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Vegetative propagation of two important *Garcinia* species of Assam, NE India

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Abstract
Garcinia pedunculata and *Garcinia morella* are two multipurpose tree species of North East India. Different hormonal treatments were tested on the stem cuttings using non-mist poly propagator. In case of *Garcinia pedunculata* highest rooting percentage (80%) was recorded in the treatment IBA 2000 ppm, and in *Garcinia morella* stem cuttings treated with IBA 4000 ppm gave highest rooting percentage (40%). Juvenile stem cuttings were seemed to be suitable for vegetative propagation of the above two species.

Keywords: *Garcinia*, vegetative propagation, Juvenile stem cutting, IBA.

Introduction
Vegetative propagation is an alternative way to seed germination. It helps in rapid multiplication of tree to type superior planting material, mass production of plants in short time and conservation of germplasm of important tree species [1, 2]. Though, lots of species produce a large number of seeds, but only a few are able germinate in their natural habitat. *Garcinia pedunculata* and *G. morella* are two multipurpose species of NE India which are used as ethno-medicine, spice, fruit, vegetable and also connected with some socio-cultural aspects of many communities in North-East India. Despite of much economic value of these species, it is observed that both species are facing problems related to their regeneration as seed of *G. morella* take a long time for germination, while the seed viability of *G. pedunculata* is very short. The present study is an attempt to find out the suitable concentration of hormone for juvenile stem cuttings for vegetative propagation.

Materials and methods
Seeds of *Garcinia pedunculata* (GP) and *G. morella* (GM) were collected from Dullung Reserve Forest, Assam, North East India and were sown in the departmental nursery of NERIST (North Eastern Regional Institute of Science and Technology), Arunachal Pradesh, India. After germination the seedlings were transplanted to polythene containers filled with nursery soil and decomposed cow dung in ratio of 1:1. The experiment was carried out under shade nursery. The seedlings were watered regularly. No fungicides and pesticides were applied during their growth condition.

Environmental condition of propagation
A simple poly-propagator was constructed consisting of wooden frame tightened with aluminum coil. Some plastic trays (70×40 cm^2) were placed under the polyhouse where the germination trays (30×30 cm^2) were kept. A polythene was used in inner side of each plastic trays which separates germination trays from the plastic trays. The plastic trays were then filled with filter water. A thermometer was placed to determine the temperature and a digital hygrometer was used for humidity measurement. The humidity was maintained above 75% and the temperature was control below 25 ^{0}C.

Cutting preparation
Eight months old seedlings of *G. pedunculata* and *G. morella* grown in nursery of NERIST were used as stock plants and the cuttings were taken from these seedlings. A population of healthy seedlings was selected and cuttings were harvested between 5 to 6 PM. From each seedling, two cuttings of about 10 cm length were taken and only top two leaves were left on the cuttings, the rest were cut away from the node portion.

The cuttings were then kept in a beaker filled with distilled water immediately. The remaining two leaves were cut to half size to reduce the evaporation from the leaves in both species however cuttings with small leaves were used as such. Twenty cuttings were taken for each treatment and kept together with a rubber band.

Preparation of solutions

IBA (Indole-3-butyric acid) was used to determine the effect on the rooting of stem cuttings. Stock solution of 1000 ppm, 2000 ppm and 4000 ppm of IBA were prepared by adding the required amount of chemical dissolved in 96% ethanol and then the volume was adjusted by adding 50% ethanol. Each stock solution was used only for one time [3].

Treatment plan and assessment of cutting

Four treatments were given to each species, (three different concentration levels for two species and one control) having two replicates for each treatment with a total of 40 cuttings (20 cuttings in each replicate) (Table 1). A set of 20 cuttings was dipped in the hormone of different concentration. The base portion upto 3cm long of each bundle of cuttings were dipped in the different treatments for 5 seconds. Immediately the rubber band was loosened from the bundle and the base portion of the cuttings were directed to a current of cold air to evaporate off the alcohol.

The cuttings were put into a beaker and water was sprayed on the leaves by using a sprayer. Then cuttings were allotted to the plots. The base portion (only 3cm) was inserted into the rooting medium. The cuttings were than maintained under the polyhouse by giving a foliar spray in every morning between 8-9 A.M. and in the evening between 4-5 P.M. Cuttings were sprayed with the fungicides, (Carbendazim+Mancozeb) mixed with distilled water at a concentration of 1g/L at the end of 1st week and again fungicide was applied at a concentration of 2.5g/L in the 4th week. If any fungus was noticed on the cuttings then immediately fungicides were applied on it.

Table 1: List of treatments applied to the cuttings of *G. pedunculata* and *G. morella*.

Treatments	*Garcinia pedunculata*	Treatments	*Garcinia morella*
GP1	IBA 1000 ppm	GM1	IBA 1000 ppm
GP 2	IBA 2000 ppm	GM2	IBA 2000 ppm
GP 3	IBA 4000 ppm	GM3	IBA 4000 ppm
GP 4	Control (without application of any treatment)	GM4	Control (without application of any treatment)

The data of rooting, shooting and leaf initiation was taken in every week. Cuttings were considered rooted when at least one adventitious root of a length 0.5 cm long and shoot of 0.5 cm was observed. The experiments were continued till there was no newly root formation for a consecutive 30 day period.

Establishment of rooted cuttings

When cuttings were rooted, gradually spraying of water was controlled and poly propagators were opened in the night time for alternative days and then kept open for whole day to increase the adaptation capacity to a low relative humidity. The rooted cuttings of the two species were potted in polythene containers containing a medium of sand, garden soil and decomposed manure in 1:2:1 ratio. The polybags were sieved for aeration. Later, the polythene bags with rooted cuttings were shifted to nursery shade house and the rooted cuttings were watered regularly.

Results

Rooting percentage of cuttings

Adventitious rooting was developed in all the treatments with varying rooting percentage. Most of the cuttings were rooted in the 9th week in *Garcinia pedunculata* and after 10th week of treatment in *G. morella*. Highest rooting percentage (80%) was observed in cuttings treated with IBA 2000 ppm (GP2) and followed by IBA 1000 ppm (GP1) with 50% rooting in cuttings. The lowest rooting (15%) was found in control (GP4) (without application of hormone), whereas cuttings treated with IBA 4000 ppm (GP3) had only 20% rooting percentage.

In *G. morella*, the highest rooting percentage (40%) was obtained with treatment GM3 (treatment with IBA 4000 ppm) and the other treatments GM1 (IBA 1000 ppm), GM2 (IBA 2000 ppm) and GM4 (control) showed the same rooting percentage (10%) (Table 2 & Fig. 1).

Table 2: Mean root number, mean root length, mean shoot length and mean leaf number of *Garcinia pedunculata* and *Garcinia morella*. The values are mean ± SE.

Treatments	Rooting Percentage (%)	Mean Root number	Mean root length (cm)	Mean leaf number	Mean shoot length (cm)
GP1	50	1.2 ± 0.20	3.6 ± 0.46	1.20 ± 0.33	0.53 ± 0.08
GP2	80	3.25 ± 0.25	3.5 ± 0.24	2.00 ± 0	1.19 ± 0.25
GP3	20	4.5 ± 0.5	3.27 ± 0.36	2.00 ± 0	1.15 ± 0.06
GP4	15	1.0 ± 0	0.57 ± 0.03	2.00 ± 0	0.27 ± 0.06
GM1	10	1.0 ± 0	2.8 ± 0.10	00	0
GM2	10	4.5 ± 0.5	1.22 ± 0.127	2.00 ± 0	0.35 ± 0.05
GM3	40	2.0 ± 0.19	4.83 ± 0.322	2.13 ± 0.13	2.35 ± 0.54
GM4	10	1.0 ± 0	2.30 ± 0.141	2.00 ± 0	1.2 ± 0.14

SE = Standard error, GP = *Garcinia pedunculata*, GM = *G. morella*.

Hormonal effect on root and shoot formation

The hormonal effect on root number, root length and leaf number of the rooted cuttings of the two species (*Garcinia pedunculata* and *Garcinia morella*) were also different. Response of root and shoot elongation was different on different treatments. In *G. pedunculata*, the mean root number of cuttings was highest (4.5) in the treatment GP3 (treated with IBA 4000 ppm) and the mean root number for the treatment GP2 (treated with IBA 2000 ppm) was 3.25, GP1 (treated with IBA 1000 ppm) was 1.2 and lowest mean root number (1.0) was found in GP4 (control). On the other hand, in *G. morella*, mean root number was highest in treatment with IBA 2000 ppm i.e. GM2 (4.5). GM1 (IBA 1000 ppm), GM3 (IBA 4000 ppm) and GM4 (control) had mean root number of 2.0, 1.0 and 1.0 respectively (Table 2 & Fig. 2).

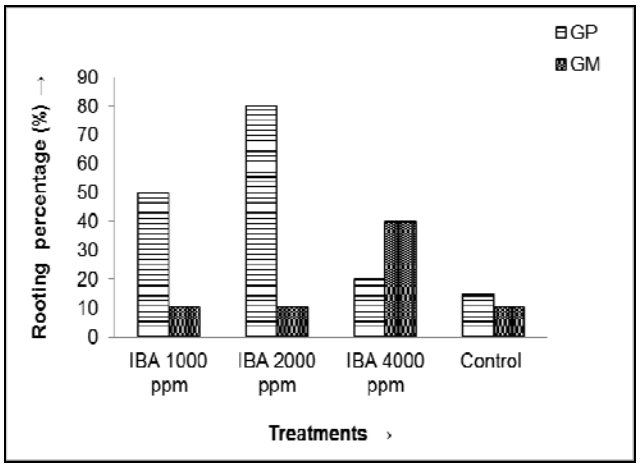

Fig 1: Effect of hormone concentration on the rate of rooting of *G. pedunculata* and *G. morella*.

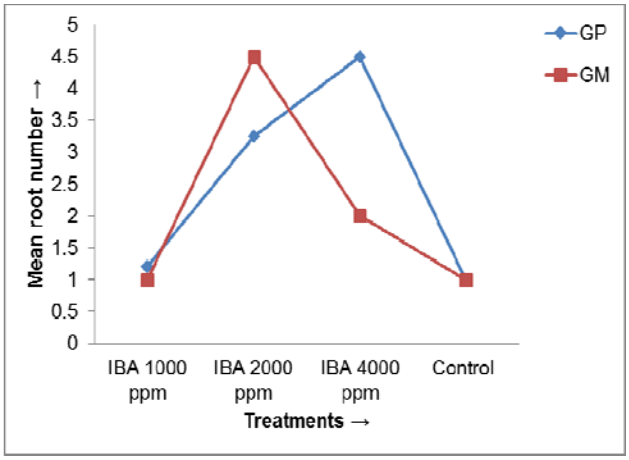

Fig 2: Effect of different treatments on the mean root number of the rooted cuttings of *G. pedunculata* and *G. morella*.

In *G. pedunculata*, the highest mean root length was 3.6 cm for the treatment IBA 1000 ppm (GP1) and, for others; mean root length for IBA 2000 ppm (GP2), IBA 4000 ppm (GP3) and for control (GP4) were 3.5 cm, 3.27 cm and 0.54 cm, respectively. The highest mean root length (4.83 cm) was reported in treatment GM3 (IBA 4000 ppm) in cuttings of *G. morella* and lowest mean root length (1.22 cm) was found in GM2 treatment (IBA 2000 ppm). Treatment GM1 (IBA 1000 ppm) and GM4 (control) had the mean root length of 2.8 cm and 2.3 cm respectively (Fig. 3).

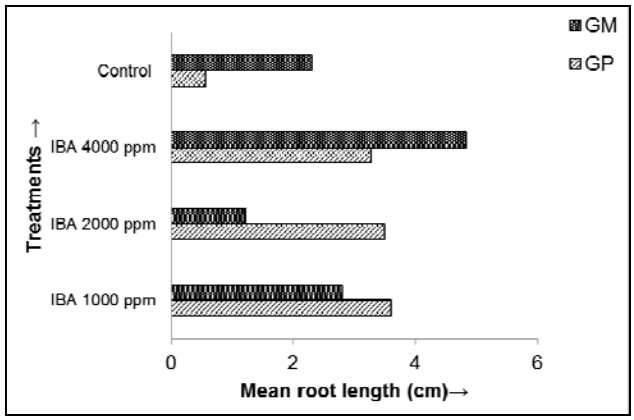

Fig 3: Effect of concentration of hormone on mean root length of the rooted cuttings of *G. pedunculata* and *G. morella*.

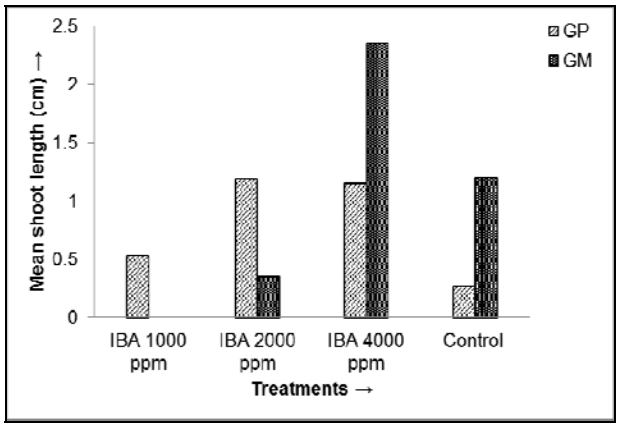

Fig 4: Effect of different treatments on the mean shoot length of the rooted cuttings of *G. pedunculata* and *G. morella*.

In *G. pedunculata* cuttings, mean shoot length was highest (1.19cm) in GP2 (IBA 2000 ppm) and lowest (0.27 cm) in control (GP4). In *G. morella*, maximum mean shoot length (2.35 cm) was found in treatment GM3 (IBA 4000 ppm) followed by GM4 (1.2 cm) and GM2 (0.35 cm); and treatment GM1 (IBA 1000 ppm) didn't show any shoot length increased (Fig. 4).

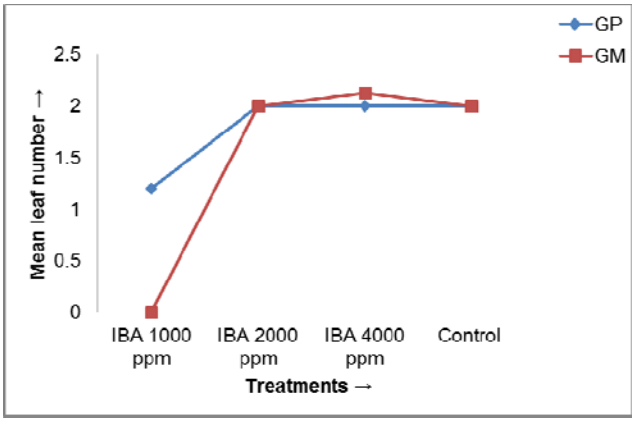

Fig 5: Effect of different treatments on the mean leaf number of the rooted cuttings of *G. pedunculata* and *G. morella*.

In *G. pedunculata* cuttings, mean leaf number (newly formed leaf) was similar (2.0) in all treatments (GP2, GP3 & GP4) except treatment GP1 (1.2). On other hand, in *G. morella* cuttings, GM2 (IBA 2000 ppm) and GM4 (control) showed similar newly formed leaf number (2.0) but GM1 did not showed any new leaf formation. Rooted cuttings treated with IBA 4000 ppm (GM3) were with higher mean leaf number (2.13) than the other treatments (Fig. 5).

Discussion

There are number of propagation systems used in commercial horticulture that are based either on spraying mist, fogging or enclosing the cuttings in polythene. The polythene propagator system provides a very wonderful system of vegetation propagation of many tropical tree species, having capacity to rooting in unfavourable climatic condition also. Temperature and humidity are the two most important factors which are controlled under this system to certain level [4].

A few studies on vegetative propagation of species in Clusiaceae were reported [5]. An examination of literature reveals that *Garcinia kola* (Heckel) propagate vegetatively within non-mist poly-propagator by softwood stem cuttings

[6]. In present study, juvenile leafy shoots resulted the highest rooting percentage (80%) cuttings treated with IBA 2000 ppm in *G. pedunculata* and the lowest rooting percentage in control (without application of hormone), IBA 4000 ppm treatment also showed lower rooting percentage (20%). The present results show that polythene propagator system with low technology provides a very wonderful system of vegetation propagation of many tropical tree species, and are capable to rooting in unfavourable climatic condition also, by controlling temperature and humidity to a certain level [4]. In *G. morella*, the highest rooting percentage (40%) was found in the treatment IBA 4000 ppm. On the other hand IBA 1000 ppm treatments, IBA 2000 ppm treatments and control (without application of hormone) resulted the same rooting percentage (10%). Response of root and shoot elongation was different in different treatments in both *Garcinia pedunculata* and *G. morella*, and hormonal effect on root number, root length and leaf number of the rooted cuttings were also different. The highest mean root number of *Garcinia pedunculata* cuttings was in the treatment IBA 4000 ppm and lowest in control. The highest mean root length was 3.6 cm in treatment IBA 1000 ppm and lowest for control (0.54 cm). The effect of hormone on shoot elongation was insignificant in both species. The mean leaf number (newly formed leaf) was similar (2.0) in IBA 2000 ppm, IBA 4000 ppm and control treatments except IBA 1000 ppm treatment (1.2). On the other hand, mean root number was highest in IBA 2000 ppm treatment in *G. morella* and lowest found in control (without application of any growth regulator). Treatment IBA 4000 ppm represents with highest mean root length (4.83 cm) and lowest mean root length was shown in the treatment with IBA 2000 ppm. Treatment with IBA 4000 ppm resulted highest mean number (2.13) of newly formed leaf where no new leaf formation was occurred in the treatment IBA 1000 ppm. The present study is in agreement with the findings of other workers [3-4] who used non-mist polythene propagator technology and propagated successfully leafy stem cuttings of tropical trees by using growth regulators like IBA and NAA. *Garcinia lucida* leafy stem cuttings and grafting were also used for propagation vegetatively and half of the leafy stem cuttings were rooted and 64-100% of grafted plants were established successfully [7]. A number of workers have studies effects of rooting medium and leaf area on rooting of *Garcinia kola* leafy stem cuttings [8-9]. But vegetative propagation by using stem cutting was not very successful.

Softwood grafting is the successful method for vegetative propagation of *G. indica* and *G. gummi-gutta* [10] due to presence of yellow resin exudates in stem which intervene the production of adventitious roots. Many important hardwood tree species have low capacity of formation of adventitious rooting, and are considered recalcitrant to routine, commercial-scale vegetative propagation [11]. The species difficult to root can be propagated vegetatively by providing proper environment, observing seasonal growth development, type of cuttings (softwood, hardwood, root etc.), cutting manipulation and desired hormonal treatment. The capacity of trees to be propagated vegetatively influence their greater size and structural complexity at maturity and results in a loss in rooting ability, as an alternative young plants, coppice or 'rejuvenated' shoots may be used [12-13].

Conclusion

In *Garcinia pedunculata*, cuttings treated with IBA 2000 ppm is the best treatment for vegetative propagation and treatment IBA 4000 ppm is suitable for *G. morella* cuttings. The polypropagator system is highly approachable and low cost method. Since both *Garcinia pedunculata* and *G. morella* are medicinally important plants, therefore, the present study may helpful in conservation of these species.

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