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Vegetative propagation of physic nut (*Jatropha curcas* L.) through stem cuttings

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Abstract: The selected healthy branches of *Jatropha curcas* were cut into 15 cm and 25 cm length having 4 to 5 nodes in each category of apical portion (thickness < 1cm), middle portion (1.0 to 1.5 cm) and basal portion (1.5 to 2 cm). The base positions of apical, middle, basal portions of cuttings were dipped in the 100, 200, 400, 800 and 1000 ppm of IAA (Indole-3-acetic acid) and IBA (Indole-3-butyric acid) respectively for four hours. After which the cuttings were planted in the polypots filled with rooting media consists of sand, soil and farm yard manure (FYM) in the ratio of 1:2:1. Maximum sprouting (100%) was observed in 25 cm as well as 15 cm length cuttings of different portions. In case of 25 cm length different sections like apical cuttings when treated with 200 ppm, 800 ppm IAA and 400 ppm IBA, basal cutting with 800 ppm IAA and 200, 400 ppm IBA and middle cuttings with 200 ppm IAA, similarly 15cm length basal portion cutting treated with 400 ppm IAA produce 100 per cent sprouting. Other characters like rooting percentage (93.33%), root length (37.66cm), fresh biomass (73.21g) and dry biomass (34.06g) were observed maximum in apical portion cutting of 25 cm length treated with 100 ppm IBA, 800 ppm IBA, 100 ppm IAA and 100 ppm IAA respectively where as root number (17.0) found maximum in middle portion cutting of 15cm length treated with 1000 ppm IAA. It showed that the apical portion of 25 cm length cuttings treated with IAA and IBA resulted in maximum sprouting, rooting percentage, root length, fresh biomass and dry biomass production.

Keywords: IAA, IBA, *Jatropha curcas*, Stem cutting, Vegetative propagation

INTRODUCTION

India ranks sixth in terms of energy demand and its economics is projected to grow at 8-9% over next two decades and energy demand is accepted to grow at an annual rate of 4-8% over the next couple of decades. So “Energy independence” will be one of the vital areas to make India as a developed nation. Considering the seriousness of cost and pollution affect due to the use of petroleum products, biofuel is an effective alternative to these. Among biofuel, biodiesel has immense attention as a renewable, biodegradable and non-toxic fuel since the past decade (Stavarache *et al.*, 2007, Sarin *et al.*, 2007 and Tiwari *et al.*, 2007). Due to high domestic demand of edible oils, biodiesel is arguably produced from non-edible Tree Born oil seeds (TBOs) in Indian condition from seeds of Neem (*Azardirachta indica*), Karanj (*Pongamia pinnata*), Mahua (*Madhuca latifolia*), Undi (*Callophyllum inophyllum*) and Physic nut (*Jatropha curcas*). Out of which *J. curcas* has a lot of potential as a biodiesel crop. (Kou and Chun, 2007; Openshaw, 2000). *J. curcas* belongs to Euphorbiaceae family, a plant of Latin American origin which is now wide spread throughout the arid and semi-arid tropical regions of the world. It is a perennial shrub to small tree living up to 50 years with height 3- 4 m sometimes up to 6 m with numerous side branches that arise from its main stem (Patil and Singh, 1991). It can be cultivated successfully in the regions having scanty to heavy rainfall with annual rainfall ranges from 250 -1200 mm, well drained soil with good aeration and well adapted to marginal soil even in arid and semi-arid conditions and had low fertility and moisture demand (Katwal and Soni, 2003). Besides its use for production of biodiesel, the oil also yields byproducts like glycerine and seed cakes after transesterification process. Glycerine can be used in soap and cosmetics preparation while seed cake can be used as biofertilizer, fuel briquettes and paper making (Kumari *et al.*, 2010). Jatropha can be propagated commercially by seedling raised from seeds and stem cutting. Propagation from seeds are heterozygous, also delay the flowering, fruiting and seed production quantitatively as well as qualitatively where as vegetatively propagated seedlings are superior traits of the mother plants with respect to yield, oil content, disease resistant are maintained and thereby reducing the seed bearing age. Keeping in view of the importance of the crop and its propagation methods, the present experiment was designed with the objective of mass production of quality planting material through vegetative propagation of *J. curcas.*

MATERIALS AND METHODS

The investigation was carried out at College of Forestry, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar during March, 2012. The experiment was started with collection of apical portion, middle portion and basal portion of *J. curcas* from identified plus trees. The cutting of selected healthy branches bring out which were of 15 cm and 25 cm lengths having 4 to 5 nodes under each category of apical portion (thickness < 1cm), middle portion (1.0 to 1.5 cm) and basal portion (1.5 to 2 cm). The bases of apical, middle, lower portions of cuttings were dipped in the 100, 200, 400, 800 and 1000 ppm of IAA and IBA respectively for four hours. After which the cutting were planted in the polypots filled with rooting media consists of sand, soil and farm yard manure (FYM) in ratio of 1:2:1. The polypots were put under agro-shed net and watered as per the requirement. Observations like sprouting percentage, rooting percentage, mean root length (cm), mean number of roots, mean fresh biomass (g) and mean dry biomass (g) were observed. The experiment was designed in completely randomized design (CRD) and data observed were subjected to statistical analysis as for the methods detailed by Gomez and Gomez (1984). The data were transferred from where ever required before suitability of ANOVA analyzed in statistical package SAS version 7.0.

RESULTS AND DISCUSSION

The investigation revealed a significant influence of IAA and IBA on the cuttings of *J. curcas* for sprouting (Table 1). Maximum sprouting (100%) was observed in 25 cm as well as 15 cm length of different portions. In case of 25 cm length different portions like apical cuttings when treated with 200 ppm, 800 ppm IAA and 400 ppm IBA, basal cutting with 800 ppm IAA and 200, 400 ppm IBA and middle cuttings with 200 ppm IAA, Similarly 15 cm length basal portion cutting treated with 400 ppm IAA produce 100 per cent sprouting. Earliness in sprouting and increase in number of sprouts may be due to better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators (Chandramouli, 2001). Further it has been reported by Haissig (1984) that stored food materials with the help of growth regulators may have fastened the sprouting there by enhancing the utilization of carbohydrates at base of cutting through photosynthesis. Osbonne and McManus (2005) also mentioned that auxin positively influence in cell enlargement, bud formation and promotes the production of other hormones in conjunction with cytokinins. According to Wright (1975) that in vegetative propagation, the sprouting depends on food reserve available within the cuttings. In case of rooting percentage (Table 2), IAA treated in basal portion cuttings of 25 cm length showed maximum rooting (81.66%) for the mean value of rooting percentage (over all concentration) which was found statistically at par with rooting of basal portion cutting of 25 cm length treated with IBA. In case of apical, middle and basal portion cuttings of 15 cm length treated with 200 ppm IBA, 100 ppm IBA and 200 ppm IBA respectively resulted in maximum rooting percentage. Similarly in case of apical portion, middle portion and basal portion cuttings of 25 cm length treated with IBA 100 ppm, IAA 100 ppm and IAA 1000 ppm respectively resulted in maximum rooting. This may due to the synergetic effect of the total amount of indigenous auxin present in the cutting and exogenous auxin applied at various concentrations to the different type of cutting enhances the cambial activity at optimum photoperiod and temperature. Waisel and Fahn (1965), Smith and Wareing (1972) reported that endogenous IAA, photoperiod and temperature presume to control the cambial activities and thereby rooting in treated cuttings. Exogenously

Table 1. Effect of IAA and IBA on sprouting (%) of different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	86.66	83.33	86.66	83.33	70.00	76.66	81.11
2.	15 cm middle portion + IAA	90.00	86.66	66.66	83.33	86.66	86.66	83.33
3.	15 cm basal portion + IAA	86.66	80.00	100.00	90.00	83.33	86.66	87.77
4.	15 cm apical portion + IBA	90.00	83.33	76.66	83.33	86.66	76.66	82.77
5.	15 cm middle portion + IBA	96.66	83.33	73.33	76.66	90.00	86.66	84.44
6.	15 cm basal portion + IBA	90.00	96.66	86.66	80.00	80.00	86.66	86.66
7.	25 cm apical portion + IAA	96.66	100.00	90.00	100.00	90.00	86.66	93.88
8.	25 cm middle portion + IAA	96.66	100.00	96.66	96.66	93.33	86.66	95.00
9.	25 cm basal portion + IAA	96.66	96.66	96.66	100.00	73.33	90.00	92.22
10.	25 cm apical portion + IBA	96.66	93.33	100.00	93.33	80.00	86.66	91.66
11.	25 cm middle portion + IBA	100.00	90.00	96.66	96.66	86.66	86.66	92.77
12.	25 cm basal portion + IBA	96.66	100.00	100.00	93.33	96.66	90.00	96.11
	Mean	**93.61**	**91.11**	**89.16**	**89.72**	**84.72**	**85.55**	

Cutting types- CD at 5% - 4.36; Concentration- CD at 5% - 3.08; Interaction- CD at 5% - 10.69

Table 2. Effect of IAA and IBA on rooting (%) of different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	50.00	46.66	40.00	33.33	40.00	26.66	39.44
2.	15 cm middle portion + IAA	56.66	43.33	43.33	43.33	66.66	60.00	52.22
3.	15 cm basal portion + IAA	53.33	46.66	60.00	60.00	50.00	40.00	51.66
4.	15 cm apical portion + IBA	56.66	66.66	63.33	50.00	56.66	26.66	56.65
5.	15 cm middle portion + IBA	86.66	56.66	60.00	56.66	66.66	60.00	64.44
6.	15 cm basal portion + IBA	66.66	66.66	56.66	66.66	60.00	40.00	59.44
7.	25 cm apical portion + IAA	86.66	80.00	80.00	63.33	80.00	60.00	74.99
8.	25 cm middle portion + IAA	83.33	73.33	83.33	66.66	53.33	63.33	70.55
9.	25 cm basal portion + IAA	90.00	80.00	80.00	80.00	73.33	76.66	81.66
10.	25 cm apical portion + IBA	93.33	73.33	73.33	53.33	53.33	60.00	67.77
11.	25 cm middle portion + IBA	73.33	76.66	76.66	80.00	50.00	63.33	70.00
12.	25 cm basal portion + IBA	76.66	83.33	70.00	76.66	86.66	76.66	78.33
	Mean	**72.77**	**66.10**	**65.55**	**61.66**	**61.38**	**56.10**	

Cutting type- CD at 5% - 4.631;Concentration-CD at 5% - 3.273; Interaction-CD at 5% - 11.343

Table 3. Effect of IAA and IBA on root length (cm) in different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	12.00	13.00	36.00	14.00	16.00	10.66	16.94
2.	15 cm middle portion + IAA	19.00	21.33	15.00	13.33	33.66	12.33	19.11
3.	15 cm basal portion + IAA	24.00	15.66	12.00	13.00	14.00	10.66	14.88
4.	15 cm apical portion + IBA	23.00	16.00	15.00	15.00	16.33	10.66	15.83
5.	15 cm middle portion + IBA	16.00	24.66	16.00	16.33	26.66	12.33	18.66
6.	15 cm basal portion + IBA	16.66	18.66	22.66	33.33	18.00	10.66	16.66
7.	25 cm apical portion + IAA	30.66	16.33	14.33	18.66	09.66	12.00	16.94
8.	25 cm middle portion + IAA	24.66	28.33	23.66	23.00	13.66	18.66	22.00
9.	25 cm basal portion + IAA	31.66	19.66	12.66	27.33	16.00	12.33	19.94
10.	25 cm apical portion + IBA	12.33	11.66	14.33	37.66	16.66	12.00	17.44
11.	25 cm middle portion + IBA	34.66	16.66	26.66	28.66	11.66	18.66	22.83
12.	25 cm basal portion + IBA	21.00	27.66	19.00	17.33	19.66	12.33	19.55
	Mean	**22.13**	**19.13**	**18.83**	**19.80**	**17.66**	**12.77**	

Cutting type-CD at 5% - 0.580;Concentration-CD at 5% - 0.409; Interaction-CD at 5% - 1.426

applied hormones are responsible to increase rooting in auxin treated cutting by enhancing hydrolysis activities (Nanda *et al*., 1968). Similarly for maximum root length (Table 3) observed in apical, middle and basal portions cuttings of 15 cm length treated with 400 ppm IAA, 1000 ppm IAA and 800 ppm IBA respectively where as in case of 25 cm length cuttings of every category showed maximum root length treated with 100 ppm IBA, 800 ppm IBA and 100 ppm IAA respectively. The possible reason for IAA and IBA at various concentration treated to the different types of cuttings showing maximum root length might be because of early formation of root and more utilization of food material by the treated cutting (Ghatnatti, 1997). Variation in root length at different concentrations for various cutting types also may be due to synergetic effect of the indigenous auxin present in the cutting type and exogenous auxin applied to the cuttings, favoring rapid cambial activities and thereby enhancing the root length. The difference among auxin could also be related to other factors such as higher stability and slow rate of consumption of IBA, so that the free IBA required to induce rooting will be available over a longer period of time than IAA (Krisantini *et al*., 2006). For root number results (Table 4) showed, when apical portion, middle portion and basal portion cuttings of 15 cm length treated with IAA and IBA separately showed maximum root number at 400 ppm IAA, 1000 ppm IAA and 400 ppm IBA respectively. Similarly when 25 cm length of each category treated with IAA and IBA separately resulted maximum root number in 100 ppm IAA, 200 ppm IAA and 200 ppm IBA respectively. This may be due to the effect of the applied concentration of IAA and IBA to different types of cutting favoring for production of more number of roots because of biochemical changes caused by the auxins and combined effect of biochemical changes and environmental factor like temperature,

Table 4. Effect of IAA and IBA on root number of different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	09.00	11.00	16.00	11.66	11.00	07.33	11.00
2.	15 cm middle portion + IAA	11.66	13.66	10.66	10.00	17.00	09.66	12.09
3.	15 cm basal portion + IAA	13.00	11.33	10.00	10.00	11.00	09.33	10.77
4.	15 cm apical portion + IBA	15.00	11.66	11.00	11.00	12.66	07.33	11.44
5.	15 cm middle portion + IBA	13.00	14.00	11.33	13.33	14.66	09.66	12.66
6.	15 cm basal portion + IBA	12.00	13.00	15.66	12.33	13.00	09.33	12.55
7.	25 cm apical portion + IAA	16.66	13.00	10.66	14.33	09.00	12.33	12.61
8.	25 cm middle portion + IAA	14.66	16.33	13.33	12.00	11.33	12.66	13.44
9.	25 cm basal portion + IAA	14.33	15.66	10.66	13.66	12.66	10.66	12.94
10.	25 cm apical portion + IBA	12.66	11.00	10.66	15.66	11.66	12.33	12.33
11.	25 cm middle portion + IBA	12.66	13.00	14.66	14.33	11.33	12.66	13.10
12.	25 cm basal portion + IBA	14.66	15.00	13.00	14.33	13.66	10.66	13.55
	Mean	**13.25**	**13.25**	**12.30**	**12.72**	**12.41**	**10.32**	

Cutting type - CD at 5% - 0.697; Concentration -CD at 5% - 0.492; Interaction -CD at 5% - 1.710

sunlight and humidity. The supply of auxins (IBA) from the base of the cuttings appears to stimulate rooting in *J. curcas*. The enrichment of rooting may perhaps a transformation of auxin after absorption (Bijalwan and Thakur, 2010). According to Adekola *et al.* (2012) and Aminul-Islam *et al.* (2010) longer cuttings of *J. curcas* were found to perform better in terms of all the rooting due to fact that longer cuttings probably have higher food reserves. Again Kathiravan *et al.* (2009) reported that longer cuttings were more successful in vegetative propagation than shorter cuttings. Overall it is suggested that the level of endogenous auxins and other rooting factors increased after the leaf fall or bud breaking stage (February-March) in *J. curcas*, which subsequently activates the cambium and the plant factors associated with rooting (Dhillon *et al.*, 2006) and the concentration of hormone is an important factor in rooting of cuttings (Nautiyal *et al.*, 1991). The result of fresh biomass (Table 5) observed maximum in apical, middle and basal portions cuttings of 15cm length when treated with 200 ppm IBA, 1000 ppm IAA and 100 ppm IBA respectively, where as in case of 25 cm length of each category treated with 100 pm IAA, 100 ppm IBA and 1000 ppm IAA respectively exhibit maximum. This may be due to various concentration of auxin applied for different types of cutting favoring better rooting, root length and overall growth of the plant. Dry biomass (Table 6) was found maximum in 15 cm length cuttings treated with 200 ppm IBA, 1000 ppm IAA and 100 ppm IBA respectively and in 25 cm length cuttings treated with 100 ppm IAA, 100 ppm IBA and 1000 ppm IAA respectively for apical portion, middle portion and basal portion. The result shows similar trend as of fresh biomass. This may be due to the reduction in weight of cutting raised plants as there

Table 5. Effect of IAA and IBA on fresh biomass (g) in different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	42.00	46.00	64.00	46.00	42.77	36.90	46.27
2.	15 cm middle portion + IAA	55.10	35.00	43.50	52.21	66.91	39.42	48.69
3.	15 cm basal portion + IAA	48.20	41.93	39.62	58.00	40.17	38.52	44.40
4.	15 cm apical portion + IBA	60.98	64.19	46.57	52.20	42.58	36.90	50.57
5.	15 cm middle portion + IBA	56.57	61.26	59.03	60.31	63.13	39.42	56.62
6.	15 cm basal portion + IBA	65.23	53.24	64.34	52.09	59.21	38.52	55.43
7.	25 cm apical portion + IAA	73.21	61.49	56.79	58.95	43.32	58.22	58.66
8.	25 cm middle portion + IAA	63.24	60.98	63.27	56.64	60.66	51.00	59.30
9.	25 cm basal portion + IAA	71.36	60.66	49.96	58.39	56.17	51.18	57.95
10.	25 cm apical portion + IBA	58.12	48.32	53.43	66.46	49.30	58.22	55.64
11.	25 cm middle portion + IBA	65.49	57.17	61.08	60.60	48.38	51.00	57.28
12.	25 cm basal portion + IBA	58.53	63.36	54.49	53.13	57.64	51.18	56.39
	Mean	**59.83**	**54.47**	**54.67**	**56.25**	**52.52**	**45.87**	

Cutting type -CD at 5% - 1.22; Concentration- CD at 5% - 0.868; Interaction- CD at 5% - 3.008

Table 6. Effect of IAA and IBA on dry biomass (g) in different types of cuttings of *J. curcas.*

S. N.	Cutting type	100 ppm	200 ppm	400 ppm	800 ppm	1000 ppm	Control	Mean
1.	15 cm apical portion + IAA	18.55	20.48	29.70	21.29	19.50	17.04	21.10
2.	15 cm middle portion + IAA	26.82	17.08	21.81	23.45	30.99	18.73	23.14
3.	15 cm basal portion + IAA	22.41	19.44	18.34	26.94	19.40	18.05	20.76
4.	15 cm apical portion + IBA	28.11	29.75	22.14	24.27	19.78	17.04	23.51
5.	15 cm middle portion + IBA	26.19	28.28	27.34	28.08	29.32	18.73	26.32
6.	15 cm basal portion + IBA	30.35	24.69	29.96	24.82	27.36	18.05	25.87
7.	25 cm apical portion + IAA	34.06	28.43	25.26	27.50	20.09	29.47	27.47
8.	25 cm middle portion + IAA	30.20	28.27	29.42	26.23	28.16	24.19	27.74
9.	25 cm basal portion + IAA	32.38	26.15	23.14	27.38	25.19	24.00	26.37
10.	25 cm apical portion + IBA	27.22	22.33	24.61	31.01	22.82	29.47	26.24
11.	25 cm middle portion + IBA	31.14	27.17	29.08	28.74	23.47	24.19	27.30
12.	25 cm basal portion + IBA	26.42	30.33	26.17	25.10	28.16	24.00	26.70
	Mean	**27.82**	**25.20**	**25.58**	**26.23**	**24.52**	**21.91**	

Cutting type-CD at 5% - 0.569; Concentration- CD at 5% - 0.401; Interaction- CD at 5% - 1.397

was proportionately loss of moisture took place from the plants during oven drying.

Conclusion

It was concluded that the apical cuttings of 25 cm length from plus tree of *J. curcas* produces seedlings when treated with 100 ppm of IAA with maximum in fresh biomass (73.21g) and dry biomass (34.06g) and other characters like sprouting percentage (96.66%), rooting percentage (86.66%), root length (30.66cm) and root number (16.33). Hence this treatment may be preferred over other treatments for vegetative propagation through stem cuttings of *J. curcas* for mass multiplication.

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