Journal of Root Crops, 2015, Vol. 41 No. 2, pp. 37-42
Indian Society for Root Crops
ISSN 0378-2409, ISSN 2454-9053 (online)

Effect of Pruning on Cassava Stem, Foliage and Tuber Yield

S. Sunitha, C.S. Ravindran, James George and J. Sreekumar

ICAR- Central Tuber Crops Research Institute,Sreekariyam,Thiruvananthapuram-695017, Kerala, India

Corresponding author: S. Sunitha, e- mail: sunitharajan1@rediffmail.com

Received: 24 November 2015; Accepted: 26 December 2015

Abstract

Field experiments were conducted for three years (2009-2012) to study the effect of pruning in cassava using three varieties (Sree Jaya, Sree Vijaya, and CE-347), three methods of pruning (pruning of 1/3rd top portion at 3rd month, pruning at ^{3rd} and 6th months and no pruning and two nitrogen doses (100 and 125 kg ha^{-1}) at ICAR-CTCRI, Thiruvananthapuram, Kerala. The treatments were assessed based on the total tuber yield, foliage yield and stem yield obtained. Pooled analysis of the three years data indicated significant difference with respect to the effect of pruning only and not for varieties or nitrogen levels. Control treatment without pruning recorded maximum tuber yield, however, it was on par with single pruning at 3rd month. Two prunings at 3rd and 6th months reduced the tuber yield significantly. Single pruning at 3$_{rd}$ month resulted in maximum foliage yield closely followed by pruning twice at 3rd and 6th month respectively. Leaf yield was less under no pruning. Stem yield was maximum with no pruning, but was on par with single pruning at 3rd month. Pruning twice significantly reduced the stem yield. So, wherever, foliage can be effectively used, single pruning can be practised without adversely affecting the tuber and stem yield of cassava.

Key words: Cassava, pruning, foliage yield, stem yield, tuber yield

Introduction

Cassava (*Manihot esculenta* Crantz) is an important source of starchy food in tropical regions. Cassava is a benchmark for food security because it is affordable by the poor and can be raised even when adverse climatic conditions limit the production of other foods. Apart from its role as staple / subsidiary food, the value of roots as a raw material for industrial starch and fuel alcohol is well recognised. Cassava roots are a rich source of energy, an average source of vitamins and minerals and a poor source of proteins. Cassava leaves are rich in calcium and a good supplier of proteins. Cassava leaves vary considerably in moisture, vitamin C and iron content.

Cassava has an indeterminate growth habit. There are five distinct growth phases in cassava: sprouting stage (5-20 days), leaf and root system development stage (20-90 days), canopy establishment stage (90-180 days) and high carbohydrates translocation stage (180-300 days). Once the sett is planted in the field, the stem that grows from the axillary buds may show two types of branching. Branches may develop from the lower part of the stem during initial stages or from the distal part towards later stages. Generally two stems are allowed to grow from the mother stem for realising better tuber yield and good quality planting material. Studies conducted at ICAR-CTCRI revealed that the leaf area development is slow upto third week after planting. Subsequently, leaf area development is faster and full canopy stand is attained between third and sixth month (Ramanujam and Biradar, 1987). For better light interception, a leaf area index of 2.5 to 3.5 was found to be optimum for cassava (Ravi, 2000). An optimum canopy spread and leaf area are sufficient to produce better tuber yield. So pruning can be adopted without adversely affecting the tuber yield.

Pruning or topping in cassava means the removal of a part of the shoot growth during the growing period of the crop. Stage and intensity of pruning depends on the purpose for which it was carried out. Pruning avoids mutual shading when the stand is dense or growth is excess. Leaves can be used as feed to cattle, pigs and chickens and reduces the demand of water during dry periods. However, severe pruning may result in reduction in tuber yield and can create wound entries for pests and pathogens. Most of the earlier studies reported varied effects on yield after pruning. Villamayor and Labayan (1982) found that a single pruning of 20 cm shoot length or longer at 3 months after planting (MAP) significantly reduced the yields. On the other hand, removing the upper 30 cm of the shoots at 4, 6, and 8 weeks intervals, starting at 4, 5 or 6 MAP did not affect root yield (Abenoja and Cerna 1983). Santiago (1980) reported that topping at 2-3 MAP reduced yields significantly while Arana (1979) reported an increased yield with pruning at 2 MAP. In a study conducted in Brazil, pruning at monthly intervals during September to April in two seasons and cassava when harvested after 22 months did not affect the dry matter content and root yield (Aguiar *et al.,* 2011). The present study was conducted under humid tropical conditions of Kerala, India to assess the response of different varieties and nitrogen application towards pruning and to find out the frequency of pruning in order to realise optimum cassava yield.

Materials and Methods

Experiments were conducted at ICAR-CTCRI, Thiruvananthapuram, Kerala for three consecutive years (2009-2010, 2010-2011 and 2011-2012) in split-split plot design with 3 cassava varieties in main plots (V1-Sree Jaya, V2-Sree Vijaya, V3- CE-347), three pruning treatments in sub plots [pruning of 1/3rd top portion at 3rd month (P1), pruning of top 1/3 rd portion at 3rd and 6th months (P2) and no pruning (P3) and two nitrogen levels in sub-sub plots [(100 kg ha^{-1} (F1) and 125 kg ha^{-1} (F2)] with all the treatments replicated thrice. The experiment was laid out at ICAR- CTCRI, Thiruvananthapuram, Kerala. The crop received 1400-1800 mm rainfall from the two main rainfall seasons (SW monsoon June – September and NE monsoon, September- December) during the period.

The soil of the experimental site was acidic, laterite with 40-50 % gravel. Cassava were planted coinciding with SW monsoon season during May-June every year at a plant spacing of 90 x 90 cm. Farm yard manure was applied uniformly @ 12.5 t ha^{-1} in all the treatments. P and K fertilizers were applied uniformly @ 50 kg and 100 kg respectively in all the treatments. Nitrogen fertilizer was applied in two equal splits, first, 45 days after planting and second, after one month. Each plot comprised 36 plants with 16 plants in the net plot. Pruning treatments were imposed as per schedule viz., pruning at 3rd month, both at 3rd and 6th months and no pruning. Foliage yield was recorded at every pruning. All the varieties were harvested after 7 months and the tuber yield was recorded. The stem yield and foliage yield were also recorded at the time of harvest. The individual years data and pooled data were analysed statistically (SAS, 2010) and the results are presented.

Results and Discussion

The varieties used in the study viz., Sree Jaya , Sree Vjaya and CE-347 are erect branching types. The data on the effect of different treatments on tuber yield, foliage yield and stem yield during the experimental period are presented in Table 1 to 3.

Tuber yield

The tuber yield obtained during the three years of study is presented in Table 1. Results revealed that, during the first year, there was no significant difference in the tuber yield among the varieties. Among the fertilizer levels also, the tuber yields were on par. However, the frequency of pruning had significant effect on the tuber yield. P1 resulted in maximum tuber yield (30.1 t ha^{-1}) followed by P3, with no pruning (27 t ha^{-1}). These were significantly superior over P2 (23.5 t ha^{-1}). The interaction effects were significant and among the interaction effects, maximum tuber yield was recorded by V2P1F1 and V2P3F2 (34.7 t ha^{-1}) closely followed by V3P1F1 (34 t ha^{-1}).

During the second year of the study, there was significant effect among varieties and frequency of pruning on cassava tuber yield. The highest tuber yield was obtained from the variety, CE 347 (39.26 t ha^{-1}) which was significantly superior to the variety Sree Jaya (32.41 tha^{-1}) and Sree Vijaya (31.63 t ha^{-1}). The treatment without any pruning had resulted in the highest tuber yield (39.92 t ha^{-1}) and was significantly superior to the pruning treatments at 3rd month (P1) pruning at 3rd and 6th months (P2). Nitrogen application at two levels, did not result in any significant difference in the tuber yield. Among the interactions which differ significantly, V3P3F2 resulted

Table 1. Cassava tuber yield (t ha^{-1}) as affected by varieties, frequency of pruning and nitrogen levels

	Tuber yield (t ha^{-1})			
Treatments	2009-2010	2010-2011	2011-2012	Mean
Variety (V)				
Sree Jaya	20.9	32.4	13.51	22.27
Sree Vijaya	30.35	31.6	23.76	28.57
CE-347	29.35	39.2	17.76	28.77
CD	7.310	4.32	NS	
Pruning (P)				
Pruning at 3rd month	30.1	34.2	18.21	27.50
Pruning at 3rd and 6th month	23.5	29.1	13.16	21.92
No pruning	27.0	39.9	23.66	30.18
CD	3.12	3.78	7.762	
Fertilizers(F)				
N: 100 kg ha^{-1}	27.6	33.8	19.57	26.99
N: 125 kg ha^{-1}	26.1	35.1	17.12	26.10
CD	NS	NS	NS	

Table 2. Cassava fresh foliage yield (t ha^{-1}) as affected by varieties, frequency of pruning and nitrogen levels

	Fresh foliage yield (t ha^{-1})			
Treatments	2009-2010	2010-2011	2011-2012	Mean
Variety (V)				
Sree Jaya	13.0	9.0	3.73	8.57
Sree Vijaya	12.3	9.6	5.38	9.09
CE-347	11.68	9.8	4.45	8.64
CD	0.98	NS	NS	
Pruning (P)				
Pruning at 3rd month	12.83	9.8	4.98	9.20
Pruning at 3rd and 6th month	10.24	11.0	6.02	9.08
No pruning	13.96	7.6	2.57	8.04
CD	NS	1.01	NS	
Fertilizers(F)				
N: 100 kg ha^{-1}	12.0	9.0	4.54	8.51
N: 125 kg ha^{-1}	12.69	9.9	4.50	9.03
CD	NS	NS	NS	

in maximum tuber yield (50.6 t ha^{-1}) and it was on par with V3P3F1(49.01 t ha^{-1}) ,V1P3F1(42.3 t ha^{-1}) and V1P3F2 (40. 98 t ha^{-1}). The lowest yield was recorded by V1P2F1.

During the third year of study, there was no significant difference in the tuber yield among the different varieties or the nitrogen doses. The treatment without pruning resulted in the highest tuber yield (23.7 t ha^{-1}) which was significantly superior to pruning at 3rd and 6th months. The combination V2P3F2 produced maximum tuber yield (32 t ha^{-1}) and was at par with V2P3F1 (31.96 t ha^{-1}). The lowest yield of 7.35 tha^{-1} was recorded by V1P2F2.

Pooled data analysis showed significant difference with respect to the effect of pruning only. Control treatment without any pruning resulted in maximum tuber yield, however, it was on par with single pruning, at 3rd month

Table 3. Cassava stem yield (t ha^{-1}) as affected by varieties, frequency of pruning and nitrogen levels

	Stem yield (t ha^{-1})			
Treatments	2009-2010	2010-2011	2011-2012	Mean
Variety (V)				
Sree Jaya	8.22	24.97	8.33	13.84
Sree Vijaya	7.23	22.36	11.08	13.55
CE-347	7.32	25.48	16.44	16.41
CD	NS	1.95	NS	
Pruning (P)				
Pruning at 3rd month	7.79	25.49	12.98	15.42
Pruning at 3rd and 6th month	6.03	18.62	9.44	11.36
No pruning	8.94	28.71	13.43	17.02
CD	1.14	3.21	NS	
Fertilizers(F)				
N: 100 kg ha^{-1}	7.61	24.27	12.47	14.78
N: 125 kg ha^{-1}	7.56	24.27	11.43	14.42
CD	NS	NS	NS	

(Table 4). Two prunings at 3rd and 6th months reduced the tuber yield significantly. It was evident that excessive pruning results in reduced tuber yield whereas a single pruning during the active vegetative phase of the crop, i.e., during 3rd month can regain the vegetative growth. In this experiment cassava was planted during May coinciding with SW monsoon season and was fertilized 45 DAP and one month later. Thus, with the availability of moisture from continuous rains (SW monsoon) and the nutrient application, new flushes have come out compensating growth and tuberization. However, second pruning towards the end, at 6th month resulted in the set back of active photosynthesis and translocation of photosynthate to the roots. Many of the earlier findings reported that both positive and negative effects of pruning in cassava tuber yield. The differences may be due to the intensity of shoot removal, variety, time and length of pruning. This was confirmed by Villamayor et al. (1992) who reported that cassava plants pruned at 30 cm above ground at 6th, 8th or 10th MAP resulted significantly higher tuber yield than unpruned plants and those pruned at 2nd or 3rd month after planting. In the present study, P3, in which top one third of the shoot was pruned twice negatively affected the tuber yield.

Table 4. Cassava tuber, leaf and stem yield as affected by varieties, frequency of pruning and nitrogen levels (Pooled analysis)

Treatments	Tuber yield (t ha^{-1})	Leaf yield (t ha^{-1})	Stem yield (t ha^{-1})
V1P1F1	22.17	8.64	12.4
V1P1F2	23.25	8.21	9.78
V1P2F1	20.64	8.91	12.56
V1P2F2	16.94	9.38	11.21
V1P3F1	26.31	7.14	17.45
V1P3F2	24.38	9.23	19.64
V2P1F1	32.48	10.89	20.6
V2P1F2	30.71	9.47	18.46
V2P2F1	22.91	8.65	9.19
V2P2F2	22.88	9.37	8.89
V2P3F1	31.22	7.52	13.40
V2P3F2	31.29	8.67	10.78
V3P1F1	30.45	9.25	15.41
V3P1F2	26.07	8.76	15.85
V3P2F1	22.88	8.76	12.49
V3P2F2	25.42	9.46	13.85
V3P3F1	33.99	6.95	19.54
V3P3F2	33.91	8.73	21.34
CD	10.423	3.17	8.26

V1: Sree Jaya; V2: Sree Vijaya; V3: CE-347; P1: pruning once at 3rd month ;P2: pruning twice at 3rd and 6 th month; P3: no pruning; F1: 100 kg N/ha; F2: 125 kg N/ha

Fresh foliage yield

During first year of the study, significantly higher foliage yield (13 t ha^{-1}) was obtained for the variety Sree Jaya compared to CE-347 (11.68 t ha^{-1}) and it was on par with that of Sree Vijaya (12.3 t ha^{-1}). Pruning and fertilizer levels had no significant effect on leaf yield (Table 2). The interaction effects were significant and V2P1F1 resulted in maximum leaf yield followed by V1P3F2, V1P3F1 and V2P1F2.

During the second year, there was no significant difference among the varieties with regard to foliage yield. Pruning at 3rd month and 6th month resulted in significantly higher leaf yield compared to unpruned plants. Among the interactions, V3P2F2 resulted in maximum foliage yield followed by V3P2F1, V3P1F2. During third year of the trial, total foliage yield was not found affected by any of the variety or pruning treatments. However, the variety Sree Vijaya with pruning at 3rd and 6th month resulted in more foliage yield.

Pooled data analysis showed significant difference in foliage yield with regard to pruning treatments. Single pruning at 3rd month resulted in maximum foliage yield closely followed by pruning twice at 3rd and 6th month. Foliage yield was lowest under no pruning (Table 4). Cassava has indeterminate growth habit and one third of the shoot top when pruned, the lateral buds became active and branching started, and thus the total foliage production is increased. In a study involving pruning of cassava prior to harvest at different intervals, pruning the plants beyond 25 days of harvest resulted in slow development of new leaf canopy and setting in of normal assimilation (Van Oirschot,2000) .

Fresh stem yield

During the first year, only pruning treatments resulted in significant difference in stem yield. Maximum stem yield was recorded in unpruned plants followed by P1, pruning once at 3rd month (Table 3). Among the interactions, maximum stem yield was obtained in V2P1F1, followed by V3P3F2, V1P3F2 and V1P3F1.

During the second year, highest stem yield was obtained from the variety CE-347 which was on par with Sree Jaya and significantly superior to Sree Vijaya. Highest stem yield was recorded in unpruned plants which was significantly superior to plants pruned at 3rd and 6th months. Stem yield at the two nitrogen levels were at par. Among the interactions, maximum stem yield of 41.77 t ha^{-1} was obtained in V1P3F2, on par with V1P3F1, V2P1F1 and V2P1F2. No significant difference among

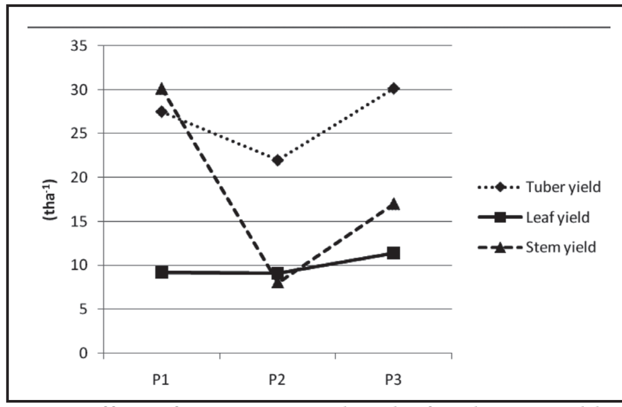

Fig.1. Effect of pruning on tuber, leaf and stem yield in cassava (Mean of three years)

any of the treatments was observed during the third year. However, variety, CE-347 and unpruned plants resulted in more stem yield.

As in tuber yield and leaf yield, pooled data analysis showed significant difference only with respect to pruning treatments. Stem yield was maximum in unpruned plants, but was on par with one pruning at 3rd month. Pruning twice significantly reduced stem yield (Table 4). It is reported that detopped cassava plants produced taller plants than debranched ones, showing that the plants recovered at a faster rate with detopping (Noameshie, 1990).

This was attributed to rapid regrowth of stem and branches after cut back. Pruning during the physiological rest time after active vegetative and tuber bulking stages indicated an increase in dry matter and tuber yield whereas during high vegetative growth period resulted in higher productivity of above ground parts and lower productivity of underground parts, when the plants were pruned at monthly interval over a period of one year (Juliano et al., 2011).

Conclusion

In the present study, all the varieties used were of short duration and were harvested 7 MAP. The growth of unpruned plants was never disturbed and produced maximum storage roots, whereas, the pruned ones had to recover by producing new stems and leaves. This reduced carbohydrate available for storage roots. However, single pruning did not affect the tuber yield significantly indicating that the plants could recover the physiological activity and thus contributing for storage of roots. The foliage available while pruning can be used for mulching, cattle feed, nutrient source, silk worm rearing, as packing material, especially while transporting planting materials or similar purposes. Cassava leaves contain 3-5 % nitrogen on dry weight basis and its incorporation can contribute to soil fertility. It is also reported that cassava leaves can be used for the production of eri silk worms (AICRPTC, 2013) and thus can be used economically. The young leaves are a green leafy vegetable, used in cooking or fed to chickens and pigs. Thus, wherever leaves can be used, single pruning of top one third portion during 3rd month in cassava can be practised without sacrificing the tuber yield. Moreover, the stem yield or the planting material for the next crop also is not adversely affected due to pruning. However, severe pruning either in quantum or more frequencies should be avoided.

References

Abenoja, E. A. and Cerna, A. F. 1983. The effect of age and frequency of topping in cassava on quality of shoots, dry matter and tuber yield. *The Radix,* **5** (1): 12- 13.

AICRPTC. 2013. Annual Report 2013-2014, All India Co coordinated Research Project on Tuber Crops, ICAR-CTCRI, Thiruvananthapuram, Kerala.

Aguiar, and Eduardo Barreto . 2011. Pruning dates and productivity of cassava. *Pesq. agropec. bras.,* [online]., **46** (11): 1463-1470.

Arana, M. N. 1979. The effects of time of pruning on the yield of cassava (Golden yellow) B. S. thesis, DMMMSU, Bacnoten, La union, p.14.

Juliano Silva de Andrade, Anselmo Eloy Silveira Viana, Anselmo Eloy Silveira Viana, Adriana Dias Cardoso, Sylvana Naomi Matsumoto, Sylvana Naomi Matsumoto. 2011. Pruning times on cassava. *Revista Ciencia Agronomica* , **42**(3): 693-701.

Noameshie, Agboh, A.1990. Effects of intercropping cassava (*Manihot esculenta* Crantz) cowpea (*Vigna unguiculata* L. Walp) on their yields and the insect pest population on cowpea. Ph. D. thesis, Department of Agronomy, University of Ibadan, Nigeria, 215.

Oirschot, Van Q.E.A., O'Brien, G.M., Dufour, D, El-Sharkawy, M.A. and Mesa, E. 2000 The effect of pre-harvest pruning of cassava upon root deterioration and quality characteristics. J. *Sci. Food and Agriculture,* **8**0 (13): 1866-1873.

Ramanujam, T. and Biradar, R.S. 1987. Growth analysis in cassava (*Manihot esculenta* Crantz*). Ind. J. Plant Physiol*., **30**: 144-153.

Ravi, V. 2000. Physiological aspects of tuber crops. In: Production technology of tuber crops. (C. R. Mohankumar, G. M. Nair, James George, C. S. Ravindran and V. Ravi), Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India. pp.133-174.

Santiago, C. C.1980. Response of cassava to topping and manuring under MMSU conditions. B.S. thesis , MMSU, Batac, Illocos, Norte, 39.

SAS (Statistical Analysis Software). 2010. SAS Institute Inc., *www.sas.com*.

Villamayor, S.G. and Labayan, A.L. 1982. Detopping and its effect on cassava production. *The Radix,* **4** (2) : 7-8.

Villamayor, S. G., Dingal, A. G., Evangelio, F. A., Ladera, J. C., Medellin, A. C., Sagise, G. E. and Burgos, G. B. 1992. Recent progress in cassava agronomy research in the Philippines In: R H Howler (ed.) Cassava Breeding, Agronomy and utilization research in Asia. Proc. 3rd Regional Workshop, Malang, Indonesia, Oct. 22-27.1990, pp. 245-259.