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Research Article

Standardization of clonal propagation of *Pterocarpus indicus* Willd. an important and endangered tree species

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ABSTRACT

Clonal propagation is one of the most effective tools for improving productivity of the forestry system. The study describes the scope and development of clonal propagation technology for *Pterocarpus indicus*. Developing rapid and improved clonal study reveals that clonal prorogation of this species is possible through stem cuttings. The study standardized the types of cuttings and concentration of IBA on success and survival of stem cuttings in this species. The experiments which comprised of concentrations of IBA viz., 1000 ppm, 2000 ppm, 3000 ppm, 4000 ppm, 5000 ppm, 6000 ppm and control and type of cuttings viz., leafy shoot, soft wood and semi hard wood cuttings of *Pterocarpus indicus*. The percentage of sprouting, rooting and survival differed significantly between treated and untreated cuttings. Semi hard wood cuttings treated with 4000 ppm of IBA maximized sprouting (85.76%) and rooting (72.16%) along with increased survival (68.38%). Survival and growth of the clonal plants were found to better using with cuttings with proper concentration of IBA and also combined with suitable rooting media. However, there was significant variation in shoot length, root length of cuttings due to IBA treatments. The results suggested that it could be possible to produce clones of high yielding superior genotypes of *Pterocarpus indicus* on large scale through stem cutting for popularization and establishment of commercial forestry and agroforestry.

Keywords: *Pterocarpus indicus*, endangered tree, macro propagation, cuttings

INTRODUCTION

Pterocarpus indicus (Willd) is commonly known as Indian padauk belonging to the family Fabaceae. It is a large deciduous, tropical tree species native to South Asia and East Indian regions (Thomson, 2006). It produces a high-quality timber, which is used in both structural work and for fine furniture, decorative flooring, cabinet work, and musical instruments (Soerianegara & Lemmens, 1993). It is a rapidly-dwindling natural resource because the wood is so highly prized and because the tree supplies many other products. It exudes a gum or resin, called 'kino' or 'sangre de drago' (dragon's blood), which is a powerful astringent, and the boiled shredded bark is used for tanning as well as for medicinal preparations (Senthilkumar et al., 2020). Besides the wood, Indian padauk is also notable for its medicinal (Ragasa et al., 2006) and ornamental uses as well as its nitrogen-fixing ability (Joker, 2000; Thomson, 2006; Junanto et al., 2008; Orwa et al., 2009; Lok, 2011). Mangkoedihardio et al. (2008) also showed the use of this tree in phytoremediation.

P. indicus, has been listed as an endangered species by IUCN since 2018, as its natural population number has declined and possibly extinct in some countries (World

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Conservation Monitoring Centre, 1998). Therefore, conservation efforts to protect this species must be carried out based on the appropriate conservation strategy.

Clonal propagation is a way of sustainable use of genetic resources designed to achieve particular traits and thereby, conservation. Within very short time, huge quantity of quality planting materials can be produced through vegetative propagation. In the tropics, branch cutting, stem cutting and nodal cutting were effectively experienced for clonal propagation. Rooting of cuttings is a model technique of clonal propagation due to less expensive and less time consuming. This technique is very excellent to continue certain desirable traits of an endangered species. Nevertheless, the recalcitrant nature of the seeds of many species and seed periodicity (Irregular nature of seed production) make seed collection problematic. To overcome these problems, many studies have been carried out to examine the ability of successful rooting of cutting of a considerable number of tropical forest tree species. Rooting success of cuttings depends on species variation, growth hormone and concentration of hormone as well. But no realistic effort has been taken to conserve *P. indicus* through cuttings.

MATERIALS AND METHODS

The experiment was conducted at Forest College and Research Institute, Mettupalayam located at 11’9’N latitude and 77’56’E longitude at an altitude of 300 m above MSL. It is situated at the foot hills of the Western Ghats, sprawling over an area of 200 ha. The climate is semi-arid tropical type with hot summer and cold winter. The dry season starts from early February to mid-June and wet season starts from mid-August to early November. The mean annual rainfall in the region is 895 mm distributed over 49 rain days with north east monsoon contributing to 60% and the balance through summer showers and southwest monsoon. The mean maximum and minimum temperature are 30^{o}C and 20^{o}C, respectively.

The three types of cutting *viz.*, leafy shoot, soft wood and semi hard wood cuttings were excised from the selected trees of *P. indicus*. The cuttings were further trimmed to a length of approximately 15-20 cm with minimum two to five nodes. All the leaves were removed before subjecting to the rooting hormone treatments. A slanting cut was given at the basal part of all the cuttings. Then the cuttings were treated with 0.2% bavistin and treated with Indole Butyric Acid (IBA) at various concentrations ranging from 1000 to 6000 ppm on quick dip basis. Such treated cuttings were planted in poly bags of 10 x 15 cm size (200 gauge thickness) filled with nursery mixture (1:1 ratio of soil and sand) and kept under controlled condition (Temperature 33 ± 1°C and RH 80 and 90%). Watering was done once in three days.

The experiment was laid in Completely Randomized Design (CRD) with three replications and each replication consisting of 50 cuttings. Most of the cuttings were started rooting at after 25 days. The data on various rooting parameters was recorded by observing the cutting from each replicate of each treatment after 5 weeks of treatment. The final observations on sprouting percent, rooting percent, and survival percent were recorded after 8 weeks of the experiment. The destructive samplings were done in the five randomly selected cuttings of each treatment and replication and then mean values were arrived. The observations *viz.*, shoot length, root length, collar diameter, root/shoot ratio, sturdiness quotient and volume index were made. Data were subjected to analysis of variance (ANOVA) and find the significance as per the procedure devised by Panse and Sukhatme (1967). Critical difference (CD) values were calculated for comparing the treatment means at p=0.05.

RESULTS AND DISCUSSION

Macro propagation is one of the most effective tools for improvement in forestry. Improvement of forest species through breeding is rather difficult because of their long

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generation times, prevalence of out breeding and operational difficulties (Chauhan et al., 2015; Das et al., 2015). Therefore, the genetic gains in forestry achieved by tree breeding including hybridization have been rather few (Tewari, 1994). Recently there has been growing interest in using the techniques of clonal forestry and thereby exploiting the considerable amount of genetic variability already existing in the populations of forest tree species. This has arisen partly because of the increasing number of forest tree species that have been found amenable to vegetative propagation (Kiondo et al., 2014) and partly because of demonstration of tremendous yield improvement by adopting clonal forestry approaches (Surendran et al., 2000). Srivastava (2000) & Rambhimi (2014) and confirmed the advantage of vegetative propagation and expressed that it reduces the juvenile period and subsequently facilitates early fruiting.

The per cent sprouting, rooting percentage and survival percentage differed significantly due to growth regulator. In leafy shoot cuttings with quick dipping in growth hormone IBA 4000 ppm recorded the maximum per cent sprouting (16.28%), rooting per cent of (3.92%) and maximum survival per cent (6.10%) (Table 1).

The influence of growth regulators on production of clonal plants from soft wood cuttings of was highly significant. In soft wood cuttings, IBA 4000 ppm recorded the higher sprouting per cent (55.32%), rooting per cent of (31.39%) and survival per cent (37.13%) compared to over all mean performance**.** In semi hard wood cuttings, IBA 4000 ppm recorded the maximum per cent sprouting (81.45%), followed by IBA 6000 ppm (81.45%) compared to grand mean (41.30%). Among the growth regulator treatments, IBA 4000 ppm recorded the significant higher rooting per cent of (72.16%) followed by IBA 6000 ppm (68.05%) and IBA 5000 (65.33%) compared to the general mean (34.35%). The maximum survival per cent was obtained from IBA 4000 ppm (68.38%) and minimum in control (0.00%), over all mean performance was (30.71%) (Table 1). IBA 4000 ppm at semi hard wood cuttings exhibit the maximum shoot length (28.06 cm), root length (28.21 cm), collar diameter (0.90), root shoot ratio (1.01), sturdiness quotient (31.33) and volume index (22.50 cm^3) was noted. In a holistic perception, considering all three types of cuttings viz., leafy shoot, soft wood and semi hard wood cuttings, the superiority of semi hard wood cuttings was evident due to higher rooting per cent coupled with other growth parameters in the growth regulator concentration of IBA

Table 1: Effect of different concentrations of IBA on rooting and survival of *Pterocarpus indicus*

Treatment	Leaf shoot cuttings			Soft wood cuttings			Semi hardwood cuttings		
	Sprouting (%)	Rooting (%)	Survival (%)	Sprouting (%)	Rooting (%)	Survival (%)	Sprouting (%)	Rooting (%)	Survival (%)
T1 - IBA 1000 ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T2 - IBA 2000 ppm	0.00	0.00	0.00	0.00	0.00	0.00	12.98	6.54	3.23
T3 - IBA 3000 ppm	6.77	1.54	2.02	23.01	12.35	12.30	35.67	28.39	22.65
T4 - IBA 4000 ppm	16.28*	3.92*	6.10*	55.32*	31.39*	37.13*	85.76*	72.16*	68.38*
T5 -IBA 5000 ppm	13.90*	3.55*	5.30*	47.23*	28.42*	32.27*	73.23*	65.33*	59.43*
T6 - IBA 6000 ppm	15.47*	3.70*	5.46*	52.54*	29.60*	33.26*	81.45*	68.05*	61.25*
Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	7.49	1.82	2.70	25.44	14.54	16.42	41.30	34.35	30.71
SED	1.47	0.34	0.95	2.98	5.73	4.22	3.56	2.14	5.87
CD (0.05)	2.94	0.68	1.9	5.96	11.47	8.44	7.12	4.28	11.74

* Significant at 5% level

4000 ppm and 1:1 mixture of sand and soil composition (Table 2-4). Macro propagation through different types of cuttings is generally considered as an important tool for rapid multiplication of true-to-type genotypes with the highest genetic quality materials (Chauhan et al., 2015). Exogenous application of harmones has been found to be promote rooting in many species and growth regulators like IBA (Das et al., 2015).

Similar study was earlier reported by Umarani et al. (2000); Dhixya (2014); Vennila et al. (2017) & Prabakaran et al. (2017) for propagation of *Azadirachta indica*, *Dalbergia sissoo* and *Lannea coromandelica* through hard wood cutting, which also confirms the results of current findings.

Propagation of tree species through stem cuttings is a function of several factors one of which is medium of propagation (Harsh & Mathana, 1985; Gurumurthi et al., 1994). The role of rooting media in inducing rooting and developing healthy seedlings in stem cutting is well known. An ideal rooting media should be able to provide

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Table 2: Rooting and shooting responses under various treatments in leaf shoot cuttings of *Pterocarpus indicus*

Treatment	Shoot length (cm)	Root length (cm)	Collar diameter (cm)	Root : Shoot	Sturdiness quotient	Volume index (cm^3)
T1 - IBA 1000 ppm	0.00	0.00	0.00	0.00	0.00	0.00
T2 - IBA 2000 ppm	0.00	0.00	0.00	0.00	0.00	0.00
T3 - IBA 3000 ppm	12.72*	9.26*	0.37*	0.73*	33.94*	1.79
T4 - IBA 4000 ppm	19.76*	13.99*	0.53*	0.71*	37.44*	5.50*
T5 -IBA 5000 ppm	11.22	6.53*	0.41*	0.58*	27.18*	1.91
T6 - IBA 6000 ppm	13.32	10.58*	0.50*	0.79*	26.60*	3.34
Control	0.00	0.00	0.00	0.00	0.00	0.00
Mean	8.15	5.76	0.26	0.40	17.88	1.79
SED	1.86	0.97	0.04	0.01	2.03	1.05
CD	3.72	1.94	0.08	0.02	4.06	2.11

* Significant at 5% level

Table 3: Rooting and shooting responses under various treatments in soft wood cuttings of *Pterocarpus indicus*

Treatment	Shoot length (cm)	Root length (cm)	Collar diameter (cm)	Root : Shoot	Sturdiness quotient	Volume index (cm^3)
T1 - IBA 1000 ppm	0.00	0.00	0.00	0.00	0.00	0.00
T2 - IBA 2000 ppm	0.00	0.00	0.00	0.00	0.00	0.00
T3 - IBA 3000 ppm	16.65*	14.40*	0.51*	0.86*	32.52*	4.36
T4 - IBA 4000 ppm	25.87*	21.75*	0.72*	0.84*	35.88*	13.45*
T5 -IBA 5000 ppm	14.69*	10.16*	0.56*	0.69*	26.04*	4.67
T6 - IBA 6000 ppm	17.43*	16.45*	0.68*	0.94*	25.48*	8.15*
Control	0.00	0.00	0.00	0.00	0.00	0.00
Mean	10.66	8.97	0.35	0.48	17.13	4.38
SED	0.34	0.24	0.07	0.08	2.54	1.56
CD	0.68	0.48	0.13	0.17	5.09	3.12

* Significant at 5% level

Table 4: Rooting and shooting responses under various treatments in semi hardwood cuttings of *Pterocarpus indicus*

Treatment	Shoot length (cm)	Root length (cm)	Collar diameter (cm)	Root : Shoot	Sturdiness quotient	Volume index (cm^3)
T1 - IBA 1000 ppm	0.00	0.00	0.00	0.00	0.00	0.00
T2 - IBA 2000 ppm	13.65	10.53	0.41	0.77	22.75	2.33
T3 - IBA 3000 ppm	18.06*	18.67*	0.64	1.03*	28.40*	7.30
T4 - IBA 4000 ppm	28.06*	28.21*	0.90*	1.01*	31.33*	22.50*
T5 -IBA 5000 ppm	15.93	13.18	0.70*	0.83*	22.75	7.82
T6 - IBA 6000 ppm	18.91*	21.34*	0.85*	1.13*	30.02*	13.64*
Control	0.00	0.00	0.00	0.00	0.00	0.00
Mean	13.52	13.13	0.50	0.68	19.68	7.66
SED	1.75	2.77	0.08	0.06	3.67	1.62
CD	3.50	5.54	0.16	0.12	7.34	3.24

* Significant at 5% level

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enough moisture and nutrients for root initiation and further development besides preventing the desiccation of the cut ends.

In addition, the present investigation also carried out to root different types of cuttings of *Pterocarpus indicus* by using various growth regulators. Out of seven treatments (IBA 1000 to 6000) used, IBA 4000 ppm reigned supreme in terms of shoot length, root length, collar diameter and root shoot ratio. Auxins were known to trigger the rooting of cuttings of many species. Auxins played multifarious role related to the division and elongation of meristematic cells, differentiation of cambial initials into root primordial and in the mobilization of reserve food material, thereby enhancing the activities of the hydrolyzing enzymes (Nanda & Kochhar, 1984).

Among auxins, superiority of IBA to that of other auxins had been reported earlier by many investigators in *Acacia albida* (Ahmed, 1988), *Woodfordia floribunda* (Shah et al., 1994) *Parkia biglandulosa* (Reeves et al., 1996), *Dendrocalamus hamiltonii* (Sood et al., 1994), *Azadirachta indica*, *Casuarina equisetifolia*, *Ceiba pentandra*, *Gmelina arborea* and *Thespesia populnea* (Parthiban et al., 1999), *Ceiba pentandra* (Rajendran et al., 2002) and *Pterocarpus dalbergioides* (Venkatesh and Pandey, 2006).

CONCLUSION

The Investigation clearly reveals that the optimized stem size of 15 cm length and 15 cm diameter were dipped in 4000 ppm concentration of IBA solution for 15 minutes and then planted in poly bags contains root media with sand: soil (1:1) is suitable for enhancing rooting and survival percentage. It is easiest and cheapest method of vegetative propagation. The techniques evolved would be most handy and could be applied anywhere in its habitat. Such knowledge will aid propagators, geneticists and tree improvement specialists in selecting treatments that reduces propagation costs by maximizing rooting success. Hopefully the present studies will also pave the way to develop clones of superior trees of *Pterocarpus indicus* for use in agroforestry or large scale commercial plantations. Therefore the present study can be highly useful for supplying of superior planting stock with desirable traits so as to achieve quick economic return from commercial plantations and other agroforestry fields through the advantage of clonal propagules which induce early flowering and fruiting, higher yield and quality of product in clonal orchard compared to conventional plantations.

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