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Growth performance of *Ceriops decandra* propagules as influenced by plant growth regulator: A conservation effort

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ABSTRACT

Vegetative propagation could be an important advantage and also envisioned to be the best alternative for planting stock production in the absence or lack of seeds. In Pichavaram, mangrove forest Tamil Nadu, the *Ceriops decandra* (Rhizophoraceae) is one of the most endangered species and IUCN also declared this species as near threatened. Propagation of *C. decandra,* by propagule cuttings, treated with plant growth regulators (PGRs) is feasible and it was possible to produce three saplings from one propagule. The effect of PGRs like indole butyric acid (IBA), naphthalene acetic acid (NAA), gibberellic acid (GA_3) on propagule cuttings of *C. decandra* were studied and the results revealed that best growth performance was recorded when the cuttings were treated with GA_3 2000 ppm. The combination of NAA and IBA increased the rooting and leaf formation. Among the treatments, GA_3 enhanced the number of leaves and roots, shoot and root length, fresh and dry weight of roots increased to a larger extent. All the plants are transferred to field in the mangrove forest of Pichavaram, TamilNadu, India.

KEY WORDS: *Ceriops decandra,* conservation, growth, plant growth regulator, rooting

INTRODUCTION

Mangroves are the only trees amongst a relatively small group of halophytic higher plants that live in the intertidal zones at the interface between land and sea. These are well-adapted to survive flooding and high salinity conditions. They are of great significance both in terms of their utilization of forestry and fish products. Their indirect potential as protecting coastlines and maintaining estuarine ecological balance. Due to several natural and anthropogenic pressures globally, these mangrove forests are being destroyed every year, which called for a conservation strategy that can expedite the restoration of degraded areas at a faster pace. In the present day, context of intensive afforestation and management of mangrove forestlands, it is most important to develop fast and economically viable methods of raising superior stocks.

Habitat loss and fragmentation are seen as the major threats to terrestrial productivity and biodiversity (Soulé, 1991). In the marine environment, problems of habitat degradation have so far primarily affected vegetated estuarine and coastal habitats, including wetlands, salt marshes, sea grass beds, kelp forests and mangroves (Hatcher *et al*., 1989; Norse, 1993; Smith and Snedaker, 1995; Selvam *et al*., 2005; Xu *et al*., 1998). This is critical as these ranks among the most productive of marine systems and most susceptible to decimation. A wide variety of marine organisms, including subsistence and commercially important fisheries are dependent on vegetated aquatic marine habitats for at least part of their life cycle (Boesch and Turner, 1984). Indirect effects of human impact on the major habitat farming organisms may be even greater than direct effects due to fishing or collecting activities (Soulé, 1991).

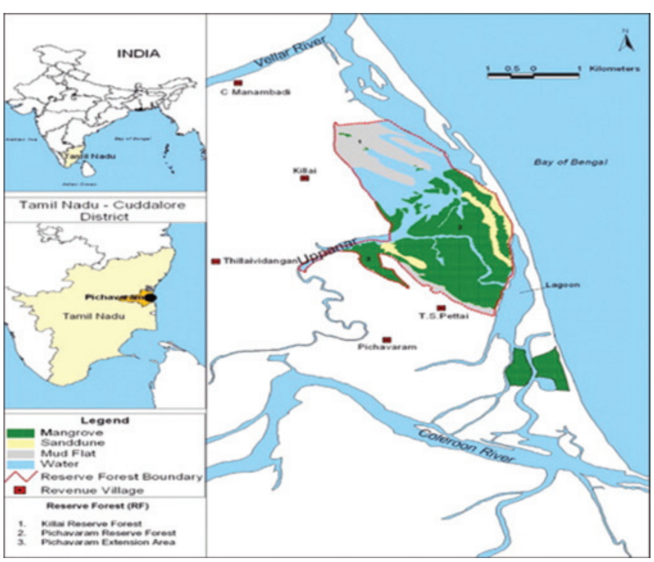
The tropical vast area of mangrove forest were converted into aquaculture, tin mining, and agricultural areas or housing and factory lots (Aksornkoae *et al*., 1992) and some of them were abandoned after these uses. This results in devastated conditions of the coastal area. This habitat has been under severe destruction worldwide at alarming levels (Kathiresan and Ravikumar, 1995). Such levels of destruction and habitat fragmentation raise concern about the conservation of mangrove diversity. Restoration of mangrove forests is urgent need to reconstruct original coastal ecosystem. To restore mangrove ecosystem, the practical problems includes a shortage of viviparous seedlings to plant and the disturbed soil conditions (Komiyama *et al.*, 1992). Vegetative propagation provides an opportunity to harness and exploit genetic variation directly (Zann, 1995). The success of this technique requires proper hormonal balance, temperature, rainfall, humidity, nature of media and light that collectively decide the status of regeneration of roots in cuttings (Dhua and Mitra, 188). Although vegetative propagation is least expensive, its success is still limited to mangroves. The present investigation aimed to study the effect of plant growth regulator (PGR) on rooting, root number leaf formation and fresh, dry weight of roots by applying some growth hormone substances by dipping method on response of *Ceriops decandra* propagule cuttings.

C. decandra (Griff.) Ding Hou (Family: Rhizophoraceae) locally known as Chirukandal (Tamil) is a medium-sized straight, columnar, evergreen small tree, under favorable conditions reaching up to 3.5 m in height. This species is highly threatened by the removal of mangrove areas for coastal development throughout its range. It is estimated that 26% of mangrove area has been lost within this species range over a 20 years period (1980-2000) (Duke *et al.*, 2007). In order to compensate such multifarious constrains of natural regeneration, application of vegetative propagation method would be one of the right options for rejuvenating balanced population of *C. decandra* in the mangrove ecosystems.

MATERIALS AND METHODS

Collection of Plant Materials

Mature and healthy Propagules of *C. decandra* were collected from adult and reproducing trees in Pichavaram mangrove forest situated at 11º 27' N Latitude and 79º 47' E Longitude, in the East coastal region of Tamil Nadu, India.



Cutting of Propagules

The collected propagules were cut into 2-5 cm pieces using a clean and sharp knife.

Removal of Fugal Infestation

The propagule cuttings were treated with a fungicide for the removal of fungal infestations if any. Bovistin and monochrotophos were mixed in 1:1 proportion in 1 L distilled water. In the fungicide solution, the propagule cuttings were soaked for 5 min. After soaking it was again washed with distilled water.

Removal of Phenol Content in Propagules Cuttings

Preparation of stock solution

20 g of sodium carbonate (Na_2CO_3) and 20 g of sodium tungstate ($Na_2WO_4.2H_2O$) were dissolved successively in 80 ml distilled water and make up the final volume to 100 ml. It is a 20% stock solution.

Preparation of working solution (10% and 5%)

50 ml from the 20% stock solution and 50 ml of distilled water was added. This gives a 10% working solution. Another 25 ml of stock solution and 75 ml of distilled water were mixed. This gives a 25% working solution.

Short-term treatment to remove phenolic compounds

10% solution was taken in small cups. The basal portions of the cuttings were kept immersed in the solution for 5-10 min. The treated cuttings were washed with distilled water for about 2-3 times.

Long-term treatment to remove phenolic compounds

The propagule cuttings were treated in 10% solution, for about 20-30 min. In 5% working solution for final treatment. Wash the treated cuttings with distilled water 2-3 times. Now the propagule cutting is ready for hormone treatment.

Preparation Hormone Stock Solution

1 g of indole butyric acid (IBA), naphthalene acetic acid (NAA) and add little drops of 1 N NaOH were mixed until it dissolves, and 1 g of gibberellic acid (GA_3) dissolved in 70%. Ethanol made this three solutions with distilled water to 100 ml. The strength of this stock solution is 10,000 ppm. Using this stock solution, we can prepare the hormone treatment solution were prepared.

Treatment of Cuttings

The PGRs like IBA, NAA and GA_3 are used for the hormonal treatment. Propagule cuttings are treated with hormones solutions *viz.*, 1000 and 2000 ppm of IBA, GA_3 and combination of IBA 1000 ppm and NAA 2000 ppm by dipping the propagule cuttings about 12 h.

RESULTS

Vegetative Propagation of *C. decandra* through Propagule Cuttings

The vegetative propagation of ceriops propagules produced more number of primary leaves and roots and high root lengths by various combinations of IBA and NAA are graphically presented in Figures 1-5.

Effect on Number of Primary Root Production

Results revealed that among all the hormone treatments (IBA, NAA and GA_3) 1000 and 2000 ppm, the GA_3 (2000 ppm) induced the best root production, while compared to the other treatments. The combination of IBA 1000 ppm and IBA ppm also produced more number of primary roots.

Effect on Primary Leaf Production

GA_3 2000 ppm concentration treated cuttings showed the highest production of primary leaves when compare to the other treatments. The combined treatment of IBA 1000 ppm and NAA 2000 ppm also produced more number of primary roots. There was no any response in untreated cuttings.

Effect on Primary Root Length

Greater root lengths of propagule cuttings were obtained when GA_3 2000 ppm alone was used when compared to IBA 1000 ppm and NAA 2000 ppm applied together. When cuttings were treated with all the hormones, but the maximum root length was observed with GA_3 2000 ppm.

Effect on Fresh Weight of Roots

GA_3 showed high fresh weight when compared to other hormones and combinations. Cuttings treated with NAA (2000 ppm) produced the maximum fresh. However, IBA 1000 ppm showed very low fresh weight when compared to other treatments.

Effect on Dry Weight of Roots

Cuttings treated with both hormones developed the maximum dry weight. This same result obtained in GA_3 treated cuttings also. GA_3 treated cuttings showed the significant result of dry weight when compared to the other hormonal treatments. Finally GA_3 (2000 ppm) and

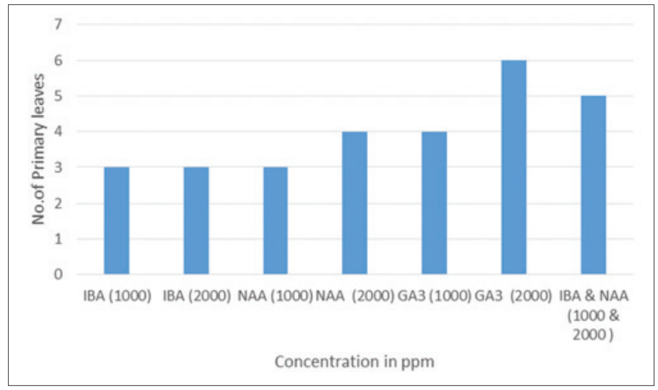


Figure 1: Effect of growth hormones on number of primary leafs in *Ceriops decandra* propagule cuttings

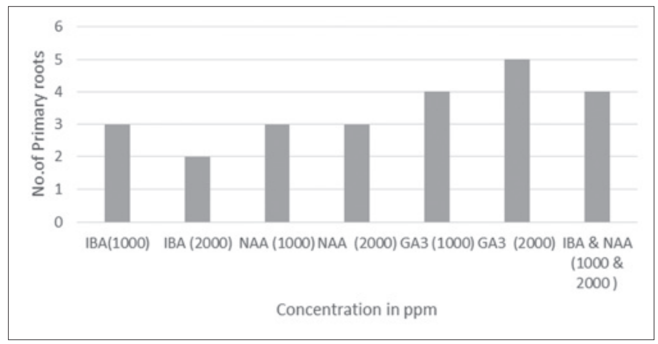


Figure 2: Effect of growth hormones on number of primary roots in *Ceriops decandra* propagule cuttings

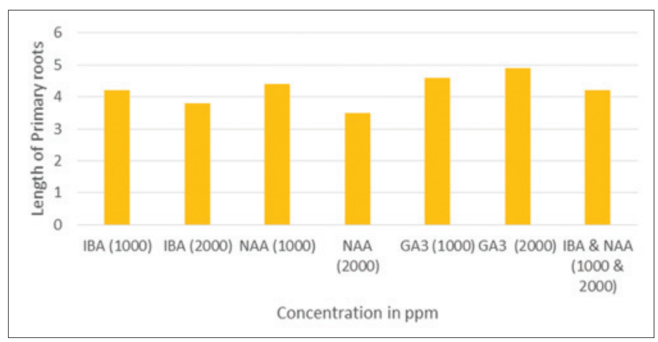


Figure 3: Effect of growth hormones on length of primary roots in *Ceriops decandra* propagule cuttings

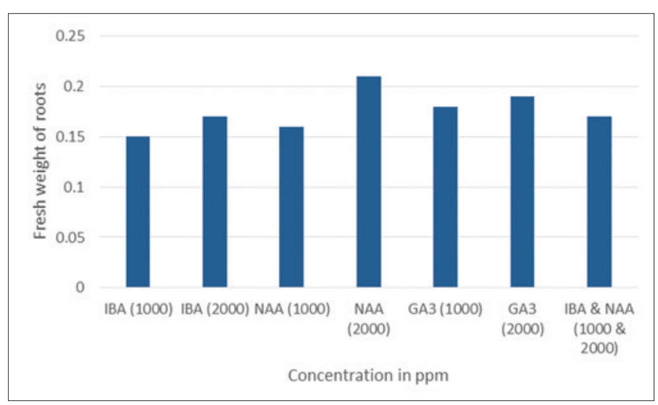


Figure 4: Effect of growth hormones on root fresh weight of *Ceriops decandra* propagule cuttings

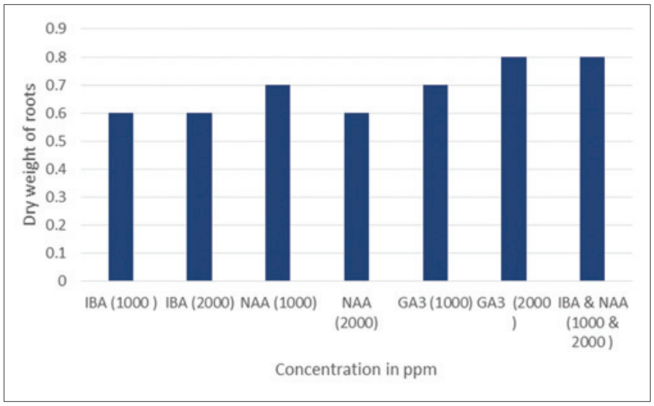


Figure 5: Effect of growth hormones on root dry weight of *Ceriops decandra* propagule cuttings

the combination of IBA and NAA showed significant results than the other hormones used separately.

DISCUSSION

Vegetative propagation methods produce plants with identical genotype with the mother plant (Schreiner, 1939).The present study, aimed to produce three saplings from a 20 cm long *C. decandra* propagule. Hence growth hormone-treated propagule cuttings provide a reasonable means for mass production of *C. decandra* propagules. Combined auxin treatment was reported to have a strong effect on the rooting response of stem cuttings/air layers of difficult-to-root species (Basak *et al*., 1995; Jackson, 1986). In the present study, combined treatment with IBA and NAA also produced highest rooting percentage, root number and length in both the types of cuttings over the control. The stimulatory effects of auxins on adventitious rooting of stem cuttings and air layers of several other mangrove and non-mangrove species have been reported earlier (Basak *et al*., 1995; Das *et al*., 1997; Davis and Haissig, 1994; Hartmann *et al*., 1997). The differential root regeneration capacities of different growth hormones individually or in combination might depend on their respective capacities for the regeneration and elongation of roots (Ghosh and Basu, 1974).The large number of root primordia induced by the root promoting hormones act as effective metabolic sinks, drawing on the nutritional reserves of the cuttings for their growth and development (Das *et al*., 1996). In many of the tree species clonally propagated materials initially grow much faster (Swain *et al*., 2005). Rooting of cuttings and air layering are the common vegetative propagation technique used for tree species. Most importantly for mangrove afforestation, these techniques are not very expensive (Carlton and Moffler, 1978). The results showed that GA_3 singly was a better rooting hormone than NAA or a combination of IBA and NAA. It was also evident that the beneficial effects of IBA were enhanced with the increase in concentrations up to a certain optimum level. This result is in accordance with earlier reports in *Ulmus leavigata* by Chauhan and Reddy, 1974; Pathak *et al*., 1975; Kanwar *et al*., 1996. Significant effect on the primary root length and number of roots and leaves were earlier recorded in mangroves *Rhizophora mangle* (Ray, 1991), and in *Avicennia marina* (Schreiner, 1939; Kathiresan and Moorthy, 1994) recorded that 93% rooting response from IBA (1500 ppm) treated *R. apiculata* propagule cuttings, 42% rooting response from IBA (2500 ppm) treated *R. apiculata* and *A. marina* air layers, 48% rooting response from IBA (2000 ppm) treated *R. apiculata* and *A. marina* and 56% rooting response from IBA (2000 ppm) treated *A. marina* stem cuttings. A number of workers also have shown that rooting is facilitated when the carbohydrate reserve foods are in abundance (Haissig, 1974; Rauter, 1983). GA_3 exerts profound effects on the fundamental process of plant growth and development. GA_3 is widely regarded as a growth promoting compound that positively regulates processes such as seed germination, stem elongation and leaf expansion (Smith and Snedaker, 1995). However, Banyal and Rai, 1983 found that GA_3 reversed the inhibition of hypocotyl elongation of *Brassica campestris* L., under osmotic stress which indicates that the decrease in endogenous concentrations may be a major consequence of salt stress. The exogenous application of gibberellins stimulated stem elongation and leaf area expansion in *R. mangle* propagules floating in 35 g/L seawater (Ray, 1991). The auxin-induced effect on rooting of cuttings is presumed to be mediated through its effect in mobilizing the reserve food material by enhancing the activity of hydrolytic enzymes (Nanda *et al*., 1968). GA_3 application was reported to increase the weight of aerial parts in *Viola* (Thorne-Miller and Catena, 1991). Exogenously applied, gibberellin promoted stolon elongation and inhibited tuber formation and increased fresh weight in potato (Vlahos, 1991). Combined auxin treatment was reported to have a strong effect on the rooting response of stem cuttings/air layers of difficult-to-root species (Basak *et al*., 1995; Jackson, 1986). In this study, combined treatment with IBA and NAA also produced highest rooting percentage, root number and length in both the types of cuttings over the controls. The stimulatory effects of auxins on adventitious rooting of stem cuttings and air layers of several other mangrove and non-mangrove species have been reported earlier (Basak *et al*., 1995; Das *et al*., 1997; Davis and Haissig, 1994; Hartmann *et al*., 1997). This study thus establishes good promise of a cost-effective and promising technique of propagation for the endangered mangrove species for raising populations of superior clones for planting in seed orchards or directly in the field to aid in our efforts to conserve mangrove species.

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