings (14) produced from a single conventional cutting. This means that the multiplication ratio has increased

from 1:14 up to 1:23. If the cycle is repeated in the next season, the ratio of ministems:conventional cuttings produced from a single mother plant would be 576:196, an increase of 380 cuttings or a 200% increase in the propagule number.

As mentioned before, a significant variety x time of harvesting interaction was seen in the first experiment. Although main effects cannot be discussed in such situations, the effect of the variety factor is quite clear as the two varieties have different plant stature. MU 51 with an erect plant type has given a higher number of cuttings in both experiments compared to the bushy type 'Kirikawadi'. It is also evident that there has not been a significant increase in the number of cuttings obtained by prolonging the harvest until 8 months after planting in the variety MU 51. Therefore, there is no great advantage of keeping MU 51 beyond 6 months after planting in a multiplication programme. The variety 'Kirikawadi', on the other hand, continues to grow and produce more vegetative growth until 8 months after planting.

The number of nodes in a cutting is just as important as the absolute length of a cutting. Krochmal (1969) has recommended that a cutting should have at least three nodes irrespective of the size of the cutting. Ministems used in this study have met this requirement. Many scientists have shown that tuber yield increased with the size of the cutting (Anon, 1982; Garcia & Rodriguez, 1986; Onwume and Charles, 1994) reported that longer cuttings increased tuber fresh weight and number, and attributed this to the more number of sprouts and more stored food found in longer cuttings. This reporting was not found to be true in this study, where there was no significant difference between the two cutting types. Cassava is a crop of long age and there is time for recovery of any initial set back. It is important to note that even at 6 months after planting, there was no yield difference between the two cutting types. This suggests that, for a multiplication programme, harvesting can be done at 6 months after planting. A reduced multiplication cycle means reduced cost of production.

An economic analysis was done with respect to the use of this technology. The additional cost involved in raising a ministem is Rs. 7. This includes the material and operational costs on shading and irrigation. Thus, at a multiplication ratio of 1:23, the total additional cost involved would be Rs. 161. The total number of healthy plants that would be available for planting at the end of the second cycle would be 576 as opposed to 196 produced through the conventional system. If the farmer decides to sell his crop as conventional cuttings at this point, at a moderate rate of 10 cuttings per plant, he would get 5760 cuttings from the former method as compared to 1960 from the conventional method. At a selling price of Rs. 1 per cutting, he would get an additional income of Rs. 3800 through the ministem technology. This would

be only at an additional cost of Rs. 161. This shows that there is a significant economic gain in producing planting material through ministems and that this technology can be recommended for multiplying cassava under the low country wet zone conditions of Sri Lanka.

### CONCLUSIONS

Stem pieces of 5-7.5cm (ministems) can be used for direct planting in the field as effectively as conventional cuttings of 15-20 cm, for the purpose of getting a higher multiplication ratio in cassava. Ministems can give a high establishment rate with 30% shading for the first two weeks and supplementary irrigation for the first four weeks. Plants arising from ministems have a vegetative growth as high as those arising from conventional cuttings, in terms of plant height, plant girth and plant fresh weight. This was found to be true for the two recommended varieties MU51 and 'Kirikawadi' and for the two harvesting times of 6 and 8 months after planting. An increase in the multiplication ratio from 1:14 to 1:23 could be achieved through ministems in the initial cycle alone. It is estimated that the multiplication ratio can be increased from 1:196 to 576 by repeating the cycle. The multiplication cycle may be reduced to 6 months after planting without experiencing a significant loss in tuber yield. The economic gain at the end of the second cycle would be substantial.

### ACKNOWLEDGEMENTS

The authors wish to thank former Deputy Directors (Research) Mr. D. L. Wickramasinghe and Mr. C. A. Sandanayake and late Mr. C. Wijesundara, of the Regional Agricultural Research and Development Centre, Bombuwela for their encouragement and support extended to us throughout this study. The assistance received from Mrs. C. D. Wickramasinghe, Research Assistant and Mrs. H. Perera, clerical staff of the Regional Agricultural Research and Development Centre, Bombuwela is also highly appreciated.

### REFERENCES

- Anonymous. 1982. Land preparation and planting of cassava. Tuber and Root Crops Manual Series No 9, International Institute of Tropical Agriculture. IITA, Ibadan, Nigeria.
- Anonymous. 2002. Exports on Root Crops and FOB values during 1991 - 2001. Export Development Board Statistics for 2002. EDB, Colombo, Sri Lanka.
- Chant, S.R. and J.A. Marden. 1958. A method for the rapid propagation of cassava cuttings. *Tropical Agriculture* 35: 195-199.
- Ezumah, H.C. and B.N. Okigbo. 1980. Cassava planting systems in Africa. Proceedings of a workshop on cassava cultural practices held in Salvador, Bahia, Brazil, 18-21 March, 1980.

- Forno, D.A., C.J. Asher and D.G. Edwards. 1976. Mist propagation of cassava tip cuttings for nutritional studies: effects of substrate calcium Concentration; temperature and shading. *Tropical Agriculture (Trinidad)* 53:1, 47-55.
- Garcia, M. and S. Rodriguez. 1986. Optimum length of cuttings for planting Cassava (*Manihot esculenta*). *Ciencia- y-Tecuica-en-la-Agriculture, - Viandas - tropicales* 9:1, 23-33.
- Gurnah, A.M. 1974. Effects of method of planting and the length and types of cuttings on yield and some yield components of cassava (*Manihot esculenta* Crantz) grown in the forest zone of Ghana. *Journal of Agricultural Science* 7:103-108.
- Keating, B.A., G.L. Wilson and J.P. Evanson. 1988. Effects of length, thickness, orientation and planting density of cassava (*Manihot esculenta* Crantz) on subsequent establishment, growth and yield. *East-African Agricultural and Forestry Journal* 53:3, 145-149.
- Krochmal, A. 1966. Labour input and mechanization of cassava. *World Crops* 18:28-30.
- Krochmal, A. 1969. Propagation of cassava. *World Crops* 21:193-195.
- Onwume, I.C. and W.B. Charles. 1994. Tropical root and tuber crops production, perspectives and future prospects. *FAO Plant Production and Protection Paper* 126. FAO, Rome.
- Sykes, J.T. and P.M. Harney. 1972. Rapid clonal multiplication of manioc from shoot and leaf bud cuttings. *Journal of Royal Horticultural Society* 97: 530-534.
- Sykes, J.T. and P.M. Harney. 1974. Cassava propagation: the effects of rooting medium and IBA on root initiation in hardwood cuttings. *Tropical Agriculture (Trinidad)* 51: 13-21.