Determination of suitable cutting size for vegetative propagation and comparison of propagules to evaluate the seed quality attributes in *Jatropha curcas* Linn.

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Abstract

An attempt was made to propagate the Jatropha, ***Jatropha curcas* Linn.** through stem cutting without any rooting hormonal treatments. The cuttings were selected with three different lengths, viz. 20 cm (L_1), 30 cm (L_2) and 40 cm (L_3) and four different stem thickness: 1.5-2.0 cm (T_1), 2.0-2.5 cm (T_2), 2.5-3.0 cm (T_3) and 3.0-3.5 cm (T_4). The cuttings were planted in the nursery and observed for survival percentage, number of leaves per plant, root volume, root fresh and dry weight on 90 days after planting. The result revealed that the stem cutting with 40 cm length (L_3) and 2.5 to 3.0 cm thickness (T_3) was found to be very suitable for quicker regeneration with seedling quality characteristics compared to other types of cuttings. Hence, to find out the suitable propagating material for commercial exploitation, the best performed stem cutting with 40 cm length (L_3) and 2.5 to 3.0 cm thickness T_3) along with freshly harvested seeds were forwarded to field trial. The plant biometric characteristics, fruit and seed quality attributes were observed in both the treatments and compared to find out the best propagating techniques. The plants propagated by seeds recorded more plant height (1.65 m), number of branches (3.2). However, the flowering was four days earlier by cuttings than the plants propagated by seeds. The reproductive character of the monoecious inflorescence in terms of male to female flower ratio was higher in seed propagated crop (24:1) than cuttings (22:1). ***J. curcas*** propagated through seeds recorded better performance related to plant biometric and seed quality characteristics compared to cuttings, which induced early flowering and more female flowers than the seed crop.

Keywords: *Jatropha, Jatropha curcas,* Seed quality, Survival percentage, Vegetative propagation.

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Introduction

Jatropha (***Jatropha curcas* Linn.**) of Euphorbiaceae family is a small sized perennial having xerophytic adaptations . It is now regarded as a plant of biodiesel value in addition to being a potential species for wasteland afforestation. In India it is found in almost all the states and is traditionally used for medicine, oil, pesticide and cosmetics. To reduce the pressure on demand of petroleum product, an eco-friendly bio-diesel plant i.e. cultivation of jatropha on large scale assumes greater importance. Realizing the importance of oil from ***J. curcas***, massive afforestation works are geared up both by Government of India and many state governments.

Almost in any part of the world, jatropha in the form of a plantation for seed production is not common[1].

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However, plantations of several hectares have only been reported in west and central Africa. The success of crop and its performance in further generation is decided by the methods of propagation. In perennials, vegetative propagation is highly preferred for all desirable characters, viz. fruit characters, seed quality characters, oil content, etc.[2]. In Jatropha, both seeds and stem cuttings are used for mass multiplication. The present study is focused on mass multiplication strategy for ***J. curcas*** without involving any costly misting system and rooting hormones for induction of roots and also compares the two propagules, viz. the seeds and cuttings for evaluation of fruit and seed quality characters.

Fig. 1 : Different cutting sizes of Jatropha

Fig. 2 : Sprouting of Jatropha cuttings

Materials and Methods

Collection and grading of cuttings

To determine the optimum length and thickness of the cuttings for vegetative propagation, a large number of cuttings were collected from 2.5 to 3.5 years old mother plant from Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore, India. After removal of the side branches and leaves, the cuttings were made into 20 cm (L_1), 30 cm (L_2) and 40 cm (L_3) length and 1.5-2.0 cm T_1), 2.0-2.5 cm (T_2), 2.5-3.0 cm (T_3) and 3.0-3.5 cm (T) stem thickness. Based on the length and thickness, the cuttings were graded in to small, medium and large (Fig. 1).

Rooting of cuttings

About 15 cm high nursery beds of size 10 × 1 m were made in the field at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Twenty five cuttings in each category were planted in the raised beds with four replications. The observations, viz. survival percentage, number of leaves per plant, root length, root volume, root fresh and dry weight were recorded on 90 days after planting. For assessing survival percentage, seedlings that survived after three months were counted and expressed as per cent. Root length of the seedlings was measured from collar region to the root tip, expressed in centimeter. The number of fully opened leaves present in each cutting was counted and expressed as number of leaves/cutting. For assessing the root volume, the seedlings were scooped out, washed in running water, the root portion was detached at the nodal base of seedling and placed in a measuring cylinder containing known volume of water. By measuring increase in the water column, root volume was assessed and the mean value was expressed in cc/cutting. Fresh weight of root was calculated for different treatments and expressed in g/cutting. For analyzing dry weight of root, it was placed in paper bag and air dried for 24 h then kept in a hot air oven maintained at 85 ± 2°C for 24 h, cooled in a desiccator, weighed and expressed as g/cutting. The data were subjected to an Analysis of Variance and treatment differences tested (t test) for significance (P=0.05) after Gomez and Gomez[3].

Results and Discussion

Vegetative propagation

In the present study, the survival percentage differed significantly due to length and thickness of the cuttings. Among the different lengths, L_3 recorded the highest survival (65%), while, L_1 recorded the lowest survival (56%). Among the thickness, T_3 recorded the highest survival of 66 per cent followed by T_4 (62%). The cuttings of 40 cm length with 2.5 to 3.0 cm thickness recorded the maximum survival per cent (68%) (Table 1). It is presumed that the medium sized cuttings might have got sufficient food material and hormones for induction of root and shoot. According to Davis[4] hormones have been shown to regulate different aspects of plant growth and development including cell division, cell elongation and differentiation. Reinhard Henning[1] observed that the cuttings about 60-120cm long are highly amenable for vegetative propagation. It is also been presumed that the sprouting behaviour of

stem cuttings varies with age, genotypes and physiological status of mother plant[5], which may also be one of the reasons for good performance of the medium sized cuttings.

The vigour of the sprouted cuttings in all grades of cuttings was rated in terms of number of leaves/cutting, root length (cm) and root volume (cc/cutting). More number of leaves were produced from L_3 (16.00) compared to L_1 (10.94) and L_3 recorded the maximum number of leaves (15.14) than T_1 (11.37). However, the cutting length 40 cm and thickness 2.5 to 3.0 cm recorded the maximum number of leaves/cutting (26.33) (Table 1). The cutting with more thickness (T_3) produced the lengthier roots (22.35 cm). Regarding the thickness T_3 measured longer root length (21.64 cm)[3] than T_1 (18.12 cm) (Table 2). The cuttings of 40 cm length (L_3) recorded the maximum root volume (3.97) compared to 20 cm (L_1) which recorded the minimum value of 3.41 (Table 1). The small sized cuttings registered very poor growth and were inferior to the medium and longer sized cuttings (Fig. 2). A reduction in root length was observed with reduction in size of cutting, due to inadequate supply of nutrients and leaching of nutrients in shorter cuttings resulted in poor performance in rooting[6]. Hegde[7] expressed that this might be due to higher adventitious ability of juvenile characters of larger cutting compared to smaller cutting which are having tender tissues, with unsaturated latex and the higher content of metabolites like tannin, lignin, etc. which adversely interfere with sprouting and root development. The initial levels of endogenous auxin and its oxidation enzymes IAA-oxidase and peroxidase play a significant part in the rooting process. IAA-oxidase activity is involved in triggering and initiating the roots/root primordial, whereas peroxidase is involved in both root initiation and elongation[8].

The biomass productivity of the different grades of cuttings was estimated in terms of fresh and dry weight of roots. Maximum fresh and dry weight of root (47.529 and 17.821 g /cutting fresh and dry weight, respectively) was recorded by L_3 compared to L_1 which recorded the minimum of 31.822 and 12.746 g/ cutting, respectively (Table 2). The cuttings made with 40 cm length and 2.5 to 3.0 cm thickness registered the maximum fresh and dry weight of 50.336 and 19.273g/cutting. The poor performance of the small grade cutting is also attributed to the reason that the cuttings are still under maturity and may be devoid of sufficient food material for induction of roots and shoots. The under performance of the larger sized cuttings may be attributed to the reason that these cuttings are more woody and might have converted most of the food materials for the lignification which resulted in over lignified stem and caused lower rooting and shooting percentage. In *Jatropha* species, shoots are formed much earlier than roots. Shoots thus formed earlier due to reserve carbohydrates, start producing auxins which moves downward, thereby accumulating in the lower portion of the cuttings, when the concentration reaches a threshold value, endogenous auxins at the extreme basal end start getting metabolized and signal the process of root initiation[8].

Comparison of propagation by seed and vegetative cutting

To find out the suitable propagating material for commercial exploitation, the best performed stem cuttings with 40 cm length (L_3) and 2.5 to 3.0 cm thickness along with freshly harvested seeds were forwarded to field trails. The plant height differed significantly due to propagating materials. The plants propagated through seeds produced the plants with more height (1.65m) than the cuttings (1.52 m) (Fig. 4). Between the propagating materials, the plants propagated through seeds recorded more number of branches (3.2) than cuttings (2.4) (Fig. 3). Flowering was four days earlier in plants raised by cuttings than by seeds (Table 3). The variations in reproductive character of the monoecious inflorescence in terms of male to female flower ratio between the seed propagated (24:1) and cuttings propagated crops were incomparable (22:1). The plants propagated through seeds recorded the maximum fresh and dry weight of fruit (11.54 and 2.79g, respectively) than plants propagated by cuttings (10.46 and 2.25 g) (Table 3). The maximum 100 seed weight was recorded by the plants raised through seeds (104.04) than cuttings (101.66) (Table 3). The germination was more in seed plant (80%) whereas germination of 75% was recorded in seeds from cutting propagule. The plants propagated through seeds recorded the maximum dry matter production of 3.042g and the minimum of 2.904g was recorded by cuttings (Fig.3). The oil content observed a non-significant difference between the seeds of different propagation methods.

Table 1: Effect of stem cutting length and thickness on survival (%), number of leaves/cutting and root volume in *Jatropha curcas*

Stem cutting size	Survival (%)				No of leaves/cutting				Root volume (cc/cutting)			
Thickness (cm)	Length (cm)				Length (cm)				Length (cm)			
	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean
T_1	48 (43.28)	53 (47.85)	63 (54.75)	55 (48.43)	13.66	16.66	18.66	16.33	5.20	5.50	5.66	5.46
T_2	53 (47.88)	61 (52.74)	65 (55.77)	60 (50.79)	15.66	18.00	21.33	18.33	5.50	5.70	5.86	5.69
T_3	63 (54.75)	66 (56.84)	68 (60.11)	66 (56.84)	18.00	19.66	26.33	21.33	5.70	5.83	6.10	5.88
T_4	60 (50.79)	63 (54.75)	65 (55.77)	62 (53.79)	16.66	19.00	23.00	19.56	5.36	5.73	5.93	5.68
Mean	56 (49.61)	61 (52.74)	65 (55.77)		16.00	18.33	22.33		5.44	5.69	5.89	
	L	T	LT		L	T	LT		L	T	LT	
SEd	1.090	1.259	2.180		0.185	0.213	0.369		0.022	0.025	0.043	
CD (*P*=0.05)	2.261	2.611	4.522		0.368	0.425	0.736		0.043	0.050	0.086	

L_1- 20 cm, L_2 - 30 cm, L_3 - 40 cm; T_1 - 1.5-2.0 cm, T_2 - 2.0-2.5 cm, T_3 - 2.5-3.0 cm, T_4 - 3.0-3.5 cm
SEd – Standard Error deviation; CD – Critical Difference

Table 2: Effect of stem cutting length and thickness on root length (cm), root fresh and dry weight (g/cutting) in *Jatropha curcas*

Stem cutting size	Root length (cm)				Root fresh weight (g/cutting)				Root dry weight (g /cutting)			
Thickness (cm)	Length (cm)				Length (cm)				Length (cm)			
	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean
T_1	21.83	24.70	26.33	24.29	29.890	36.076	43.866	36.611	10.607	14.343	16.373	13.774
T_2	23.73	25.76	27.43	25.64	30.706	38.453	46.676	38.612	12.793	15.456	17.526	15.259
T_3	26.40	28.90	32.86	29.39	33.150	41.120	50.336	41.536	14.123	16.206	19.273	16.534
T_4	24.63	28.20	31.80	28.21	33.540	39.770	49.236	40.848	13.460	15.376	18.110	15.649
Mean	24.15	26.89	29.61		31.822	38.855	47.529		12.746	15.346	17.821	
	L	T	LT		L	T	LT		L	T	LT	
SEd	0.116	0.134	0.232		0.217	0.250	0.434		0.110	0.127	0.220	
CD (*P*=0.05)	0.231	0.267	0.463		0.433	0.500	0.866		0.219	0.253	0.439	

L_1-20 cm, L_2-30 cm, L_3-40 cm; T_1-1.5-2.0 cm, T_2-2.0-2.5 cm, T_3 - 2.5-3.0 cm, T_4 - 3.0-3.5 cm
SEd – Standard Error deviation; CD – Critical Difference

Table 3: Comparison of propagation methods on growth and seed characteristics in *Jatropha curcas*

Treatments	Days to first flowering	Male/female flower ratio (Female flower percentage)	Fresh weight of fruit (g)	Dry weight of fruit (g)	100 seed weight (g)	Germination (%)	Oil content(%)
Seeds	118	24:1 (4.2)	11.54	2.79	104.04	80(63.78)	32.72
Cuttings	114	22:1 (4.5)	10.46	2.25	101.66	75(62.56)	32.35
Mean	116	4.35	11.00	2.52	102.85	78(63.71)	32.53
S Ed	1.4661	0.031	0.205	0.066	0.8482	1.52	NS
CD (*P*=0.05)	3.1674	0.067	0.443	0.142	1.8325	3.13	

NS – Non-significant; SEd – Standard Error deviation; CD – Critical Difference

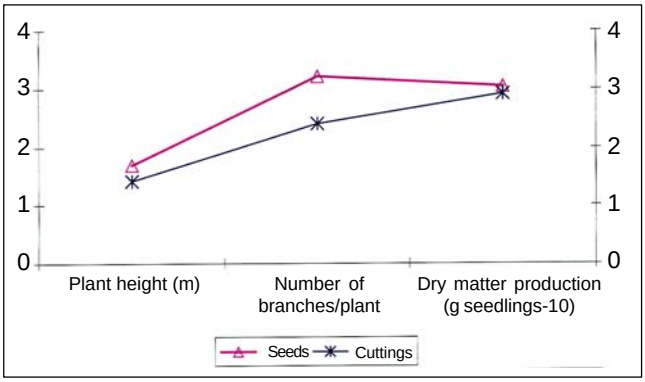

Fig. 3 : Effect of cuttings length and thickness on plant height (m) and number of branches in Jatropha

Conclusion

The present study revealed that the macro propagation of ***J. curcas*** stem cuttings with 40 cm length and 2.5 to 3.0 cm thickness is successful in generating higher survival with biomass productivity. Plants propagated through seeds recorded better performance related to plant biometric and seed quality characteristics compared to cuttings. However, the oil content was not differed significantly between the two propagules.

In the present situation, availability of quality seeds for large scale planting/ afforestation is scanty. Hence, this study implies that the stem cuttings help to develop uniform plant stock for the successful afforestation of larger area in one planting season.

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