



## Performance of Short Duration Cassava in the Trans-Gangetic Plain Region of Punjab, India

Cassava (*Manihot esculenta* Crantz), a root crop, is grown as secondary staple in Kerala, Odisha and North Eastern states, whereas in Tamil Nadu and Andhra Pradesh, it is cultivated as raw material for starch and sago industries and feed for livestock. The state of Maharashtra is slowly developing as a cassava hub for industrial use (Nedunchezhiyan et al., 2012). However, the present effects of climate change including scarcity of irrigation water are forcing the farmers to think for alternate crops. Cassava, although a long duration crop, is referred to as a crop camel as it requires less water. It tolerates extreme weather conditions like high temperature, heat waves and moisture stress (Nedunchezhiyan and Mohanty, 2005). Under favourable conditions, it revives its growth. Cassava also has the potential of high dry matter production ( $250 \times 10^3$  cal  $\text{ha}^{-1} \text{day}^{-1}$ ).

The Central Tuber Crops Research Institute, Thiruvananthapuram, India, has released a number of short duration varieties (7-8 months) of cassava, which will fit well in the major cropping systems. Nedunchezhiyan et al. (2006) and Sankaran et al. (2008) reported the suitability of short duration cassava varieties for the rainfed conditions of Odisha and Tripura, respectively. Suja et al. (2010) reported that short duration cassava can be grown in rice based cropping system for crop diversification, intensification and profit maximization. Nedunchezhiyan et al. (2003, 2008) reported that short duration cassava varieties can be grown profitably as intercrop in new and old coconut plantations. The Trans-Gangetic plain region of North India experiences long cold season that causes frost injury to many of the cultivated crops. Information on the effect of cold season on the growth and yield of cassava is scanty. Hence the objectives of the present study was to evaluate the suitability of cassava crop in the trans-gangetic plain region and to find out the effect of long winter season on short duration cassava varieties.

A field experiment was conducted at Punjab Agricultural University, Ludhiana (latitude  $30^{\circ}54' \text{N}$ , longitude  $75^{\circ}51' \text{E}$  and altitude 243 m above mean sea level) during 2012-2013. The short duration cassava varieties, Sree Jaya, Sree Vijaya and Vellayani Hraswa were planted with seven replications in randomized block design on 10 July 2012 and harvested on 10 March 2013 (8 months after planting). Setts were planted on ridges at a spacing of 75 cm x 75 cm. Fertilizers to supply N,  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$  @ 75:50:75  $\text{kg ha}^{-1}$  was applied, half N and K and full P was applied at the time of planting and the remaining half N and K, at 60 days after planting (DAP). The crop was irrigated as and when required.

The soil of the experimental site is sandy loam. The soil was characterized by pH 7.4, low organic C (0.5%) and available N ( $216 \text{ kg ha}^{-1}$ ) and medium available P ( $18.3 \text{ kg ha}^{-1}$ ) and available K ( $155 \text{ kg ha}^{-1}$ ). The area is characterized by hot and dry summer during May-June followed by humid monsoon period and then severe cold during December-January (Table 1). During the crop growth period, the average maximum and minimum temperatures were  $27.1^{\circ}\text{C}$  and  $15.5^{\circ}\text{C}$ . The average relative humidity was 73.2% with total rainfall of 537.6 mm. Growth, yield attributes and yield were recorded before the onset of winter (4 months after planting (MAP)) and after winter (8 MAP). The data collected were subjected to analysis of variance (ANOVA) using Genstat software. Comparison of treatment means for significance at 5% was done using the critical difference (CD) method.

Growth observations recorded at 4 and 8 MAP are presented in Table 2. At 4 and 8 MAP, the variety Sree Jaya was the tallest. The Vellayani Hraswa plants were the shortest. The variety Sree Vijaya produced more number of leaves (more number of nodes) and it was followed by Vellayani Hraswa. This may be due to shorter internodal length in the former case and more number of branches in the latter case. The variety Sree Jaya

Table 1. Weather parameters during the crop growth period

Months	Temperature (°C)			Mean relative humidity (RH) (%)	Rainfall (mm)
	Maximum	Minimum	Mean		
2012					
July	35.7	27.9	31.8	67	76.9
August	33.2	26.6	29.9	80	160.4
September	32.8	23.9	28.4	76	141.7
October	31.0	16.2	24.1	64	1.0
November	26.6	10.3	18.6	66	0
December	19.4	7.4	13.9	75	17.4
2013					
January	17.0	5.1	11.1	77	8.2
February	20.5	9.7	15.1	82	96.4
March	27.6	13.2	20.4	72	35.6

produced lesser number of leaves inspite of taller plants. This may be due to longer internodal length. However, the number of leaves (number of nodes) produced during the last four months was lesser than the initial four months. This may be due to the low temperature during the later stage. The rate of leaf production decreases at temperatures less than 24°C (Irikura et al., 1979; Manrique, 1990a). Due to the severe winter experienced, all the leaves were shed between December-February (Table 1) and hence no leaves were found at 8 MAP (harvest) in any of the varieties. Apical stems were observed to dry up to 30 cm due to frost injury in all the varieties. Low air temperatures (less than 15°C) caused leaf abscission in cassava (Fukai and Hammer, 1987). Fresh shoot weight was higher in Sree Vijaya compared to the other varieties at both 4 and 8 MAP. This was due to more number of leaves at 4 MAP and greater stem girth at 8 MAP. Varietal variation in growth response was reported by Nedunchezhiyan and Naskar (2004). Fresh shoot weight production was 74% during the first four months and 26% during the second four months. Low temperatures (maximum and minimum) between November and February (Table 1) affected the photosynthesis and dry matter accumulation and subsequently resulted in abscission of leaves. Hence shoot weight increase was lesser during the last four months. In subtropical regions, summer alternates with winter and the cooler temperatures during winter (22.5°C) affected the growth of cassava, in a manner similar to the water stress effects observed in the tropics (Manrique, 1990b).

Number of tubers per plant remained the same at 4 and 8 MAP. This indicated that storage root induction was completed during the initial four months and tuber bulking took place during the final four months. Among the varieties, significantly more number of tubers was noticed in Sree Vijaya. Significantly greater tuber weight per plant was observed in Vellayani Hraswa both at 4 and 8 MAP. However, at 4 MAP it was comparable with Sree Jaya. In Vellayani Hraswa and Sree Jaya, the tuber weight was more than shoot weight both at 4 and 8 MAP (Table 2). Whereas in Sree Vijaya, shoot weight was higher than tuber weight both at 4 and 8 MAP. About 64% of the tuber weight was contributed during the initial four months and 36% of the tuber weight was added during the final four months. Lesser tuber bulking rate during the last four months was due to prevailing low temperature (Table 1), which also caused complete senescence of leaves (Table 2). Considering that minimum temperature of 17°C is required for tuber development, the crop yield completely depends on the photosynthates available before the onset of the winter. The mean temperature during December and January was less than 17°C (Table 1). Net photosynthesis and storage root yield was positively correlated (Pellet and El-Sharkawy, 1993). The photosynthetic rate decreases rapidly with decreasing temperature below 25°C (El-Sharkawy et al., 1984). Nedunchezhiyan and Naskar (2004) reported very low tuber bulking during later

Table 2. Growth and yield attributes of short duration cassava varieties at various stages

Varieties	4 MAP				8 MAP (Harvest)								
	Plant height (cm)	Number of nodes	Number of intact leaves	Fresh weight of shoot (kg plant <sup>-1</sup> )	Number of tubers	Tuber weight (kg plant <sup>-1</sup> )	Plant height (cm)	Number of nodes	Number of intact leaves	Fresh weight of shoot (kg plant <sup>-1</sup> )	Number of tubers	Tuber weight (kg plant <sup>-1</sup> )	Tuber yield (t ha <sup>-1</sup> )
Sree Jaya	165	121	106	1.7	7	2.0	210	167	0	2.2	7	2.8	33.6
Sree Vijaya	140	221	212	2.0	9	1.2	175	260	0	2.5	9	2.1	25.2
Vellayani Hraswa	115	130	118	1.4	7	2.1	145	249	0	2.2	7	3.4	40.8
CD (0.05)	12	16	13	0.1	1	0.2	16	22	-	0.2	0.1	0.3	3.8

stages under Odisha conditions due to moisture stress. In areas where a cool climate arrests plant growth and tuber bulking (starch accumulation), cassava is cultivated for a long duration, up to 2-3 years (Pounti-Kaerlas, 2001; Ravi and Mohankumar, 2004). Vellayani Hraswa produced significantly higher tuber yield (40.8 t ha<sup>-1</sup>) followed by Sree Jaya (33.6 t ha<sup>-1</sup>). The variety Sree Vijaya produced the lowest tuber yield (25.2 t ha<sup>-1</sup>).

The results of the study revealed that in the trans-gangetic plains, the cassava variety Vellayani Hraswa performed better than the other varieties tried, but severe winter affected the tuber bulking. Hence, it is recommended that in future the variety may be planted at the beginning of the rising temperature i.e., during the second fortnight of March to first fortnight of April for harnessing higher yields. Thus, under Punjab conditions, cassava holds promise for crop diversification, food and agro-entrepreneurship development.

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