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Sprouting Value Index: A New Concept in Evaluation of Rooting of Cuttings

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Abstract The vigor of indole 3-butyric acid (IBA) induced rooting of stem cuttings and its suitable sprouting/rooting medium can be evaluated using sprouting value index, which is developed in *Pongamia pinnata*, a nitrogen fixing, avenue and medicinal tree species of the tropics. Field studies were carried out using three rooting medium at a location in Central Kerala, Peninsular India, during the months of February (P1), June (P2), and October (P3) in 2009, 2010 and 2011. Field trials were performed using 300 ppm, 500 ppm and 1000 ppm IBA. The control cuttings do not recorded rooting. The results obtained indicate high SVI (sprouting value index) for aerial shoot cuttings planted in root trainers with coir pith compost (RTCP) with all the three concentration of IBA applied. Sprouting percentage was increased and the speed of completion of sprouting/rooting initiation decreased by the use of IBA treatment. Increased CWR and SUP percentages indicate defects in management practices, dormancy and or the genotype of the cultivar.

Keywords: *sprouting value index, Pongamia pinnata, rooting media, rooting of stem cuttings*

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1. Introduction

There are several indices and mathematical expressions to interpret seed germination results [3,4,6,8,4] and [17] but, concepts for mathematical interpretation and to determine efficiency of vegetative planting material or for clonal propagation is scanty, especially for rooting of cuttings. Through the present study, mathematical expression for IBA induced rooting of stem cuttings is being carried out with the field oriented results in *Pongamia pinnata.*

Pongamia pinnata (L.) Pierre. is a popular medicinal and avenue tree species, which thrives well in semi-arid and evergreen area with nitrogen fixing capacity. They are found mainly in the tidal forest of India and South East Asia [5]. The non-edible oil from the seeds of this leguminous plant is commercially known as 'karanja oil', which has ethno and modern medicinal value and its oil cake is a good fertilizer [5].

Vegetative propagation in tree species is a difficult process and it is attained through hormone application mostly in stem or root cuttings, which eventually initiates adventitious root and shoots [7], [12] and [15]. Planting materials such as rhizomes, corms, bulbils, tubers etc. are being used as planting material for the past several centuries [10]. Successful propagation using stem cuttings induced by indole 3-butyric acid (IBA) has been reported by several studies in various plants [9,10,11,16,18], and [19] but no mathematical expression is available for explaining the suitability of the material in wide scale cultivation practices. Shoot cuttings are available round year for vegetative propagation [13] against the seasonal seed production and reduced seed set due to seed abortion [2] in the species. Therefore, SVI study of rooting of cuttings and its statistical correlation will be useful in future plantation programs.

2. Materials and Methods

2.1. Specimen Collection Centers and Conduct of Field Trials

For the present investigation plant samples were collected from Botanic garden, University of Kerala, Thiruvananthapuram (+ 8^o 33' 55.63" N, + 76^o 53' 10.98"E) (142ft elevation), cultivation plots at Kidangoor (+ 10^o 11' 34.99" N, + 76^o 24' 14.93"E) (83ft elevation), Botanical Garden, Department of Botany, Union Christian College, Aluva, (+10° 7' 30.65", +76° 20' 3.32") South India. Plant was identified by literature scrutiny and herbarium studies in local and national herbaria, Botanical Survey of India, Southern Circle Herbarium, Coimbatore, Tamil Nadu, South India. All field trials was conducted in the plant nursery of Dr. T.C Joseph Memorial Botanical Garden, of the Department of Botany, Union Christian College, Aluva, (+10° 7' 30.65", +76° 20' 3.32") Ernakulam district, Kerala State, India.

For the sake of large scale planting material production in mechanized gardens, trials were conducted in 100cc root-trainer blocks (24 celled) using potting mixture (RTPM), RTVC and RTCP as rooting medium.

2.2. Experiment Design

For all field trials, average of the three replicates during the months of February (P1), June (P2), and October (P3) in 2009, 2010 and 2011 were gathered and performed experiment in three different rooting media such as root-trainers with potting mixture (RTPM), root trainers with vermi compost mixture (RTVC) and root-trainers with coir pith (RTCP). Stem cuttings with the terminal bud and an average size of 7.5 to 10 cm were used. The sample size was kept twenty-four for each trials separately as the 100cc root-trainer block contains 24 cells. A non-auxin control and three Indole 3-butyric acid (IBA) concentrations were designed in this experiment namely 300ppm, 500 ppm and 1000ppm (parts per million) were used to detect the adventitious rooting ability by quick dip method. A randomized complete block design was employed. After 40 days, the cuttings were evaluated for rooting/sprouting percentages, mortality percentage, number of roots/cuttings and average root length. The data obtained were subjected to one factor analysis, employing analysis of variance (ANOVA) and two-way ANOVA.

2.3. Calculation of SVI

In order to develop the new idea of calculating sprouting value index (SVI), data regarding sprouting and successful rooting percentages (SP – sprouting percentages), percentage of planting material with callus production but without rooting (CWR – callus without rooting), percentage of sound unsprouted propagule without callus production (SUP) (was determined by vertical cut test: planting material with more than three nodes living tissues was considered viable) was prepared. Viability percentage can be prepared using the formula (VP = SP + CWR + SUP), peak value (PV = maximum mean sprouting recorded at any time during the test), final mean sprouting (final MDS = cumulative percentage of full sprouting at the end of the test divided by number of days to finish sprouting) were calculated. SVI index method developed through the present study is calculated by the equation, SVI = PV * MDS.

3. Results

Sprouting and rooting studies of stem cuttings were carried out in three different rooting medium during three seasons in an year (February, June and October), for three consecutive year and the various attributes obtained are given in Table 1 to Table 6. Stem cuttings of five-year-old plants were used as mother plant plants to obtain stem cuttings at four months intervals of time.

Table 1. VP of IBA 300ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	CWR	SP	SUP	VP
NB	P 1	0	0	4.17	4.17
	P 2	0	0	8.34	8.34
	P 3	0	0	4.17	4.17
RTVC	P 1	37.5	50.00	4.17	91.67
	P 2	37.5	52.78	4.17	94.45
	P 3	33.33	52.78	4.17	90.28
RTCP	P 1	23.33	58.33	12.5	94.16
	P 2	16.5	58.33	20.21	95.06
	P 3	20.21	55.55	20.83	96.58

Table 1, Table 2 and Table 3 gives the VP of stem cuttings in three concentrations used against the control whereas Table 4, Table 5 and Table 6 gives SVI in different concentrations. Callus, sprouting and root formation was very poor in control. High VP was obtained with all the three concentrations of IBA used (>90%) for the trials even though VP of control 4.17 per cent to 8.34 per cent.

Table 2. VP of IBA 500ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	CWR	SP	SUP	VP
NB	P 1	0	0	4.17	4.17
	P 2	0	0	4.17	4.17
	P 3	0	0	8.34	8.34
RTVC	P 1	20.83	66.67	8.34	95.84
	P 2	29.7	58.33	8.34	96.17
	P 3	25.00	66.67	4.17	95.84
RTCP	P 1	20.83	75	4.17	100
	P 2	12.5	79.18	4.17	95.85
	P 3	16.83	75	4.17	96.00

Table 3. VP of IBA 1000ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	CWR	SP	SUP	VP
NB	P 1	0	0	8.34	8.34
	P 2	0	0	8.34	8.34
	P 3	0	0	4.17	4.17
RTVC	P 1	20.33	66.67	8.34	95.34
	P 2	16.7	58.33	16.83	91.83
	P 3	12.5	66.67	16.83	96.00
RTCP	P 1	12.5	75.00	12.5	100
	P 2	8.34	75.00	16.66	100
	P 3	12.5	79.16	8.34	100

Table 4. SVI results of IBA 300ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	PV	MDS Final	SVI
RTVC	P 1	8.34	1.25	10.43
	P 2	12.5	1.32	16.5
	P 3	8.34	1.32	11.01
RTCP	P 1	12.5	1.46	18.25
	P 2	8.34	1.46	12.18
	P 3	12.5	1.39	17.38

Table 5. SVI results of BA 500ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	PV	MDS Final	SVI
RTVC	P 1	12.5	1.67	20.88
	P 2	12.5	1.46	18.25
	P 3	16,67	1.67	27.84
RTCP	P 1	16,67	1.88	31.34
	P 2	12.5	1.98	24.78
	P 3	16,67	1.88	31.34

Table 6. SVI results of IBA 1000ppm treated cuttings of *Pongamia pinnata*

Rooting medium	Period	PV	MDS Final	SVI
RTVC	P 1	16,67	1.67	27.84
	P 2	12.5	1.46	18.25
	P 3	12.5	1.67	20.88
RTCP	P 1	16,67	1.88	31.43
	P 2	16,67	1.88	31.34
	P 3	16,67	1.98	33.01

With stem cuttings of *Pongamia pinnata*, maximum SVI was obtained in RTCP 1000ppm treated cuttings

(33.01). The speed of completion of sprouting/rooting in RTVC was found lower than in RTCP.

The ANOVA results on callus formation and callus with root formation show significance at 1% level between concentrations of IBA and significance 5% level between media of study for callus formation root production show significance at 1% level between medium of study.

4. Discussions

The SVI studies worked out in the present study is a mathematical approach to determine the quality of rooting material, suitability of the medium used for rooting and the optimum concentration of IBA to be used. The long flowering cycle of many tree species and seed abortion [2] in *Pongamia pinnata* results in the reduction of germination percentage and availability of good seed samples. Seasonally available seeds and doubtfully recalcitrant nature of seeds [5] are yet another difficulty for propagation from seeds. Production of elite genotypes of any plant species can be generated by vegetative method of propagation round the year.

There is significance in all parameters considered in the selected species that shows the change in concentration of rooting hormone and medium used for rooting process affects significantly.

In field trials, all planting materials gave elite performance in RTCP planting medium. In the trials using 1000ppm IBA (Indole 3-butyric acid) treated cuttings also SVI was highest in RTCP (33.01). Significant differences in rooting were found between various rooting media when effect of rooting in sheanut stem cuttings were performed [1]. Sprouting percentage and speed of completion of sprouting/rooting initiation increased by the use of IBA treatment [nayagam15]. How ever it is shown by other workers [1] that very high IBA concentration have negative effect in rooting. Comparing the CWR and SUP percentages one can also assess the defects in management practices, dormancy and the genotype of the cultivar.

Sprouting index value (SVI) proposed through the present study is a modified form of Germination value (GV) proposed by Czabator [6] for seed germination studies. It is also suitable in field and nursery trials for vegetative propagation and IBA treated rooting of cuttings. The incorporation of CWR (callus production without rooting) along with SUP (sound unsprouted propagule) in calculating VP (Viability percentage) is effective in finding the field oriented defects. SVI and VP is an integrated measure of planting material quality. The speed of sprouting/rooting ability along with the completeness of sprouting can also be determined vegetative planting materials. Suitable rooting media hold considerably high rooting ability [1] and [13].

Even though SVI for control were found zero, the VP for all the IBA treated trials are > 90% (Table 1, Table 2 and Table 3) which indicates that by using alternate methods like pretreatments and management practices, SVI can be increased. The internal physiology of the planting material may be the reason for the same. The change in planting material and IBA treatment used affects the rooting process as in the present study; SP was increased in higher concentration (1000ppm IBA). Methods for reducing CWR and SUP values can increase SP and the sample in rooting medium with least difference in SP and VP value will give maximum performance. Results of the rooting experiments showed that with very high IBA concentration in sheanut tree cuttings, rooting ability decreased [1] and hence three concentrations of IBA were used in the present experiment.

5. Conclusions

The present study focuses on sprouting value index (SVI) method to establish suitable vegetative planting material and suitable rooting medium through field trials conducted in *Pongamia pinnata* using stem cuttings. Trials conducted in different rooting medium reveal the sprouting efficiency and vigor in different medium. SVI is a statistically treated data, which is obviously a modification of germination value for seed germination proposed by Czabator [6], the incorporation of CWR (callus production without rooting) along with SUP (sound unsprouted propagule) in calculating VP (Viability percentage) makes it suitable for vegetative cultivation practices and it interprets the quality of planting material, failure due to management practices and the selection of suitable rooting medium. This method of planting stock preparation is valuable in large-scale cultivation and much promising in producing quality clonal planting material production in economically important plants in future.

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