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Evaluation of Different Nursery Techniques in Cassava (*Manihot esculenta* Crantz)

Cassava (*Manihot esculenta* Crantz) is one of the most important calorie-producing crops in the tropics. It is efficient in carbohydrate production, adapted to a wide range of environments and soils and tolerant to drought (Cock, 1985; Nedunchezhiyan et al., 2012). The economic part, the root, is consumed as human food after different types of processing. An estimated 70 million people obtain more than 2100 KJ day^{-1} (500 kcal day^{-1}) from cassava. Cassava is propagated through stem cuttings. It is a long duration crop (6-10 months).Under rainfed conditions, where the crop growing period is short, cassava can be cultivated by nursery transplanting. Usually cassava nursery is maintained in a corner of the field as a raised bed by close planting. Maximum root damage was reported during uprooting in such nurseries, if the age was above two weeks (Nedunchezhiyan et al., 2008). Dapog nursery is a type of nursery prepared on polythene sheets having certain depth (5 cm) of bedding material like soil, sand, compost etc. and is regularly watered. This nursery can be raised in any place. Dapog nursery is easy for handling. Dapog nursery can be prepared with various combinations of soil, sand and compost. However, its effect on the establishment and root yield of cassava is not known. Hence a study was carried out to evaluate the different nursery techniques in cassava.

At the Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Odisha, India, nine different nursery techniques were evaluated in randomized block design during 2009-2010. The treatments were dapog (hydro), dapog (sand), dapog (soil), dapog (compost), dapog (sand + soil; 1:1 ratio), dapog (sand + compost; 1:1 ratio), dapog (soil+ compost; 1:1 ratio), dapog (sand+ soil+ compost; 1:1:1 ratio) and normal raised bed (check). The treatments were replicated thrice. Dapog beds were formed using polythene sheets of dimension, 2 m × 1 m and 7 cm height. The bed was surrounded by bricks to provide strength. Small holes were made at the bottom of the polythene sheets for removing excess water. The bedding materials were filled as per the treatments up to 5 cm height. In the case of dapog (hydro), holes were made in the polythene sheets in all directions at 2 cm from the ground surface to remove the excess water and the water level was always maintained at 2 cm.The beds were watered regularly and 2 cm water was maintained in dapog (hydro). Cassava (var. Vellayani Hraswa) setts of 20 cm length with 6-7 nodes were planted 5 cm apart in the nursery. In the case of dapog (hydro), 10 setts were bundled and kept vertically. The seedlings were maintained in the nursery beds up to 5 weeks from the date of planting. Three seedlings from each treatment were uprooted at weekly intervals and the number of root callus, number of roots, root length (cm) and shoot length (cm) per plant were recorded.

The seedlings from the nurseries were transplanted into the main field to study the establishment and root yield. The main field was prepared by ridges and furrows and the experiment was laid out in randomized block design in factorial combinations. Nursery techniques and the age of the seedlings (1, 2, 3, 4 and 5 weeks) were the factors. The treatments were replicated twice. The plot size was 3 m x 3 m. The seedlings were planted on the ridges at a spacing of 75 cm x 75 cm, accommodating 16 plants per plot. Farmyard manure @ 12.5 t ha^{-1} and fertilizers to supply $N:P_2O_5:K_2O$ @ 100:50:100 kg ha^{-1} was applied and the other cultural practices were duly followed as per the package of practices. The crop was grown under protective irrigation and harvested eight months after transplanting.

Root callus (which develop into root) production was significantly influenced by the method of nursery raising (Table 1). At 1 week stage, significantly higher number of root callus per plant (14.5) was observed with dapog (hydro) nursery and it was followed by dapog (compost) (13.2) and dapog (soil+compost) or dapog (sand + soil) (11.6). Similarly, in 2, 3, 4 and 5 week old seedlings also

Table1. Influence of different nursery types on root callus and root production

Treatments	Number of root callus plant^{-1}					Number of roots plant^{-1}				
	1 week	2 weeks	3 weeks	4 weeks	5 weeks	1 week	2 weeks	3 weeks	4 weeks	5 weeks
Dapog (hydro)	14.5	6.6	6.5	5.6	5.4	1.7	8.6	11.9	12.6	13.0
Dapog (sand)	11.1	5.4	4.5	2.8	2.5	1.6	4.7	9.2	9.6	9.6
Dapog (soil)	10.6	5.3	4.2	2.5	2.4	1.5	4.1	8.4	9.3	9.4
Dapog (compost)	13.2	6.6	6.3	3.5	3.2	1.6	5.4	10.6	11.5	11.7
Dapog (sand+soil; 1:1 ratio)	11.6	5.4	5.2	3.5	3.4	1.6	4.5	8.6	9.2	9.5
Dapog (sand+compost; 1:1 ratio)	11.4	5.7	5.3	3.8	3.4	1.7	5.6	9.8	11.5	11.9
Dapog (soil+compost; 1:1 ratio)	11.6	5.6	4.8	2.9	2.7	1.7	5.4	10.5	11.5	12.0
Dapog (sand+soil+compost; 1:1:1 ratio)	11.1	5.6	5.2	3.4	3.2	1.6	5.5	11.2	11.7	12.2
Normal raised bed (check)	10.5	4.6	3.6	2.6	2.4	1.6	4.8	8.8	8.9	8.8
CD (0.05)	0.8	0.4	0.3	0.2	0.2	0.1	0.2	0.7	0.7	1.2

higher number of root callus per plant was noticed with dapog (hydro). Normal raised bed nursery and dapog (soil) method resulted in significantly lower number of root callus per plant. The number of root callus per plant decreased with the increase in nursery duration from 1 to 5 weeks in all the treatments. This might be due to root development from the root callus. Appreciable variation in root formation was noticed with nursery type (Table 1). Significantly higher number of roots per plant was observed with dapog (hydro) nursery, irrespective of the age of seedlings (Fig.1). Lesser number of roots per plant was observed in normal nursery, and sand and soil alone or their combination in dapog method. The number of roots per plant increased with increase in nursery duration in all treatments. However, it was varying depending on the treatments.

Total root length (cm) was quantified and marked variation in root length was observed with respect to treatments and age of seedlings. Maximum root length was measured in dapog (hydro) and it was followed by compost alone and its combination with soil in dapog method of nursery in all the age of seedlings (Table 2). Lower root length was noticed with normal raised bed

Fig. 1. Dapog (hydro) nursery

Table 2. Influence of different nursery types on root and shoot length

Treatments	Total root length plant^{-1} (cm)					Shoot length plant^{-1} (cm)				
	1 week	2 weeks	3 weeks	4 weeks	5 weeks	1 week	2 weeks	3 weeks	4 weeks	5 weeks
Dapog (hydro)	8.7	64.5	105.8	119.7	184.2	4.4	7.5	8.9	9.5	11.0
Dapog (sand)	6.9	32.4	78.7	87.4	102.7	4.5	6.9	8.2	9.1	10.7
Dapog (soil)	6.5	30.3	70.6	88.4	97.8	4.3	7.4	8.4	9.5	10.4
Dapog (compost)	8.2	42.1	94.3	115.0	145.7	5.1	7.8	8.9	10.0	11.9
Dapog (sand+soil; 1:1 ratio)	7.2	29.7	71.3	84.8	114.3	4.5	6.6	8.1	9.0	11.0
Dapog (sand+compost; 1:1 ratio)	8.2	33.4	95.1	110.0	139.9	4.6	7.8	9.0	9.5	11.9
Dapog (soil+compost; 1:1 ratio)	7.1	42.1	90.7	109.3	144.5	4.8	7.4	8.5	9.8	11.9
Dapog (sand+soil+compost; 1:1:1 ratio)	8.2	36.9	82.9	112.3	148.8	4.8	7.7	8.6	10.2	12.4
Normal raised bed (check)	7.0	30.0	67.4	86.3	100.3	4.4	7.5	8.8	9.7	11.4
CD (0.05)	0.7	3.4	7.2	8.1	11.3	1.2	0.2	0.1	0.3	0.2

nursery, and sand and soil alone and their combinations in dapog nursery system. It was also observed that the total root length significantly increased with increase in nursery duration from 1 week to 5 weeks in all the treatments. Shoot length of nursery seedlings was measured at different stages (Table 2). Compost alone or in combination with sand and soil in dapog nursery method produced higher shoot length throughout the nursery age. This might be due to the presence of more available essential plant nutrients in the compost. Shoot growth was lesser in dapog (hydro nursery). This might be due to the bundling effect of cassava setts as well as non availability of sufficient plant nutrients. Shoot length increased with the increase in the age of nursery seedlings.

The nursery seedlings were transferred to the main field at weekly intervals. One and two weeks old seedlings showed good establishment irrespective of the nursery type (Table 3). Further, increasing the age of nursery seedlings led to lesser establishment in all the nursery types (Table 3). This might be due to more transplanting shock for aged seedlings. Among nursery types, dapog (hydro) resulted in higher percentage of establishment irrespective of the age of seedlings. The establishment percentage of dapog (hydro) nursery was 100, 100, 90, 90 and 83% with 1, 2, 3, 4 and 5 weeks old seedlings, respectively. Dapog (sand) and (compost) showed 100%, 90%, 80%, 80%, and 80% establishment in 1, 2, 3, 4 and 5 weeks old seedlings respectively. Lesser establishment of 90%, 83%, 70%, 60% and 60% were observed in 1, 2, 3, 4 and 5 weeks old seedlings of normal raised bed nursery, respectively. The root yield per plant at harvest was found to be higher with 2 and 3 weeks old seedlings in all the treatments (Table 3). Increase in the age of the seedlings decreased root yield. This might be due to root damage while transplanting the aged seedlings. Poor establishment, less vigour and growth leads to lower yield. Dapog (hydro) produced significantly higher root yield with all the age of seedlings compared to the other methods of nursery. However, the highest root yield of 3.9 and 3.8 kg plant^{-1} was observed with 1 and 2 weeks old sedlings respectively. Normal raised bed nursery produced significantly lower root yield when the age of the seedlings was more than 2 weeks.

It can be concluded that dapog (hydro) nursery resulted in more number of roots plant^{-1}. Dapog (hydro) nursery also gave the best establishment in the main field and resulted in higher root yield with 1 and 2 weeks old seedlings. Further detailed studies on the effect of bundling cassava sett, shade, type of polythene, nutrient solution etc. of dapog nursery are required.

Table3. Influence of different nursery types on establishment and root yield

Treatments		Establishment (%)					Yield (kg plant^{-1})				
		1 week	2 weeks	3 weeks	4 weeks	5 weeks	1 week	2 weeks	3 weeks	4 weeks	5 weeks
Dapog (hydro)		100	100	95	95	83	3.9	3.8	3.6	3.5	3.4
Dapog (sand)		100	90	80	80	80	2.4	2.9	2.6	2.5	2.5
Dapog (soil)		90	90	80	70	70	2.3	3.1	2.9	2.6	2.5
Dapog (compost)		100	90	80	80	80	3.3	3.3	3.0	2.8	2.8
Dapog (sand+soil; 1:1 ratio)		90	90	80	70	70	3.5	3.3	3.1	2.8	2.7
Dapog (sand+compost; 1:1 ratio)		90	90	80	80	80	3.4	3.1	2.9	2.7	2.6
Dapog (soil+compost; 1:1 ratio)		100	90	80	90	70	3.5	3.1	3.0	2.9	2.7
Dapog (sand+soil+compost; 1:1:1 ratio)		90	90	80	80	70	3.4	3.2	3.1	2.8	2.7
Normal raised bed (check)		90	83	70	60	60	2.8	2.8	2.6	2.5	2.4
CD (0.05)	Nursery type	8	6	6	5	5	0.8	0.2	0.2	0.5	0.4
	Age of the seedlings	5	4	4	3	3	0.5	0.1	0.1	0.3	0.3
	Interaction	14	11	10	9	8	0.13	0.3	0.3	0.8	0.4

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