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Performance of chip budded cassava plants for growth, tuber yield and starch content

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Abstract
The experiment was conducted at Tapioca and Castor Research Station, Yethapur to evaluate the performance of chip bud plants under field conditions for assessing the vegetative growth and tuber yield parameters. The experiment was laid out in Randomized Block Design with three replications. Cassava chip budded plants were produced through Rapid Multiplication Technique (RMT) using protray method under net house and a total of ten treatments were imposed on the plating material. At the time of harvest *i.e.,* eight months after planting, maximum plant height (141.63 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and the minimum plant height (111.42 cm) was recorded in Mini sett plants raised in Vermicompost containing *Pseudomonas.* The maximum (8.6 cm) and minimum stem girth (6.8 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and Mini sett plants raised in pot mixture containing *Pseudomonas* (T_9) respectively. The maximum tuber yield per plant (7.26 kg) was recorded in chip budded plants raised in Cocopeat containing *Pseudomonas* (T_4) which was significantly different over the other treatments. The minimum tuber yield per plant (4.58 kg) was recorded in Control (Farmers practice - Propagation by raised bed system) (T_1). The pooled mean analysis revealed that maximum starch content was recorded (25.49%) in chip budded plants raised in vermicompost containing *Pseudomonas* (T_7) which was on par (24.91%)with chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}).

Keywords: Cassava, Chip budded plants, cocopeat, vermicompost, starch content

Introduction
Cassava or tapioca (*Manihot esculenta* Crantz.) belongs to the family Euphorbiaceae which is grown widely in tropical countries. The crop is well known for its tubers and has wider adaptability to poor soil condition, drought resistance, pest and disease tolerance (Velmurugan *et al.* 2020) [6]. In addition to the above, Cassava is cultivated both as irrigated and rainfed crop depending on the distribution of rainfall. Cassava is cultivated in an area of 1.73 lakh hectares with a production of 49.50 lakh tonnes (NHB, 2019) [3] in India. It is mainly cultivated in Salem, Namakkal, Cuddalore, Villupuram, Dharmapuri and Kanyakumari districts of Tamil Nadu. In Tamil Nadu, the major area under cassava cultivation is Dharmapuri (25%) followed by Namakkal (18%) and Salem districts (16%). Sago industries are involved in the preparation starch, sago grains, vermicelli and chips (Pugalendhi *et al.* 2014 and Velmurugan *et al.* 2017) [7, 9].

Cassava is vegetatively propagated through stem cuttings (setts). A mature plant with two stems will give about 12 to 20 normal sized (20 cm) setts after one year *i.e* the propagation rate is 12 to 20 times per year. The use of shorter cuttings (12 cm long) permits a higher rate of multiplication with a given amount of planting material; however, shorter cuttings may be more difficult to establish in the field under rainfed conditions; if soil moisture at the time of planting is not favourable. The normal farmer's practice is to use 8-10 cm long cuttings from the mature part of stem and planted in vertical position in specially prepared nursery beds at a closer spacing of 5 cm. The cuttings are prepared carefully and dipped in Carbendazim (2 g/litre of water) and Dimethoate (2 ml/litre of water). The bed is constantly pot watered to moisten the soil. Three weeks after planting, the setts with root initials are used for transplanting.

At CTCRI, mini sett propagation technique has been standardized using 2-3 node cuttings, propagated in mist chamber and has been found to be most efficient. This can give 640 plants from a single plant in one year, instead of an average of 10 plants from a single cassava stem. In this technique, though the crop establishment is fairly good enough (80 – 90%) however it needs gap filling.

The rooted cuttings cannot be transported from one place to other place because of bare roots.

In seed propagated vegetables, quality seedlings are produced with suitable media in the protray. It is advantageous over the conventional raised bed system where in the seedlings are pest and disease free, utilizes precise quantum of seeds, produces uniform seedling growth and better seedling establishment in the main field due to the presence of ball of media during transplantation. Seedling production in protrays can easily be monitored and transported to the site / field, where the planting is taken up. This system of propagation is potentially viable in vegetatively propagated crops like cassava. Besides producing quality planting material this method ensures large seed production for distribution to farmers.

Cassava is highly susceptible to cassava mosaic disease (CMD) and primarily the disease spreads through infected planting materials and subsequently, transmitted by white flies. In this new rapid multiplication technique, tagging disease free plants and using them for propagation offers reliable solution to manage the disease as lesser quantity of setts are only required under Rapid Multiplication Technique (RMT) of cassava. The results of preliminary experiment revealed that chip bud cassava planting materials raised in protray containing cocopeat media was found to have better seedling vigour when compared to other media (Pugalendhi and Velmurugan, 2020) [8]. Hence, this experiment was conducted to evaluate the performance of chip budded planting materials under field condition for assessing the vegetative growth, tuber yield and quality parameters.

Materials and Methods

The field experiment was conducted at Tapioca and Castor Research Station, Yethapur involving the cassava setts of variety Yethapur 1 (YTP 1). Cassava chip budded plants were produced through Rapid Multiplication Technique (RMT) using protray method under net house. The soil analysis showed that the experimental area consisted of sandy loam soil with medium organic carbon status (0.46), low available nitrogen (219.7 mg/kg), medium phosphorous (16.1 mg/kg) and potassium (322.5 mg/kg). The crop was maintained at a spacing of 90 x 90 cm and the standard cultivation practices was adopted as recommended by the Department of Horticulture, Government of Tamil Nadu (Horticulture Crop production Guide, 2013) [2]. The plants were maintained in ridges and furrow and irrigation was given at weekly intervals depending on the soil moisture regimes.

Treatment details

The field evaluation was conducted for three years and the experiment was laid out in Randomized Block Design with three replications. A total of ten treatments were utilized *viz.*, Control (Farmers practice - Propagation by raised bed system) (T_1), Cocopeat + *Pseudomonas* + Normal sett (T_2), Cocopeat + *Pseudomonas* + Mini sett (T_3), Cocopeat + *Pseudomonas* + Chip bud (T_4), Vermicompost + *Pseudomonas* + Normal sett (T_5), Vermicompost + *Pseudomonas* + Mini sett (T_6), Vermicompost + *Pseudomonas* + Chip bud (T_7), Pot mixture + *Pseudomonas* + Normal sett (T_8), Pot mixture + *Pseudomonas* + Mini sett (T_9) and Pot mixture + *Pseudomonas* + Chip bud (T_{10}).

Assessment of growth, tuber yield and quality parameters

The vegetative growth parameters *viz.,* plant height (cm), number of leaves per plant and stem girth (cm) was recorded at bimonthly intervals. The tuber yield parameters *viz.*, number of tubers per plant, yield per plant (kg) and starch content (%) was recorded at the time of harvest.

Statistical analysis

The observations were recorded from five plants in each replication and the pooled mean data was subjected to statistical analysis and the critical differences were worked out for 5% (0.05) probability based on the method suggested by Panse and Sukhatme (2000) [4].

Result and Discussion

a). Growth parameters

The observations recorded on different plant height amount the different treatments, growth parameters are given in Table.1 the maximum plant height at two months after planting *viz.,* 48.45 cm and 48.27 cm was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and Control (Farmers practice - Propagation by raised bed system) (T_1) respectively. At four months after planting, maximum plant height (92.71 cm) was recorded in the control (Farmers practice - Propagation by raised bed system) (T_1). After six months of planting, the tallest plant (125.28 cm) was observed in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}). At the time of harvest *i.e.*, eight months after planting, maximum plant height (141.63 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and the minimum plant height (111.42 cm) was recorded in Mini sett raised plants in Vermicompost containing *Pseudomonas* (Table.1).

Table 1: Performance of different vegetative propagules for Growth Parameters

Treatments		Plant height (cm)				Number of leaves per plant				Stem girth (cm)			
		2 MAP	4 MAP	6 MAP	8 MAP	2 MAP	4 MAP	6 MAP	8 MAP	2 MAP	4 MAP	6 MAP	8 MAP
T_1	Control (Farmers practice - Propagation by raised bed system)	48.27	92.71	113.23	127.76	26.2	77.0	113.9	106.4	3.5	5.1	6.3	7.4
T_2	Cocopeat + *Pseudomonas* + Normal sett	47.84	82.32	111.03	132.82	27.8	85.1	116.2	104.9	4.3	5.6	6.6	7.6
T_3	Cocopeat + *Pseudomonas* + Mini sett	33.72	62.71	98.92	116.25	21.9	66.6	92.6	81.2	3.6	4.8	6.1	7.3
T_4	Cocopeat + *Pseudomonas* + Chip bud	43.22	77.69	111.46	122.50	30.4	92.8	117.3	108.1	4.0	5.1	6.2	8.2
T_5	Vermicompost + *Pseudomonas* + Normal sett	41.69	75.38	103.30	130.41	25.6	78.2	101.5	90.1	3.7	4.9	6.8	8.0
T_6	Vermicompost + *Pseudomonas* + Mini sett	38.20	71.39	93.56	111.42	21.2	69.0	90.7	79.5	3.3	4.7	6.4	7.8
T_7	Vermicompost + *Pseudomonas* + Chip bud	39.69	82.00	108.99	128.37	22.3	70.8	104.2	87.5	3.2	4.3	6.4	8.4
T_8	Pot mixture + *Pseudomonas* + Normal sett	46.70	79.82	100.66	124.28	22.8	78.3	99.9	84.7	3.8	5.1	5.7	7.2
T_9	Pot mixture + *Pseudomonas* + Mini sett	42.64	88.51	115.59	134.04	25.1	97.4	119.0	102.0	3.5	5.0	5.9	6.8
T_{10}	Pot mixture + *Pseudomonas* + Chip bud	48.45	91.70	125.28	141.63	27.8	102.8	124.0	113.0	4.2	5.9	6.7	8.6
CD (0.05)		1.62	3.21	5.92	5.11	2.93	5.03	5.63	4.08	0.18	NS	0.78	0.73
SEd		0.80	1.06	2.95	2.54	1.45	2.51	2.80	2.03	0.09		0.39	0.36

MAP – months after planting

Number of leaves per plant: At two months after planting, maximum number of leaves (30.4) was recorded in chip budded plants raised in Cocopeat containing *Pseudomonas* (T_4) and during four months after planting, chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) recorded maximum number of leaves (102.8). However the same treatment produced more number of leaves at six months after planting (124.0) and eight months after planting (113.0). At the time of harvest *i.e.* eight months after planting a lesser number of leaves (79.5) was recorded in Mini sett plants raised in Vermicompost containing *Pseudomonas* (T_6).

Stem growth

During the initial phase of establishment *i.e.* at two months after planting, maximum stem girth (4.3 cm) was recorded when the normal setts raised in Cocopeat containing *Pseudomonas* (T_4) which was on par (4.2 cm) with the treatment chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}). There was no significant difference between the treatments on the stem girth recorded on fourth and sixth month after planting. A significant difference on stem girth was exhibited at eight months after planting. The maximum (8.6 cm) and minimum stem girth (6.8 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and Mini sett plants raised in pot mixture containing *Pseudomonas* (T_9) respectively. The better performance of planting materials in cocopeat may be due to the reason that it had optimum CN ratio, neutral pH, better water holding capacity, non compaction of media resulting in better aeration. Moreover, the digested coirpith compost by inherent nature helps to retain moisture for longer time which might have favoured the shorter time for sprouting, maximum sprouting percentage, length of roots and number of roots in chip budded plants. In addition to the above, the planting material produced from chip bud in protray had vigorous growth and better establishment over the other treatments. The plant vigour might be the reason for the best performance of chip budded plants. The present findings are in accordance with the findings of Atif *et al.*, (2016), Prasath *et al.*, (2016) Pugalendhi and Velmurugan (2020) [1, 5, 6].

b). Tuber yield parameters

The pooled analysis of three years data on tuber yield parameter is given in Table.2 the date revealed that maximum number of tubers per plant (7.5) was recorded in chip budded plants raised in Cocopeat containing *Pseudomonas* (T_4) which was on par (7.3) with normal setts raised in pot mixture containing *Pseudomonas* (T_8). The minimum number of tubers (5.9) was observed in Mini sett plants raised in Vermicompost containing *Pseudomonas* (T_6). The maximum tuber yield per plant (7.26 kg) was recorded in chip budded plants raised in Cocopeat containing *Pseudomonas* (T_4) which was significantly different over the other treatments. The minimum tuber yield per plant (4.58 kg) was recorded in Control (Farmers practice - Propagation by raised bed system) (T_1). (Table.2). During the phase of evaluation, the planting materials produced from chip buded plants raised in cocopeat containing *Pseudomonas* produced maximum of tubers per plant and tuber yield was also higher when compared to other treatments. The improved vigour of planting material might have enhanced the growth of cassava plants which in turn resulted with better partitioning of photosynthetic assimilates resulting in higher tuber yield. It is further evident that T_1 (Farmers practice) and T_8 (Pot mixture + *Pseudomonas* + Normal sett) recorded lower yield than that of the other treatments with lesser number of tuberous roots and this would have been mainly because of previously initiated roots which might have been damaged during the time of transplanting and probably new roots would have been developed from the already established callus tissues in the lower surface of the plants.

c). Quality parameters

The pooled mean analysis of quality parameters as tabulated in Table.2 revealed that maximum starch content was recorded (25.49%) in chip budded plants raised in vermicompost containing *Pseudomonas* (T_7) which was on par (24.91%) with chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}). However, the minimum starch content was recorded in (22.69%) mini sett raised in Cocopeat containing *Pseudomonas* (T_3). (Table.2). There is not much difference in the starch content among the different treatments, however, because of the highest number of tubers and tuber yield in the treatment T_4 (Cocopeat + *Pseudomonas* + Chip bud) it might have contributed to higher starch yield per unit area which is an advantageous factor to be considered for overall starch yield. The present findings are in corroboration with the findings of Pugalendhi *et al.* 2014 and Velmurugan *et al.* 2017 [7, 9].

Table 2: Performance of different vegetative propagules of yield and starch content

	Treatments	Number of tubers per plant	Yield per plant (kg)	Starch content (%)
T_1	Control (Farmers practice - Propagation by raised bed system)	6.8	4.58	24.02
T_2	Cocopeat + *Pseudomonas* + Normal sett	6.4	5.81	23.84
T_3	Cocopeat + *Pseudomonas* + Mini sett	6.6	5.42	22.69
T_4	Cocopeat + *Pseudomonas* + Chip bud	7.5	7.26	24.86
T_5	Vermicompost + *Pseudomonas* + Normal sett	6.3	6.07	23.53
T_6	Vermicompost + Pseudomonas + Mini sett	5.9	5.17	22.78
T_7	Vermicompost + Pseudomonas + Chip bud	6.2	5.32	25.49
T_8	Pot mixture + Pseudomonas + Normal sett	7.3	4.61	24.88
T_9	Pot mixture + Pseudomonas + Mini sett	6.1	5.80	24.65
T_{10}	Pot mixture + Pseudomonas + Chip bud	6.5	4.77	24.91
	CD (0.05)	0.52	1.06	0.53
	SEd	0.25	0.53	0.26

Conclusion

From the experiment it can be concluded that maximum plant height (141.63 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) at eight months after planting. The maximum (8.6 cm) and minimum stem girth (6.8 cm) was recorded in chip budded plants raised in pot mixture containing *Pseudomonas* (T_{10}) and Mini sett plants raised in pot mixture containing *Pseudomonas* (T_9)

respectively. The maximum tuber yield per plant (7.26 kg) was recorded in chip budded plants raised in Cocopeat containing *Pseudomonas* (T_4) which was significantly different over the other treatments. The maximum starch content was recorded (25.49%) in chip budded plants raised in vermicompost containing *Pseudomonas* (T_7). Based on the findings, high density planting in cassava can be attempted for getting maximum tuber and starch yield by utilizing disease free planting materials.

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