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Sprouting Value Index: A New Concept in Vegetative Propagation Trials Using *Costus Pictus*

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Abstract: The suitability of a vegetative planting material and its suitable sprouting/rooting medium can be determined using sprouting value index, which is developed in *Costus pictus* using its rhizome, aerial shoot cuttings and bulbils. *Costus pictus* the insulin plant is a native to Mexico and is a potential medicinal herb, but no published studies were found on cultivation. Field studies were carried out using five rooting medium at a location in Central Kerala, Peninsular India, during June 2011, July 2012 and June 2013. The results obtained indicate high SVI (sprouting value index) for aerial shoot cuttings planted in vermicompost (VC-53.6) and root trainers with coir pith compost (RTCP-51.3). The SVI max for rhizome-planting material was 23.38 in VC and that for bulbil was 13.93 in VC. In field trials, all planting materials gave elite performance in VC and CP planting medium. In 100 ppm IBA treated cuttings, SVI was highest in VC (70.4) and CP (66.57). Sprouting percentage was increased and the speed of completion of sprouting/rooting initiation decreased by the use of IBA treatment. Increased CWR, SUP and VP percentages indicate defects in management practices, dormancy and the genotype of the cultivar.

Key words: sprouting value index, planting material, *Costus pictus*, rooting media, sprouting

1. Introduction

There are several methods and mathematical expressions to measure the seed germination and viability in sexually reproducing plants [1-6] but mathematical expressions for determining efficiency of vegetative planting material or for clonal propagation is scanty. Hence in the present study mathematical expression for vegetative propagation is carried out in *Costus pictus* plant where rhizome, aerial stem cuttings and bulbils can be used for vegetative propagation.

Costus pictus D. Don, (*Costus mexicanus* Liebm. *Costus igneus* Nak. *Costus mexicanus* Liebm ex Petersen or *Costus congenitus* Rowle) commonly called as fiery costus, step ladder or spiral flag or insulin plant [7, 8] is an introduced medicinal spiral ginger to Peninsular India. This plant is distributed along the coast from Mexico to Costa Rica and is locally known as *canaagria* or *cana de jabali* in Mexico [9]. The plant gains more medicinal interest in the present decade due to the knowledge that their leaves have medicinal property of anti-diabetic activity in humans [10-12]. Unlike many other plants it has rhizome, leafy aerial shoots and aerial adventitious buds, which act as potential regenerators and hence the plant is selected for the study.

Aerial shoot cuttings are easily available as it is the left over portion after the separation of leaves for medicinal extraction, also as much as 18 aerial shoots arises from one plant which may attain 2 m length [13]. Planting materials such as rhizomes, corms, bulbils, tubers etc. are being used as planting material for the past several centuries [14]. Older aerial shoots alone produces bulbils in *Costus pictus* from their axillary buds and rhizomes can be obtained only by uprooting the whole plant and it measures 42 cm in a

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3-year-old plant [13]. Successful propagation using stem cuttings induced by indole 3-butyric acid (IBA) has been reported by several studies in various plants [14-19], hence IBA induced rooting studies have also been carried out.

2. Materials and Methods

For the present investigation plant samples were collected from Botanic garden, University of Kerala, Thiruvananthapuram (+8°33' 55.63" N, +76°53' 10.98"E) (142ft elevation), cultivation plots at Kidangoor (+10° 11'34.99" N, + 76° 24' 14.93"E) (83ft elevation), Edayar (+ 10° 05' 10.36" N, + 76° 18' 17.30"E), (28ft elevation), Palakkad + 10° 45' 46.27" N, + 76° 41' 50.05"E, (349ft elevation) and from the foot hills of Kodaikkanal (+ 10° 11' 22.91" N, + 77° 40' 06.36"E), (1056 ft elevation) South India. Plant was identified, confirmed and authenticated by Botanical Survey of India (MH accession no: 173772), 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 all field trials, average of the three replicates (trials conducted during June 2011, July 2012 and June 2013) were gathered which was performed in five different rooting media such as raised standard nursery bed (NB), polythene bags with vermicompost mixture (VC), polythene bags with coir pith (CP), root trainers with potting mixture (RTPM) and root trainers with coir pith (RTCP). For trials with rhizomes, uprooted mature rhizomes of the mother plant were sized to an average of 5-6 cm. Similarly aerial shoot cuttings of the size 7.5 to 10 cm and the bulbils as such (5-12 cm) were used. The sample size was kept hundred for each trials separately. Indole 3-butyric acid (IBA) is well known as an artificial rooting material for the vegetative propagation in various plants and hence a weak concentration of IBA 100 ppm (parts per million) was used to detect the adventitious rooting ability by quick dip method in *Costus pictus* aerial shoot cuttings.

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 fresh rhizomes, stem cuttings of aerial shoots and bulbils were carried out in five different planting media in three consecutive year and the various attributes obtained without pre-treatments are given in Table 1.

In the sprouting study with rhizomes of *Costus pictus*, maximum SVI was obtained in VC. The maximum VP of 98% was observed in medium with CP. Rhizomes showed the highest PV planted in CP and lowest in RTPM.

With aerial stem cuttings of *Costus pictus*, maximum SVI was obtained in VC (53.6). The speed for completion of sprouting/rooting in NB was found low. The SVI is comparably high in all trials with aerial shoot cuttings were used as planting material.

Bulbils are natural planting material in *Costus pictus* but they gave lower SP and SVI during the study period. SVI maximum was obtained in VC and least in RTPM.

Table 1 Sprouting Value Index Results of Different Types of Planting Materials in Various Rooting Media

Planting Material	Rooting medium	SP	CWR	SUP	VP	PV	MDS Final	SVI
Rhizome	NB	70.67	11.00	13.33	95	10.67	1.41	15.04
	VC	76.67	8.33	12.00	97	14	1.67	23.38
	CP	76.67	9.00	12.33	98	14.33	1.52	21.78
	RTPM	72	10.33	10.33	92.67	9	1.56	14.04
	RTCP	70	10.33	11.00	91.33	12	1.57	18.84
Aerial Shoot Cuttings	NB	81.33	9.33	6.67	97.33	14.67	2.09	30.66
	VC	84.67	7.33	3.67	95.67	20	2.68	53.6
	CP	82	9	6.33	96.33	20.33	2.46	50.01
	RTPM	78.67	9.66	7.33	95.67	15	2.1	31.5
	RTCP	85.33	6.67	4.33	96.33	19	2.7	51.3
Bulbils	NB	64.67	14	16.33	94.99	8.33	1.11	9.25
	VC	69.67	13	14	96.67	12.33	1.13	13.93
	CP	66.33	13	13.67	93	11	1.18	12.98
	RTPM	64.33	16	14	94.33	9	1.08	9.72
	RTCP	69.67	14.66	13.33	97.67	11	1.13	12.43

For the sake of large scale planting material production in mechanized gardens, trials were conducted in 100 cc root-trainer blocks using potting mixture (RTPM) and coir pith compost (RTCP) as rooting medium in which RTCP gave higher SVI for all planting material types.

Sprouting and rooting characteristics of IBA (Indole-3 butyric acid) treated aerial shoot cuttings were also carried out using 100 ppm concentration and the results gathered are tabulated in Table 2.

Table 2 Sprouting Value Results of IBA Treated Aerial Shoot Cuttings of *Costus pictus*

Planting Material	Rooting medium	SP	CWR	SUP	VP	PV	MDS Final	SVI
IBA treated Aerial Shoot Cuttings	NB	90.33	5.67	3	99	17	3.01	51.17
	VC	96	3	1	100	22	3.2	70.4
	CP	95	3	2	100	21	3.17	66.57
	RTPM	90	4.67	3.33	98	16.33	3	48.99
	RTCP	94	3.33	2.67	100	20	3.13	62.6

Maximum sprouting/rooting results were observed for IBA (100 ppm) treated shoot cuttings planted in VC-SVI 70.4. Cuttings planted in RTPM recorded minimum SVI (48.99). The speed of completion of sprouting/rooting process increased when IBA treated cuttings were used for rooting.

4. Discussions

From the data given in Table 1, it is obvious that aerial shoot cuttings of *Costus pictus* without any pre-treatments have maximum SVI than the other two planting material — rhizomes and bulbils. SVI for aerial shoot cuttings planted in vermicompost (VC: 53.6) and root trainers with coir pith compost (RTCP: 51.3). The SVI max for rhizome-planting material was 23.38 in VC and that for bulbil was 13.93 in VC. In field trials, all planting materials gave elite performance in VC and CP planting medium. In the trials using 100 ppm IBA (Indole 3-butyric acid) treated cuttings also SVI was highest in VC (70.4) and

CP (66.57). Significant differences in rooting were found between various rooting media when effect of rooting, in sheanut stem cuttings were performed [20]. Sprouting percentage was and speed of completion of sprouting/rooting initiation increased by the use of IBA treatment. 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) for a germination study proposed by Czabator (1962) [1], but it is suitable in field trials of vegetative propagation and clonal micro propagation. 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 [20, 21].

Even though SVI for rhizome and bulbils were found lower, the VP for all the trials are > 90% 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. Majority of the bulbils produces additional sprouts to continue its growth, which requires considerable time. The change in planting material and medium used affects the rooting process as in the present study SVI gave least results in NB and RTPM whereas rooting media CP and VC gave high sprouting results that is obvious from Table 1 and Table 2. 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 [20] and hence a weak concentration of IBA was used in the present experiment which itself gave a very high SP (> 90 percent) in all rooting media.

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 *Costus pictus* using rhizomes, aerial shoot cuttings and bulbils. Vegetative planting materials include modified structures of the plant such as bulb, rhizome, stolon, sucker, bulbils or shoot or root cuttings, which are being widely used around the world for planting and cultivation purposes from the origin of agriculture. The suitability of the plant *Costus pictus* for the present experiment in addition to its medicinal qualities is that it yields rhizomes, bulbils and aerial shoot cuttings, which can be used equally as planting material. 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 (1962) [1], 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 right rooting medium. As IBA (indole 3-butyric acid) can induce adventitious root initiation form stem cuttings, a weak concentration of the same (100 ppm) was used that gave high SVI value and sprouting percentage than untreated cuttings. 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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References

[1] F. J. Czabator, Germination value: An index combining speed and completeness of pine seed germination, *Forest Science* 8 (1962) 386-396.

[2] M. A. Nichols and W. Heydecker, Two approaches to the study of germination data, *Proceedings of the International Seed Testing Association* 33 (1968) 531-540.

[3] N. A. Goodchild and M. G. Walker, A method of measuring seed germination in physiological studies, *Annals of Botany* 35 (1971) 615-621.

[4] R. F. Brown and D. G. Mayer, Representing cumulative germination: A critical analysis of single-value germination indices, *Annals of Botany* 61 (1988) 117-125.

[5] J. D. Bewley and M. Black, *Seeds: Physiology of Development and Germination* (2nd ed.), Plenum Press, New York, 1994.

[6] D. G. Santana and M. A. Ranal, Análise da germinação: um enfoqueestatístico, EditoraUnB, Brasília, 2004.

[7] P. K. Hedge, H. R. Rao and P. N. Rao, A review on insulin plant (*Costus igneus* Nak), *Pharmacognosy Reviews* 8 (2014) (15) 67-72.

[8] B. Jose and L. J. Reddy, Analysis of the essential oils of the stems, leaves and rhizomes of the medicinal plant *Costus pictus* from southern India, *International Journal Pharmacy and Pharmaceutical Sciences* 2 (2010) (Suppl 2) 100-101.

[9] R. Remya and M. Daniel, Phytochemical and pharmacognostic investigation of antidiabetic *Costus pictus* D. Don, *International Journal Pharmaceutical and Biomedical Research* 3 (2012) 30-39.

[10] P. Mani, A. R. Kumar, T. M. Bastin, S. Jenifer and M. Arumugam, Comparative evaluation of extracts of C. igneus (or *C. pictus*) for hypoglycemic and hypolipidemic activity in alloxan diabetic rats, *International Journal for Pharmaceutical Technology* 2 (2010)183-195.

[11] V. D. Devi and A. Urooj, Evaluation of anti hyperglycemic and anti lipid peroxidative effect of *Costus igneus* Nak instreptozotocin induced diabetic rats, *International Journal of Current Research* 33 (2011) 4-8.

[12] M. V. Kumudhavalli and B. Jaykar, Evaluation of antidiabetic activity of Costusigneus (L) leaves on STZ induced diabetic rats, *Der Pharmacia Sinica Journal* 3 (2012) 1-4.

[13] J. R. Nayagam, *Compendium on Costus pictus: A Medicinal Spiral Ginger*, LAP Lambert Academic Publishing, OmniScriptum GmbH & Co. KG, Saarbrücken, Germany, 2015A, pp. 10, 13.

[14] H. T. Hartmann, D. E. Kester, F. T. Davies and R. L. Geneve, *Plant Propagation Principles and Practices* (6th ed.), Asoke K. Ghosh, Prentice-Hall of India, Private Limited, M-97, Connaught Circus, New Delhi, 1997.

[15] S. D. Sharma and N. B. Aier, Seasonal rooting behaviour of cuttings of plum cultivars as induenced by IBA treatments, *Scientia Horticulturae* 40 (1989) 297-303.

[16] B. H. Howard, Relationships between shoot growth and rooting of cuttings in three contrasting species of ornamental shrub, *J. Hortic. Sci.* 71 (1996) 591-605.

[17] C. L. Rosier, J. Frampton, B. Goldfarb, F. A. Blazich and F. C. Wise, Growth stage, auxin type, and concentration in uence rooting of stem cuttings of Fraser r, *Hort Science* 39 (2004) 1392-1396.

[18] C. E. Hambrick, F. T. Davies and H. B. Pemberton, Seasonal changes in carbohydrate/nitrogen levels during field rooting of Rosamulti.ora “Brooks 56” hardwood cuttings, *Scientia Horticulturae* 46 (1991) 137-146.

[19] C. T. Tsipouridis, S. Thomidis and Bladenopoulou, Rhizogenesis of GF677, Early Crest May Crest and Arm King stem cuttings during the year in relation to carbohydrate and natural hormone content, *Scientia Horticulturae* 108 (2006) 200-204.

[20] D. B. Akakpo, N. Amissah, J. Yeboah and E. Blay, Effect of indole 3-butyric acid and media type on adventitious root formation in sheanut tree (vitellariaparadoxa C. F. gaertn) stem cuttings, *American Journal of Plant Sciences* 5 (2014) 313-318.

[21] J. R. Nayagam, *Plantation Technology for Seven Tropical Tree Species*, LAP Lambert Academic Publishing, OmniScriptum GmbH & Co. KG, Saarbrücken, Germany, 2015B, pp. 342-343.