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Effect of root trainers size on quality of seedling production of *Jatropha carcus*

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Abstract
The present study was conducted taking quality seeds of selected plus trees of *Jatropha carcus* in six different size of root-trainers, viz., T_1 (90cc), T_2 (150cc), T_3 (200cc), T_4 (250cc), T_5 (300cc), and T_6 (600cc), each root-trainer size was treated as a separate treatment and each treatment replicated four times. Each replication had 10 seedlings of 3-leaf stage in uniform potting media. At the end of three months, four seedlings were selected randomly for measurement of growth parameters and biomass studies. Total seedling height, collar diameter, shoot biomass, root biomass, tap root length and number of lateral roots were recorded. Sturdiness quotient, shoot root ratio and seedling quality index were calculated. The results of the present study show that root-trainer size had significant effect for all growth parameters. Treatment average difference for all growth parameters except number of leaves, which was maximum in T_4 and minimum in T_1 observed. The sturdiness and seedling quality have direct and positive relationship with root-trainer size.

Keywords: Root Trainer, Seedling Quality, jatropha, Growth

Introduction
Plants play an important role in the solar energy transport to bio-energy. As a potential biofuel plant species, physic nut *(Jatropha curcas* L.) has attracted great attention worldwide, with an increasing number of plantations in many tropica *Jatropha curcas* L. is a shrub belonging to the Euphorbiaceous family and is considered to be an important energy crop due to the production of biodiesel that can be utilized as a suitable alternative fuel resource. It is cultivated in many parts of the tropics and subtropics as a hedge crop and for traditional use (Heller, 1996; Kumar and Sharma, 2008) [9, 12]. Jatropha occurs mainly at lower altitudes (0 - 500 m) in areas with average annual temperatures well above 20 °C but can grow at higher altitudes and tolerates slight frost. It grows on well- drained soils with good aeration and is well adapted to marginal soils with low nutrient content. The current distribution shows that introduction has been most successful in the drier regions of the tropics and can grow under a wide range of rainfall regimes from 250mm to over 1200 mm per annum (Katwal and Soni 2003) [11].

Improvement of the planting stock production system, especially the introduction of root trainers and establishment of permanent nursery facilities in the forestry sector was initiated under a World Bank aided forestry programme. Forest nurseries with facilities for raising and maintaining many seedlings, clonal multiplication facilities, composting and growing media development units were developed in different parts of each state to meet the need of annuals planting programmes. Reusable type root trainers with different growing –cell sizes and capacities were used. The root trainers is a specially designed cylindrical containers made up of opaque material with two open ends of which the lower and tapers gradually with a smaller open end, to provide favourable condition for the root development. The principle of root trainers technology include: (1) providing appropriate environment to attain rapid development of primary roots and subsequent secondary roots,(ii) tap root and induce secondary root system so as to attain forced multiple taproots,(iii) maintaining acute angle of secondary and tertiary root tips and its subsequent pruning, so as to keep downward movement to attain network of massive root system.

Materials and Methods
The root trainers are containers made up of high density polypropylene or high density polyethylene materials, designed with (4 or 6) vertical ribs and have open bottoms. They are of different types, sizes, shape and capacity. The root trainers are placed on a root trainer stand in such a way that the drainage hole is exposed above the ground, which facilities free flow of

air. The free flow of air constantly sloughts up the primary roots when it comes out of the drainage hole resulting in proliferation of lateral roots.

Pre-treatment of seeds

For standardization of nursery techniques and to observe the effect of root trainer on *Jatropha curcas.* The seeds were soaked in cold distilled water for 24 hours two fresh seeds were sown in each root trainer of different sizes viz. 90 cc, 150 cc, 200 cc, 250 cc, 300 cc and 600 cc in the first week of March which were filled with soil, sand and FYM in the ratio of 1 : 1 :1. Regular weeding and irrigation was done at frequent intervals when required to produce healthy seedling.

Experimental Design

The seeds were sown in a completely Randomized design (CRD) with six treatments each replicated 4 times. In each replication, forty eight seedlings were raised accordingly – germination data was recorded immediately after the seeds emerged outside the soil.

T_1 - 90 cc root trainer
T_2 - 150 cc root trainer
T_3 - 200 cc root trainer
T_4 - 250 cc root trainer
T_5 - 300 cc root trainer
T_6 - 600 CC root trainer

Growth data Root shoot ratio

It was worked out on dry weight basis by dividing the weight of dry root by the weight of dry shoot of each plant separately.

$$\text{Root/shoot ratio} = \frac{\text{Root dry weight (g seedling}^{-1}\text{)}}{\text{Shoot dry weight (g seedling}^{-1}\text{)}}$$

Quality Index (QI)

The quality index of seedling was calculated empirically by adopting the formula derived by Ritchie (1984) as follows:

$$\text{Quality index} = \frac{\text{Total dry weight (g)=}}{\dfrac{\text{Height (cm)}}{\text{Diameter (mm)}} + \dfrac{\text{Shoot dry weight (g)}}{\text{Root dry weight (g)}}}$$

Sturdiness Ratio

The sturdiness quotient is the seedling height (g) in centimeters dividing by the stem diameter (d) in millimeters. (h/d) by Roller (1997) [17]. Sturdiness quotient was measured for individual seedlings and the mean of every treatment was found out by averaging the measurement of all the seedlings under each treatment.

Table 1: Effect of different root trainers on seedling parameters of *Jatropha curcas* at different interval.

Treatments		Seedling height(cm)				Collar diameter(mm)				Number of leaves			
		45 DAP	90 DAP	135 DAP	180 DAP	45 DAP	90 DAP	135 DAP	180 DAP	45 DAP	90 DAP	135 DAP	180 DAP
T_1	90 cc	11.05	24.9	40.5	59.30	8.50	13.05	16.25	19.25	4.15	8.45	13.50	17.85
T_2	150 cc	12.20	28.0	45.5	67.75	8.80	13.70	17.00	20.15	6.00	9.55	14.35	18.40
T_3	200cc	13.70	33.5	50.0	73.00	9.15	14.05	17.55	20.60	7.40	11.75	16.10	19.55
T_4	250 cc	14.60	35.6	49.5	75.70	9.30	14.95	18.15	21.15	8.15	13.10	18.20	20.70
T_5	300 cc	14.95	36.8	53.3	78.85	9.45	15.25	18.55	21.70	9.10	15.70	19.05	22.45
T_6	600 cc	15.85	40.3	56.3	81.35	9.85	16.35	19.40	22.30	11.40	18.45	21.75	24.90
F test			S	S	S	NS	S	S	S	NS	S	S	S
SE d ±			1.169	0.573	0.551	0.419	0.156	0.219	0.174	2.163	0.195	0.173	0.246
CD (P=0.05)			2.418	1.185	1.141	0.868	0.323	0.453	0.361	4.475	0.404	0.358	0.503

Table 2: Effect of different root trainers on root and biomass of *Jatropha curcas* at different interval

Treatments		Root length	Fresh wt of shoot (g)	Fresh wt of Root (g)	Dry wt. of shoot (g)	Dry wt. of root (g)	Root Shoot ratio	Sturdiness ratio	Total dry matter production	Quality Index
T_1	90 cc	19.15	70.75	24.15	28.65	9.10	0.315	3.08	37.75	5.99
T_2	150 cc	21.10	79.85	30.40	33.15	10.30	0.305	3.36	43.30	6.47
T_3	200 cc	22.90	93.65	35.55	33.75	10.15	0.305	3.54	44.50	6.45
T_4	250 cc	24.15	111.4	38.40	36.00	10.70	0.310	3.58	47.10	6.87
T_5	300 cc	25.25	120.85	39.95	37.05	11.10	0.310	3.63	48.55	7.08
T_6	600 cc	28.30	131.75	42.50	41.40	12.50	0.295	3.65	53.95	7.84
F test		S	S	S	S	S	S	S	S	S
SE d ±		0.233	1.623	0.178	0.236	0.163	0.006	0.183	0.378	0.016
CD (P=0.05)		0.480	3.357	0.367	0.489	0.338	0.011	0.378	0.782	0.034

Results and Discussions

This study presents result of the measurements of collar diameter, total height, above and below ground biomass, suitable size if root trainer to improve the planting stock of *Jatropha curcas* in nursery condition. The data present is pooled of two years.

During both the years and in pooled data of the two years shoot length of *Jatropha curcas*, recorded at 90,135 and 180 DAS as presented by the table 1. was significantly affected by the different sized root trainers, whereas the effect at 45 DAS was not statically significant Pooled data of the two years shows that at 135 and 180 DAS there was significant increase in shoot length with the successive increase in the size of root trainers from 90cc to 600cc. However at 90DAS it was observed that there was no significant difference in the shoot lengths with the increase in the size of root trainers from 200cc to 250cc and from 250cc to 300cc although there was significant difference between all other root trainers used. The use of 600 cc root trainers significantly showed maximum shoot length of 40.30, 55.65 and 81.35 cm recorded at 90, 135 and 180 DAS respectively, which was followed by the use of

300 cc root trainers exhibiting a shoot length of 36.8, 51.70 and 78.85 cm respectively at 90, 135 and 180 DAS.

Collar diameter of the *Jatropha curcas* during both the years and in pooled data of the two years presented in table 4.1.4 was significantly affected by the different sized root trainers at 90, 135 and 180 DAS whereas no significant effect was noticed at the 45 DAS.As revealed by the pooled data of the two years, collar diameter of the plants recorded at 90, 135 and 180 DAS was significantly increased with the increase in the size of root trainers from 90 to 600 cc. Consequently it was observed that plants with maximum collar diameter of 16.35, 19.40 and 22.30 mm respectively at 90, 135 and 180 DAS were produced with the use of 600 cc root trainer followed by the use of 300 cc root trainer producing plants with the collar diameter of 15.25, 18.55 and 21.70 mm at 90, 135 and 180 DAS respectively The plants with minimum collar diameter of 13.05, 16.25 and 19.25 mm respectively at 90, 135 and 180 DAS were produced with the use of 90 cc root trainer.

Number of Leaves plant^{-1}of the *Jatropha curcas* during both the years and in pooled data of the two years presented in table1. and was significantly affected by the different sized root trainers at 90, 135 and 180 DAS whereas no significant effect was noticed at the 45 DAS. Plant observations at 90, 135 and 180 DAS as shown by the pooled data reveals that successive increase in the size of root trainers from 90 to 600cc significantly showed a successive increase in the number of leaves. The use of 600 cc root trainers significantly showed maximum leaf number of 18.45, 21.75and 24.90 recorded at 90, 135 and 180 DAS respectively, which was followed by the use of 300 cc root trainers exhibiting a leaf number of 15.70, 19.05 and 22.45 respectively at 90, 135 and 180 DAS. The minimum leaf number of 8.45, 13.50 and 17.85at 90, 135 and 180 DAS respectively were observed with the use of 90 cc root trainers. Highest shoot and root length, collar diameter and number of leaves/plant was recorded in T6 (600 cc root trainers) followed by T_5 (300 cc trainer) during both the years of study also in pooled data were significantly different from control i,e 90cc root trainer. This might be due to larger size of containers (600 cc) which are beneficial to seedlings growth (Evans, 1992) [5]. Seedling size is directly related to container size that is to medium volume (Endean and Carlson 1975) [6]. Root development is impaired even after out planting resulting in distorted root system, which may affect subsequent growth of transplants, observation confirmed no coiling of roots in root trainers both with pine and tropical hard woods. Their well-developed root systems held soil medium tightly and formed the plug like subterranean part, which is beneficial in handling and out planting. Apparently the ribs inside of cavity do play an important role in training roots and root lets. The root environment is also significantly affected by the physical and chemical composition of the medium, the size and shape of the containers, the surface upon which it is placed to grow, and the ambient atmosphere of the containers (Davison and Mecklenburg, 1981) [4]. Apart from all these, air root pruning plays a vital role of raising seedling. For air root bottomless or performed plastic containers are used and are placed above the ground level with air space between ground and the container. The growth of taproots is effectively checked if they come in the contact of air. The root after coming in contact with air is burnt off by contact with air. As further growth of tap root is prevented the lateral root development commences near the collar of the plant. Air root pruning probably creates the best possible of any root configuration. The basic formative shaping takes place in the earliest stages of growth when it is most susceptible to moulding forces. (Vinod Kumar 1999) [21]. The result are supported by the finding of Gere, *et al*., (2005) [7], in *Acacia catechu* and *Albizia lebbek*, Ginwal *et al*., (2001) [8] in *Acacia nilotica*, Roa *et al*., (2006) [18] in *Bambusa bambus* and *Annona squamosa*, Dagar *et al*., (2004) [3] in *Jatropha curcas* Josiah and Jones (1992) [10] in *Albizia procerra* Khedkar Bilderback *et al*..(1991) [1] have also proved that container geometry or volume have pronounced effect on soil moisture content and aeration among root trainers,

Regarding the effect of root trainers on root and biomass of *jatropha curcas* presented in table 2. A significant difference was observed in all the root trainers used .It is evident from Table 2 that T_6 (600cc) showed maximum root length (28.30gm) fresh weight of shoot (131.75 gm), fresh weight of roots,(42.50) dry wt. of roots (12.50), sturdiness ratio (3.65). total dry matter production (53.95) and quality index (7.84) which may be due to logical to attribute the increases in dry weights and plant height from increased container size to increased soil volume and nutrient uptake in large containers. This may have resulted from increased growth rates in such containers. (Peterson and Krizeki, 1992) [15] soil respiration was significantly increased by container volume and as the volume increased there was a consistent increase in soil respiration and this was apparently due to enhanced in microbial activities in larger containers than in small containers. The condition in the larger root trainers such as increase soil volume, nutrient uptake, hormone synthesis, soil metabolism. (Peterson *et al*.,1991) [14]. As containers size increases plant leaf area, shoot biomass increase. Growth rates of shoots and roots are interdependent. Roots rely upon plant aerial portions for photosynthesis and various hormones, while plant aerial portion rely on the roots for water, nutrients support and hormones. The delicate balance between roots and shoots can be upset when the root system is restricted in a small rooting volume. The resulting imbalance can have short terms, as well as long terms, effects on plant growth. (Cantliffe, 1993; Tonutii, 1990 and Leskovar *et al*., 1990) [2, 20, 13]. Only dry wt. of shoots and root shoot ratio (0.315) highest in T_1 (90 cc) which may be due to the basic formative shaping takes place in the earliest stages of growth when it is most susceptible to molding forces (vinod kumar 1999) [21].

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