

MACROPROPAGATION PROTOCOL OF SOME TREE AND MEDICINAL PLANT SPECIES



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PREFACE

In the recent past Clonal Forestry has gained attention and it has contributed to plantation forestry, Eco-restoration programmes, gene pool conservation etc. Recent technologies such as mist propagation technique has proved to be an effective tool for the rapid cloning of selected germplasm. However, cloning techniques are not available for many Central Indian trees and medicinal plants.

In order to solve this shortfall a clonal propagation facility has been established in Division of Forest Genetics and Tree Improvement (S.F.R.I., Jabalpur) in 1987. The basic objective of the unit is to develop improved and healthy planting stocks for further multiplication and information on macropropagation technology of important tree and medicinal plant species to forestry sector personnels.

This bulletin deals with the Macro/Clonal Propagation protocols for 35 multipurpose tree species, medicinal plants, non-timber forest produce Bomboo species etc. This bulletin will benefit Foresters/researchers and other interested persons who are involved in similar works.

AUTHORS

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INTRODUCTION

1. GENERAL

Vegetative propagation techniques is one of the most effective tools for tree improvement in forestry to obtain plants of desired genetic constitution with in short period and also for the multiplication of the species which do not reproduce well by other means. Vegetative propagation in forestry involves multiplication of desirable trees selected artificially. Two major method used in vegetative propagation are heterovegetative (grafting) and autovegetative (rooting and cutting). In both the cases cuttings are served from the mother plants and grafted to the stock plants or planted directly in rooting media.

Tree improvement of woody plants through various means of breeding strategies, is rather difficult because of their long regeneration time, prevalence of out breeding and the operational difficulties. Therefore the productivity achievement in term of yield is very low. Vegetative propagation provides an opportunity to exploit genetic variations occurring in the natural population of a species. It is more attractive investment in afforestation programmes of forestry sector in terms of yield, quality and time saving process. Besides these vegetative propagation techniques help in mass multiplication of disease free improved planting stock. The homogenous clonal stands give opportunity for physiological, phenological, nutritional and genetic evolution. For the practical use of vegetative propagation technique. It is essential to identify the "Superior genotypes" or "elite sources".

Vegetative propagation is an important technique to exploit natural variation i.e. the desirable quality of selected genotype for commercial gains. Commercially important traits like fast growth, high yield, deseased resistance and desirable quality of wood can be selected and multiplied through rooting of juveline coppice shoots/stem/branch/culm cuttings for raising improved planting stock. In certain situation like sporadic seed setting (in Bamboo sps.) poor seed viability (sal, Neem etc.), Periodic flowering cycle or specific requirement of male/female plants in deciduous species etc. Clonal option is the key factor in production of improved planting stock.

2. ADVANTAGES OF VEGETATIVE PROPAGATION

Clonal propagation methods have following advantages:

1. To preserve superior germplasm.
2. Commercial propagation of economically useful species by optimising cost and enhancing value/marketability of produce.
3. To propagate species which are difficult to propagate by seeds.
4. To provide improved planting stock in short time.

5. It is a time saving short term tree improvement programme.
6. To facilitate controlled pollination and promote fruit/seed production on dwarf trees.
7. Production of species hybrids.
8. To provide genetically uniform material for nongenetic experiments.

3. METHODS OF VEGETATIVE PROPAGATION

3.1. **The root suckers-** The root produce buds from which aerial stem arise. frequently several feet from main stem.

3.2 **Rhizome-** A rhizome is a modified stem structure in which the main axis of the plant grows horizontally just below or on the surface of the ground s. This method is often used for the propagation of bamboos.

3.3 **Layering-** layering is the induction of root branches which are still attached to the parent trees. A new branch as such slightly wanded, girdled or ringled is brought in touch with the soil and when root are developed to branch it is detached to grow as a new plant on its own root system. Layering may be (i) Tip layering (ii) Simple layering (iii) Serpentine or compound layering and (iv) Trench layering.

3.4 **Cuttings-** Several plant parts like Coppice shoot branch. Stem. culms. leaf can be used for the propagation throught cuttings Stem or branch cuttings is piece of stem/branch/twig generally 10-20 cm long and 4-10 mm diameter of known genetic sources depending on the species and usually not more than 1- 10 yrs. In age and the most practiced method of propagation by cuttings. The cuttings are placed in a moist rootings culture medium to produce adventitious roots and grow as independent plants.

4. VEGETATIVE PROPAGATION IN INDIA

Rao in 1953 gave list of forest tree species which can be grown through vegetative propagation. He found that 74 species reproduce by cuttings, 11 by layers, 9 by grafting and budding and 104 by root-suckers. There are no less than 161 species which coppice or less vigotously (Rao, 1953 Rawat et al., 1994). The coppicing ability also an indication of the faculty of vegetative reproduction with the aid of hormones many of them may be induced to root.

The study of physiology of adventitious roots formation by Nanda (1968) through auxin the vegetative propagation techniques started in India. Rooting response of stem cuttings of 35 tree species using different auxins in different seasons was investigated and differences in rooting ability was observed. It was reported that planting season has a pronounced effect on rooting of cuttings and the effect appeared to be correlated with Seasonal changes in cambial activities during the annual cycle. The rooting response of various auxins also varied with the seasons and the failure of cuttings of

these species to root without auxin application in any season may be due to limiting levels of indigenous auxin under these environmental condition. Thus auxin may stimulate rooting of a plant species in one season but inhibit it in other season (Nanda et al., 1998).

Important work done on vegetative propagation of some important tropical forest tree species are as follows-

Teak (*Tectona grandis*): Nanda et al. (1968.69.70). Isikawa (1968). Bala et al. (1969). Rawat et al. (1968.73). Gurumurti et al. (1968.73). Libby and Hood (1976). Bhatnagar and Joshi (1978). Purohit (1986). Vikshasaya et al. (1985). Nautiyal et al. (1991).

Eucalyptus: Campinhos et al. (1977.83). Hertiney (1980). Chaturvedi (1983). Greary (1985). Heth et al. (1985). Chandra et al. (1986). Anon (1988). Prasad and Pal (1988b.92). Gurumurti et al. (1988.89). Lai et al. (1991).

Gmelina arborea: Arya et al. (1982). Hamsawi et al. (1985). Tang et al. (1985).

Casuarina equisetifolia: Somasundaram et al. (1977). Kondas (1983).

Bambusa vulgaris (Yellow): White (1947a). Abeels (1962). Banik (1980.84.85.91c). Stepliton (1985). Adarsh kumar (1988.91.92). Bohidar (1989). Dhuria et al. (1990).

Dalbergia sissoo: Dhuria et al. (1992).

Procopis julifera: Srivasuki et al. (1990).

Largerstromia parviflora: Chaturvedi (1988).

Acacia albida: Harsh et al. (1985). Ahmed et al. (1987).

Ficus bengalensis and F. religiosa: Nanda et al. (1985).

The S.F.R.I. Jabalpur is working on vegetative propagation of important forestry species since last 10 years and standardized their vegetative propagation techniques.

5. GENETICS OF VEGETATIVE PROPAGATION

Vegetative propagation has the advantage over seed germination in its ability to raise superior clones through the multiplication of plus individuals. The superiority of selected individual depends upon nature and amount of variation present for specific character selected. Although environmental factors influence genotypic expression, phenotypic superiority of individual gives an indication of its genetic value. The method of propagation of selected plus trees has advantages like (i) easy to adopt, (ii) genetic gain achieved in shortest period. Because of these, forest tree propagators select plus trees on the basis of data on phenotypic performance and gainfully utilize in the

improvement of productivity of forests. The technique enables the propagators to exploit non-additive genetic effects for realizing extra gain over the sexual reproduction method.

Conventional vegetative propagation techniques are now being widely used for establishing clonal seed orchard and clonal multiplication gardens. CSO and CMG are raised either from progeny of two plus trees selected from natural stands of two different character or direct multiplication of plus individuals, by the incorporation of suitable breeding strategies (e.g. subline breeding, multiline breeding, controlled crossing, positive assortive mating etc.) significant genetic gain can be achieved. The ultimate aim of such breeding is to incorporate maximum number of genes in specific character and subsequent enmassing of F₁ progeny.

6. ECONOMIC GAINS BY VEGETATIVE PROPAGATION

Economic gain from clonal plantation of forest tree species vary from species to species and depend on the comparative cost of seedling and rooted cuttings, interest rates, rotation, yields, market price of the plantation wood on harvest, intensity of management, quality of the planting site, soundness of silvicultural practices, protection, intensity and selection of clones, maximum genetic gains like higher productivity, improved product quality and disease resistance can be realised using vegetative propagation techniques.

It is possible to achieve 17-40% gain in yield through traditional breeding and 82% gain through selected superior clone of same species. Seventy three percent gain can be achieved by crossing two selected but unrelated superior clones with good specific combining ability but hybridization between two species and selection of superior clones in the hybrid progeny can result in 118% and 154% gains respectively (Leakey, 1991). There are Outstanding examples of 400-500% economic gain in the productivity in the case of plantation crops like Cocoa and Rubber in Malaya (Tan, 1987). In Congo 50-192% gain in annual increment of 6 years old Eucalyptus was estimated by Leakey (1987) where annual increment from selected clones was 35 m³/ha/yr as compared to 20-25 m³/ha/yr from selected provenance and about 12 m³/ha/yr from unselected seed lots. In Brazil in plantation of Selected clones of *E. grandis* and *E. urophylla* hybrid productivity has gone up from 36 m³/ha/yr to 45-75 m³/ha/yr resulting in 25 to 108 gains (Compinhos and Colaudiada-silva, 1990). 50% improvement in the productivity from 16 m³/ha/yr to 20-25 ha/yr is expected in Eucalyptus teriticornis plantation by ITC Bhadrachalam (Lal, 1994).

OBJECTIVES OF PRESENT STUDY

1. To Standardize the vegetative propagation protocols for some important tropical forest tree species.
2. To observe the optimum rooting response in different seasons rooting ability, hormonal treatment effect, seasonal behaviour of cutting/propagated material
3. To preserve the genotype through use of plus individuals of some important tropical forest tree species, medicinal and ornamental plants.
4. Multiplication of desired genotype for establishment of clonal seed orchards (CSO), clonal multiplication garden (CMG) and clonal forestry programme.

GENERAL METHODOLOGY

Fresh and healthy stem branch/culm cuttings and rhizome were collected from well grown tree/clump and plants of known genetic source and immediately dipped in fresh water. They were cut in to different diameter and length with two or three nodes having axillary buds with or without leaves (according to species) and they were properly sterilized with fungicides (bavestin or captan in 200 ppm) for 2-3 hours. Cut end of cuttings (0.5-1 inches vertically) were treated with root promoting hormones IBA (Indol Butyric Acid) having different concentration as quick deep method (60 seconds) Sand was used as a culture media. Temperature and relative humidity were maintained at 25-34°C 70-80% respectively in mist chamber. Rooting response was observed seasonally round the year in different concentration of IBA (500-12,000ppm).

Details of collection material, cutting size and concentration of IBA for macropropagation of different species is given in Table-1.

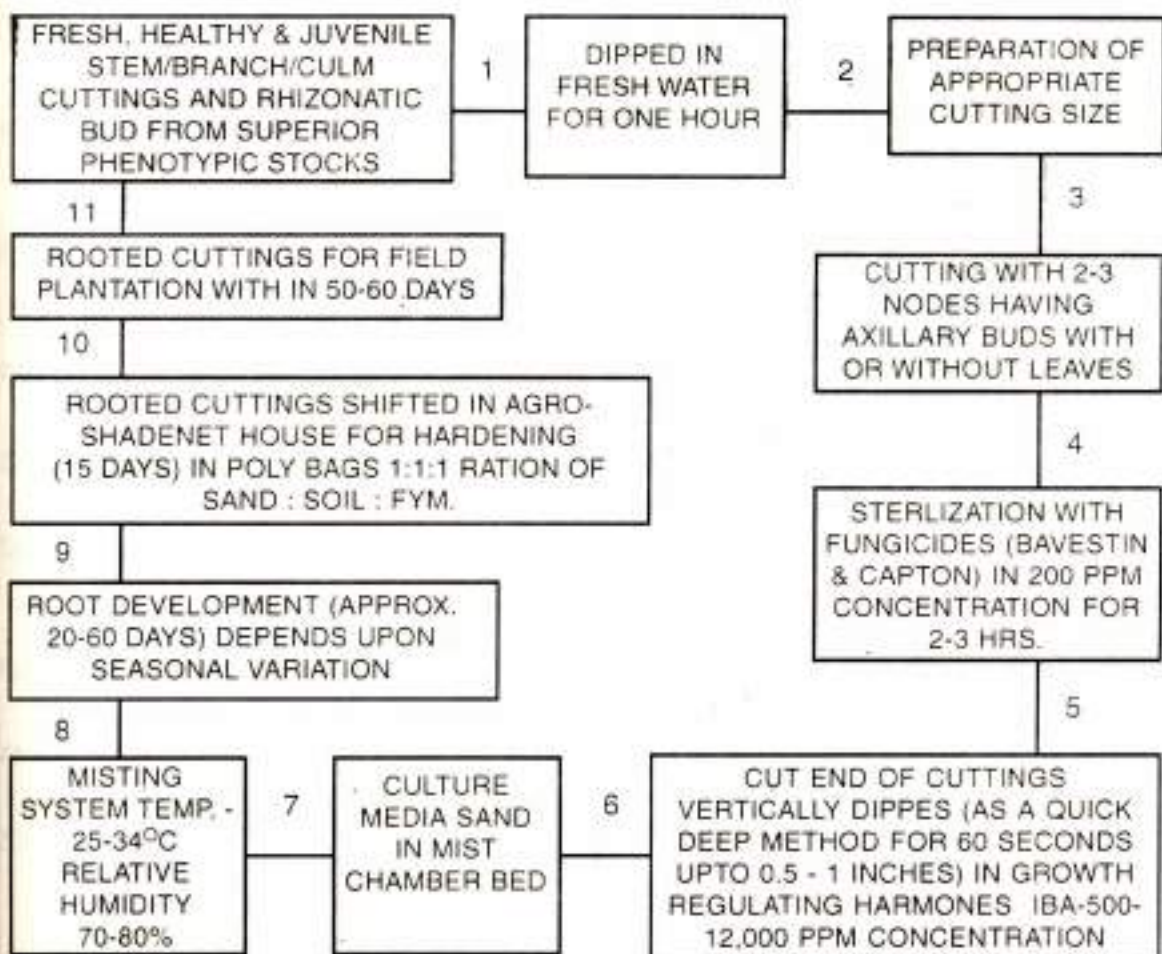


Table-1 Collection of material, cutting size and hormonal treatment for macropogation of different species.

Sl.	Name of the No.Species	Collection Material	Cutting size (dia /length)	Growth Regulator IBA (ppm)
1.	<i>Adina Cordifolia</i>	st.br.6-8 yrs.old tr.2-3nds	5-10mm,8-10cm	1,000-10,000
2.	<i>Albizia amara</i>	st.br.6-8yrs.old tr. 1-2 nds	6-8 mm,10-13cm	1000-10,000
3.	<i>Anthocephalus kadamba</i>	st.br.4-6yrs.old tr.1-2nds	4-12mm,8-12cm	1000-10,000
4.	<i>Azadirachta indica</i>	st.br.6-8yrs.old tr.2-3 nds	4-8mm,8-12cm	1,000-10,000
5.	<i>Bambusa vulgaris (Yellow)</i>	culm/br.2-3yrs.old culmp 2 nds.	6-12mm,15-20cm	500-10,000
6.	<i>Barsera dalpichana</i>	st.br. 10-12yrs.old tr.2-3nds	4-8 mm,8-12cm	500-10,000
7.	<i>Beutea monosprma</i>	st.br.6-8yrs.old tr.2-3nds	4-8mm,8-12cm	500-10,000
8.	<i>Casuarina equisetifolia</i>	st.br.4-6yrs.old tr.2-3nds	5-7mm,10-13cm	1000-10,000
9.	<i>Curcuma caesia</i>	Rh. 1 yr. old pl.1bud	with one sprout	500-4,000
10.	<i>Curcuma angustifolia</i>	Rh. 1 yr. old pl.1bud	with one sprout	500-4,000
11.	<i>Cordia myxa</i>	st.br.4-6yrs.old tr.2-3nds	4-8mm,8-10cm	1000-10,000
12.	<i>Costus speciosus</i>	Rh. 1yr.old pl.1bud	with one sprout	500-4,000
13.	<i>Dalbergia latifolia</i>	st.br.4-6yrs old tr.2-3nds	4-10mm,8-2cm	1000-10,000
14.	<i>Dalbergia sissoo</i>	st.br.4-6yrs.old tr.1-2nds	4-10mm,8-10cm	1000-10,000
15.	<i>Delonix regia</i>	st.br.4-6yrs.old tr.2-3nds.	8-10mm,8-12cm	1000-10,000
16.	<i>Erythrina indica</i>	st.br.4-6yrs.old tr.4-5nds	6-12mm,8-12cm	1000-10,000
17.	<i>Eablica officinalis</i>	st.br.6-8yrs.old tr.2-3 nds	6-8mm,8-12cm	500-1000
18.	<i>Eucalyptus teriticotnis</i>	st.br.8-10yrs.old tr.2nds	4-8mm,5-12cm	1000-10,000
19.	<i>Ficus bengalensis</i>	st.br.4-6yrs.old tr. 2-3nds	6-12mm,8-12cm	500-10,000
20.	<i>Ficus krishnai</i>	st.br.8-10yrs.old tr.2-3nds.	4-8mm,8-12cm	1000-10,000
21.	<i>Ficus religiosa</i>	st.br.4-6yrs.old tr.2-3nds	6-12mm,8-12cm	500-10,000
22.	<i>Gmelina arborea</i>	st.br.6-8yrs.old tr.2-4nds	6-10mm,8-12cm	1000-10,000
23.	<i>Grevillea teridifolia</i>	st.br.8-10yrs.old tr.2-3nds	6-10mm,8-12cm	1000-10,000
24.	<i>Lagerstreomia flosregini</i>	st.br.6-8yrs.old tr. 1-2nds	6-8mm,8-12cm	1000-10,000
25.	<i>Leucaena leucocephala</i>	st.br.4-6yrs.old tr.3-4 nds	6-12mm,8-12cm	1000-10,000
26.	<i>Morus alba</i>	st.br.4-6yrs.old tr.2-3nds	6-12mm,8-12cm	2000-8000
27.	<i>Plunobago zeylanica</i>	st.br.old tr.2-3nds	6-8mm,8-10cm	500-4000
28.	<i>Pogostomon cablin</i>	st.br. 1 yr old pl.2-3nds	3-6mm,8-12cm	500-4000
29.	<i>Pongamia pinnata</i>	st.br.8-10yrs old pl 2-3nds	8-10mm,8-12cm	1000-10,000
30.	<i>Psoralea corylifolia</i>	st.br. 1yr old pl.2-3nds.	4-8mm,8-12cm	500-4000
31.	<i>Populus deltoides</i>	st.br.1yr. old pl.2-3nds.	3-6mm,8-12cm	1000-12000
32.	<i>Rauvolfia serpentina</i>	st.br. 1yr old pl.2-3nds	3-6mm,8-12cm	500-4000
33.	<i>Tectona grandis</i>	st.br.6-8yrs.old tr.2-4nds.	6-10mm,6-12cm	1000-12000
34.	<i>Terminalia arjuna</i>	st.br.6-8yrs old tr.2-3nds.	4-10mm,8-12cm	500-10,000
35.	<i>Whithania sonanifera</i>	st.br.1yr old pl.2-3nds	4-6 mm,6-10cm	500-4,000

st.br. stem branch, tr-tree, pl-plant, nds-nodes, Rh-rhizome.

RESULTS

1. *ADINA CORDIFOLIA* (HALDU)

1.1 Rooting Response : Optimum rooting was recorded (15 to 18 %) in the month of July to August in 10.000 ppm of IBA whereas there was no rooting response in rest of the month in the same concentration of IBA. Rooting was reported with in 30-36 days after given treatment.

1.2 Suggested Protocol :

IBA (10.000ppm)—5 to 18% rooting(July to August).

2. *ALBIZIA AMARA* (CASTAR)

2.1 Rooting Response : Optimum rooting response was recorded (2 to 5%) in the month of June to August in 10.000 ppm of IBA while there was no rooting response in rest of the month in same concentrations of IBA. Rooting was reported with in 30-40 days after given treatment.

2.2 Suggested Protocol :

IBA (10.000 ppm)-2 to 5 % rooting.(June to August).

3. *ANTHOCEPHALUS KADAMBA* (KADAM)

3.1 Rooting Response : Optima rooting response was recorded (66-93%) in the month of September to November in 10,000ppm of IBA. However, poor to nonderate rooting response were observed (20-29%) in rest of the months in 6,000ppm of IBA. Rooting period was reperedted with in 28-32 days after the given treatment.

3.2 Suggested Protocol :

IBA (10.000ppm)—66-93% rooting (September to November).

4. *AZADIRECTA INDICA* (NEEM)

4.1 Rooting Response : Optimum rooting response (85-75%)were observed in the month of July to September in 8,000ppm of IBA. Poor to modorate rooting (42-80%) was recorded in rest of the months in 6000-10,000ppm. Rooting was reported with in 28 days after the given treatment.

4.2 Suggested Protocol :

IBA 8000pm— 65-75% rooting (July to September).

5. *BAMBUSA VULGARIS* (YELLOW BAMBOO)

5.1 Rooting Response : Optimum rooting (80-84%) was observed in the month of February to June in 5,000ppm of IBA. Rooting response was recorded poor to moderate(50-60%) in rest of the months in control. Rooting was reported within 15-20 days after given treatment.

5.2 Suggested Protocol :

IBA (5000ppm)—80-84% rooting (April to June)

6. *BARSERA DALPICHIANA*

6.1 Rooting Response : Optimum rooting(55-72%) was observed in the month to June in 7,000 ppm of IBA. The rooting response was recorded poor to moderate (35-45%) in rest of the months in 6000-8000 ppm of IBA. Rooting was reported within 25-35 days after the given treatment.

6.2 Suggested Protocol :

IBA 7,000ppm-55-72% rooting (month of April).

7. *BEUTEA MONOSPERMA* (PALAS. DHAK)

7.1 Rooting Response : Optimum rooting was recorded (80 to,85%) in the month of March to June in 4,000ppm of IBA. Rooting response was recorded poor to moderate (72 to 80%) in rest of the months in 5,000-6,000ppm of IBA. Rooting was reported within 30-36 days after the given treatment.

7.2 Suggested Protocol :

IBA (4,000ppm)—80-85% rooting(March to June).

8. *CASUARINA EQUISITIFOLIA*

8.1 Rooting Response : Optimum rooting was observed in the month of February to September (35-45%) in 6,000 ppm of IBA. The rooting response was recorded at par to moderate (25-35%) in rest of the month in 4000-8000 ppm of IBA. Rooting was reported within 27-32 days after the given treatment.

8.2 Suggested Protocol :

IBA 6,000ppm-35-45% rooting (February to September)

9. CURCUMA CAESIA (ROXB)

9.1 Rooting Response : Optimum rooting was observed (52-73%) in the month of March to May in 1,500ppm of IBA while rooting response was poor to moderate (48-60%) in rest of the months. Rooting was reported with in 24-29 day after the given treatment.

9.2 Suggested Protocol :

IBA (1,500ppm)—52-73% rooting (March to May).

10. CURCUMA ANGUSTIFOLIA ROXB (TIKHUR)

10.1 Rooting Response : Optimum rooting (56-76%) was recorded in the month of February to April in 2,000ppm of IBA whereas it was recorded poor to moderate (42 to 68 %) in rest of the months. Rooting was reported with 22-28 days after the given treatment.

10.2 Suggested Protocol :

IBA (2,000ppm)-58-76% rooting (April).

11. CORDIA MYXA (LASODA)

11.1 Rooting Response : Optimum rooting response (35-50%) was observed in the month of september in 10,000ppm of IBA however it was Poor to moderate (15-5%) in rest of the months in 1000-10000 ppm. Rooting was reported with in 35 days after the given treatment.

11.2 Suggested Protocol :

IBA 10,000ppm—35-50% rooting (September).

12. COSTUS SPECIOSUS (KEOKANDA)

12.1 Rooting Response : Optimum rooting was observed in the month of January to May (85 to 95%) in 500-1,000 ppm of IBA while it was poor to moderate (65-80%) in rest of the months in same concentration of IBA. Rooting was reported with in 30-35 days after the given treatment.

12.2 Suggested Protocol :

IBA (500-2,000ppm)-85-90% rooting (January to May).

13. DALBERGIA LATIFOLIA (SHISHAM)

13.1 Rooting Response : Optimum rooting (35-45%) was observed in the month of March to May in 8.000 ppm of IBA. While it was moderate (25-32%) in rest of the months in 4000-8000 ppm of IBA. Rooting was reported with in 32-35 days after the giving treatment.

13.2 Suggested Protocol :

IBA 8.000 ppm 35-45% rooting (March-May).

14. DALBERGIA SISSOO (SISSOO)

14.1 Rooting Response : Optimum rooting (88-99%) was observed in the month of February to April in 4.000-8.000 ppm of IBA. However it was poor to moderate (29-50%) in rest of the months in 3000-5000ppm of IBA. Rooting was reported with in 30-35 days after the given treatment.

14.2 Suggested Protocol :

IBA (4000-8000ppm)-80-89% rooting (F March ebrto May).

15. DELONIX REGIA (GULMOHAR)

15.1 Rooting Response : Optimum rooting (25-35%) was recorded in the month of January-Jun in 6000ppm of IBA. however it was poor to moderate (10-20%) in rest of the months in 2000-6000 ppm of IBA. Rooting was reported in 28-32 days after the given treatment.

15.2 Suggested Protocol :

IBA(6000ppm)- 25-35% rooting (January toJun)

16. ERYTHRINA INDICA

16.1 Rooting Response : Optimum rooting (75-80%) was recorded 5000ppm of IBA. Rooting was reported in 30-35 days after giin the month of February to April in 10.000 ppm however it was treatment .

Poor to moderate (60 to 80%) in rest of the months in 4.000-8.000ppm concentration of IBA. Rooting was reported with in 23-27 days after the given treatment.

16.2 Suggested Protocol :

IBA (10.000ppm)—75-80% rooting (February-April).

17. EMBLICA OFFICINALES (ANOLA)

17.1 Rooting Response : Optimum rooting (12-15%) was observed in the month of March to April in 6,000-8,000ppm) of IBA, however it was poor to moderate (5-10%) in rest of the months in 4,000ppm . Rooting was reported with in 30-32 days after the given treatment.

17.2 Suggested Protocol :

IBA (6,000ppm-8,000ppm)—12-15% rooting (March-April).

18. EUCALYPTUS TERITICORNIS

18.1 Rooting Response : Optimum rooting (60-70%) was recorded in the month of April to June in 4,000ppm of IBA, however poor to moderate (30 to 40%) in rest of the months in 6,000-8,000ppm of IBA. Rooting was reported with in 23-26 days after the given treatment.

18.2 Suggested Protocol :

IBA (4,000 ppm)—60-70% rooting (April-June)

19. FICUS BENGALENSIS (BAR, BARGAD)

19.1 Rooting Response : Optima rooting (26%) was observed in the month of January to June in 6,000 ppm of IBA however it was poor to moderate (8-12%) in rest of the months in 4,000 ppm of IBA. Rooting with in 30-36 days after the given treatment.

19.2 Suggested Protocol :

IBA (1500ppm)-26% rooting (January-June)

20. FICUS KRISHNAI

20.1 Rooting Response : Optimum rooting was observed in the month of Jan to June (12-17%) in 5,000ppm) of IBA. The rooting response was recorded poor to nil in rest of the month (5-10%) in 4000- 8000ppm of IBA. Rooting was reported within 25-35 days after the given treatment.

20.2 Suggested Protocol :

IBA 5,000-12-17% rooting (January to June)

21. *FICUS RELIGIOSA* (PEEPAL)

21.1 Rooting Response : Optimum rooting were observed in the month of January to June (58%) in 7000ppm of IBA. Rooting response was recorded poor to moderate in rest of the month (34 to 46%) in 4 000 to 6000 ppm of IBA. Rooting was recorded with in 20-30 day after the given treatment.

21.2 Suggested Protocol :

IBA (7.000ppm)-66% rooting (January to June)

22. *GMELINA ARBORIA* (KHAMER)

22.1 Rooting Response : Optimum rooting was observed in the month of April to June (30 to 50%) in 10.000ppm of IBA. Rooting response was recorded poor to moderate in rest of the months in same concentration of IBA. Rooting was reported with in 24-30 days after the given treatment.

22.2 Suggested Protocol :

IBA (10.000 ppm) 30-50% rooting (April to June).

23. *GREVILLEA PTERIDIFOLIA*

23.1 Rooting Response : Optimum rooting was observed in the month of March to June (27 to 40%) in 4.000ppm of IBA. Rooting response was recorded poor to moderate in rest of the months (16 to 25%) in 2.000-8.000ppm of IBA. Rooting was reported with in 24-30 days after the given treatment.

23.2 Suggested Protocol :

IBA (4.000PPM)—27-40% rooting (March to June).

24. *LAGESTEOMIA FLOSSREGINI* (JARUL)

24.1 Rooting Response : Optimum rooting was recorded (53%) in the month of August in 7.000 ppm of IBA however poor or moderate (6-18%). Rooting response was recorded in rest of the month in 2000-4000ppm of IBA. Rooting was reported with in 27-30 days after the given treatment.

24.2 Suggested Protocol :

IBA (7000pp)-53%-rooting (August).

25. LEUCAENA LEUCOCEPHALA (SOO BABUL)

25.1 Rooting Response : Optimum rooting (80-85%) was recorded in the month of August in 8,000 ppm of IBA however it was poor to moderate (42 to 60%) in rest of the months in 6000-10,000ppm of IBA. Rooting was reported with in 44 days after the given treatment.

25.2 Suggested Protocol :

IBA (8,000ppm)—80-85% rooting (August).

26. MORUS ALBA (SHAHTOOT)

26.1 Rooting Response : Optimum rooting (100%) was recorded in the month of March to June in 6,000 ppm of IBA however it was poor to moderate (50 to 70%) in rest of the months in 2,000-4,000ppm of IBA. Rooting was reported with in 22-25 days after the given treatment.

26.2 Suggested Protocol :

IBA (6000 ppm)—100% rooting (March to June).

27. PLUMBAGO ZEYLANICA L. (CHITRAK)

27.1 Rooting Response : Optimum rooting (74-88 %) was recorded in the month of March to July to August in 1,500 ppm of IBA, while however rooting was poor to moderate (52 to 69%) in rest of the months control. Rooting was reported with in 23-26 days after the given treatment.

27.2 Suggested Protocol :

IBA (1500ppm)—74-86% rooting (July-August).

28. POGASTOMON CABLIN

28.1 Rooting Response : Optimum rooting (85-94 %) was recorded in the month of June-August in 1,500 ppm of IBA, however it was poor to moderate (32 to 64%) in rest of the months in same concentration. Rooting was reported with in 30-35 days after the given treatment.

28.2 Suggested Protocol :

IBA (1,500ppm)—85-94% rooting (Jan-August).

29. PONGAMIA PINNATA (KARANJ)

29.1 Rooting Response : Optimum rooting (88-100 %) was recorded in the month of March to June in 8,000-10,000 ppm of IBA, however it was poor to moderate in rest of the months (55 to 70%) in 2,000ppm of IBA. Rooting was reported with in 30-35 days after th given treatment.

29.2 Suggested Protocol :

IBA (8,000 & 10,000ppm)—88-100% rooting (March to June).

30. PSORALIA CORYLIFOLIA LINN (BABCHI)

30.1 Rooting Response : Optimum rooting (79-88 %) was observed in the month of June to August in 1,500 ppm of IBA. While rooting was recorded poor ot moderate (30-50%) in rest of the months in the same concentration of IBA. Rooting was reported with in 30-35 days after th given treatment.

30.2 Suggested Protocol :

IBA (1500ppm)—79-88% rooting (June& August).

31. POPULUS DELTOIDES (POPLER)

31.1 Rooting Response : Optimum rooting response was recorded (81 to 94%) in the month of March to June in 4,000 ppm of IBA, however it was poor to moderate (40-60%) in rest of the months in (6,000-12,000ppm) of IBA. Rooting was reported with in 28-32 days after th given treatment.

31.2 Suggested Protocol :

IBA (4,000ppm)—81-94% rooting (March to June).

32. RAUVOLFIA SERPENTINA (SARPGANDA)

32.1 Rooting Response : Optimum rooting was recorded (88 to 100%) in the month of July to September in 2,000 ppm of IBA, however it was poor to moderate (63 to 81%) in rest of the months in (500-3,000ppm) of IBA. Rooting was reported with in 20-26 days after th given treatment.

32.2 Suggested Protocol :

IBA (2,000ppm)—88-100% rooting (July to September).

33. *TECTONA GRANDIS* (SAGAOUN)

33.1 Rooting Response : Optimum rooting (15 to 20%) was observed in the month of June to August in 12.000 ppm of IBA, however it was nil in rest of the months in the same concentration. Rooting was reported with in 20-26 days after th given treatment.

33.2 Suggested Protocol :

IBA (12.000ppm)—15-20% rooting (June to August).

34. *TERMINALIA ARJUNA* (KAHAWA)

34.1 Rooting Response : Optimum rooting (35 to 45%) was observed in the month of JAN to June in 6.000 ppm of IBA, however it was recorded at par to moderate (25-35%) in rest of the month in 4000-7000 ppm of IBA. Rooting was reported with in 28-34 days after th given treatment.

34.2 Suggested Protocol :

IBA (6.000ppm)-35-45% rooting (Jan-June).

35. *WITHANTA SOMNIFERA* (ASHVAGANDHA)

35.1 Rooting Response : Optimum rooting (85 to 94%) was recorded in the month of June to August in 1.500 ppm of IBA, however it was poor to moderate (32-64%) in rest of the months in same concentration. Rooting was reported with in 30-35 days after the given treatment.

35.2 Suggested Protocol :

IBA (1.500ppm)-85-94% rooting (June-August).

CONCLUSION

TREE SPECIES

1. Out of total 26 species studied 13 species were found very easy and easy to root. However, in 13 species rooting response was either moderate or difficult. Best rooting season for 18 species was Feb-June, which coincided with spring season while in remaining 7 species it coincided with rainy season (i.e., July-Sept) found suitable.
2. Rooting mostly occurred in the range of IBA conc. 4000-8000 ppm, and it varying from species to species.
3. General loss of Rooting in other months was 10-40% in tree species which are very easy and easy to propagate. However, it was generally 15-20% in species moderate to propagate and 5-15% in difficult to propagate.
4. The species which were very easy to propagate IBA concentration induced rooting in other months (the month in which optimum variation was not found). However, lowering of IBA concentration induced rooting in other months in species which are easy to propagate and difficult to propagate.

MEDICINAL PLANTS

1. Among 9 medicinal plants tried 8 species come under the category of easy to root.
2. Maximum (6) species rooted in rainy season.
3. Rooting in medicinal plants occurred comparatively in low concentration of IBA than tree species.
4. 8 species rooted even without any intervention of auxin. It shows that in other months in mist chamber majority of medicinal plants can be propagated in mist chamber through out the year but application of auxins increases rooting percentage.

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