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NURSERY TECHNIQUE OF Local Tree Species - II

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PREFACE

The bulletin has been prepared to assist the practicing foresters in establishing forest nurseries and in raising seedlings of woody species commonly planted at different altitudes of forest divisions of Arunachal Pradesh. The technique can also be used as a handy reference to train the field staff, local farmers, Research Institutes, Government Departments, Village Panchayats, school students, NGOs and others who are increasingly associated with the noble act of planting trees.

The important aspects of the nursery technique for each species starting from the general information of the species, and various aspects like flowering, fruiting, morphology of fruit/seed, seed collection, storage and pretreatment etc have been presented in a simple language.

The bulletin helps the foresters in planning their nursery and plantation programmes as it gives valuable technical information like the number of seeds/kg, number of viable seedlings/kg, germination %, plant survival percentage, germination period as well as method of seed sowing in nursery beds and seeding management to provide quality seedlings for plantation. We specially thank to Dr. K. Haridasan, Forest Geneticist, for going through the manuscript and making useful suggestions. Thanks are also due to Dr. S.N.Hegde, Director, S.F.R.I, Itanagar, for useful suggestions & views in improving the text and presentation of this information bulletin. Further, the fund support by the Department of Environment & Forests, Arunachal Pradesh for the production of bulletin is also gratefully acknowledged.

We hope, the bulletin is a positive step in orienting field officers and staff in addition to those associated with forestry activities in planning their nursery and plantation programmes. While every attempt has been made to make the bulletin comprehensive and error - proof, yet the authors can not lay any claim to perfection, therefore, we appreciate any suggestions for further improvement of the bulletin.

Itanagar Authors

FOREWORD

Of late, with the increasing thrust on afforestation and greening of the country, there is an increasing demand for the supply of seedlings for plantations, year after year. Celebration of Van Mahotsava through out the country has added significance to planting seedlings on vacant land thus creating environmental awareness in everybody's mind. Quality seedlings are the most important items for successful plantation activity. Keeping this in view, nursery technique for fifteen selected local tree species used in forestry programmes has been compiled and presented in this information bulletin.

A brief account of the important aspects of each species starting from the general information, flowering, fruiting, morphology of the fruit/seed, seed collection, storage, seed biology, pre-treatment, germination period & percentage and nursery technique has been presented in a simple manner with illustrative photographs and drawings.

It is indeed a useful work and the authors deserve appreciation for their efforts in compiling such valuable information based on the trials and experiments conducted at SFRI and other institutes in India.

I hope the bulletin would certainly help the field staff and officers and also all those interested in forestry activities in planning their nursery and subsequent plantation programmes through out the state of Arunachal Pradesh and NE Region at large, thereby achieving the objective of afforestation and improvement of quality of environment.

S.N. Hegde
Director
SFRI, Itanagar

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	Species	Part	Magnification
Fig. 1.			
1.	Adenanthera pavonina	fruit & seeds	*X* ½
2.	Albizia arunachalensis	fruit *XV4&* seed	*X* ½
3.	Alnus nepalensis	seeds	**X I**
4.	Artocarpus chaplasha	fruit & Seeds	**X 1/3**
5.	Bischofia javanica	fruit & seeds	X ½
6.	Bridelia retusa	fruit	***X*** ½
7.	Elaeocarpus aristatus	fruit & seed	***X* 1/3**
8.	Elaeocarpus floribundus	fruit & seed	X l/3
9.	Elaeocarpus sphaericus	fruit & seed	**X 1**
10.	Michelia kisopa	fruit X ½ & seed	*X* ½
11.	Mimusops elengi	fruit XI & seed	***X*** ½
12.	Phoebe cooperiana	fruit & seed	*X* ½
13.	Sapindus emarginatus	fruit & seed	***X*** ½
14.	Schima wallichii	fruit & seeds	***X*** ½
15.	Spondias pinnata	fruit & seed	X l/3

Adenanthera pavonina (Red chandan)

A medium sized unarmed deciduous tree. Bark - dark brown to greyish brown, rough in older trees, white or brownish-white inside. This species occurs in lower elevations preferably on slopes. The timber is good for furniture and house construction. Fruit - pod, 15 to 23 cm X 2 cm wide, and each pod has 8 to 15 bright scarlet seeds. Seeds are collected by plucking pods, which get twisted on maturity. Seeds are orthodox due to the hard seed-coat and hence they can be stored for about 24 months. Seed permeability decreases when stored in open air, however, it does not affect the seed viability. Scarification (breaking of hard seed-coat) of seeds increases the germination rate and decreases the germination period drastically. Seeds are also used for decoration purpose.

Seed collection period	December - February
Number of seeds/kg	3,750
Seed viability	24 months
Pre-sowing treatment	Over night soaking of seeds in hot water (70°C) gives good result.
Germination Period	7 to 30 days
Germination percentage	75
No, of seedlings obtained/kg seeds	2,800

Scarified seeds are soaked in hot water for overnight and then water is drained. Seeds are sown vertically **keeping the micropyle end downward** at a depth of 1 to 1. 3 cm in polythene bags or in rows in shaded mother bed. Polybags are kept under light shade and watering is done as and when required. The germination commences after a week of sowing and continues up to four weeks or so. Germination is epigeal. The seedlings become ready for plantation in the coming rainy season.

Albizia arunachalensis (Siris)

It is a medium sized deciduous leguminous tree. This endemic species is found sporadically from 1000 to 1500 m altitude. Fruits - Pods, 8 to 15 cm long and 0.8 to 1 cm wide. Pods are collected just before dehiscence of seeds by lopping up of branchlets, dried in sunlight, and seeds are released by gentle beating with a bamboo stick. Seeds are orthodox and properly dried and packed seeds can be stored up to a period of two years under low temperature.

Seed collection period	September - October
Number of seeds/kg	50,422
Seed viability	25 months
Pre-sowing treatment	Over night soaking in hot water (80°C) or 1 to 2 minutes soaking in 50% conc. H_2SO_4 gives better germination.
Germination period	8 to 45 days
Germination percentage	52
Seedlings obtained/kg seed	26,200

Seeds are soaked in hot water (80°C) for 36 hours, After that, water is drained out. Seeds are sown in mother beds in rows 5 /10 cm apart at a depth of 0.8 to 1.0 cm. Germination is epigeal, starts after 8 to 10 days of sowing and continues up to 45 days. Watering should be done as per requirement. Excess watering can cause damping off of the seedlings. When seedlings attain 2 to 3 leaves stage (normally after about 30 days of sowing), they are transplanted in the polythene bags. After transplanting, the seedlings are kept in shaded mother bed. Initial growth of seedlings are very fast and they become ready for planting in fields with in 9 months.

Alnus nepalensis (Alder)

A tall deciduous and fast growing tree . It is native to India and Myanmar and distributed throughout the Himalayas from west to east between 800 to 2500 m elevation. It is an early succession stage species and amongst the first to become established naturally on denuded areas. Fruits - cone, 1.3 to 2.5 cm long and 0.8 cm in diameter, can be collected from November to December. Seeds have a narrow membranous and minute wing. Cones are dried in sunlight and seeds are separated by gentle hammering. Seeds loose viability completely within a year when stored at room temperature (20 °C), while seeds stored at 0 °C temperature give 27 percent germination after one year (Ram Boojh and Ramakrishnan, 1981). It is a valuable species for timber, fuel wood and handicraft works. The leaves are used as a cattle fodder.

Seed collection period	November - December
Number of seeds/kg	18,00,000
Seed viability	3 months
Pre-sowing treatment	stratification
Germination Period	8 to 30 days
Germination percentage	**58**
Seedlings obtained/kg seeds	10,40,000

Mother bed with a mixture of sand, FYM and soil 1:1:1 ratio is prepared well in advance. Seeds are sown by broadcasting in open mother beds immediately after the collection because of short viability of seeds. After sowing seeds are covered by a thin layer of soil or straw to maintain the moisture and temperature. Beds are watered twice daily. Germination starts after 8 to 10 days of sowing and seedlings become ready for transplanting in polythene bags after about 25 days of germination.

According to Ram Boojh and Ramakrishnan, (1981) alder seeds give best germination at a constant temperature of 20 °C under continuous light. Germination under darkness and at depth below 0.5 to 1.0 cm is found to be very poor, and seeds are photosensitive.

Artocarpus chaplasha (Sam-kathal)

A gigantic deciduous tree, attaining a clean bole of 20 to 25 m with a spherical crown. It occurs in the tropical evergreen and mixed deciduous forests. It is distributed through out the sub-Himalayan track and outer hills from Nepal Eastwards ascending to Assam, Arunachal Pradesh, Bangladesh, Myanmar and Andaman. Fruits- sorosis, oblong. Ripened fruits are collected from the end of June to July. Care should be taken not to collect the seeds damaged by insects. The pulp is allowed to rot in a heap and then fruits are washed in a bucket of water. As the seeds sink down, they are easily separated from the pulp. Seeds are also removed using a knife or Dao by cutting carefully along with the fruit pulp and dried for 2 to 5 days under proper shade. Seed oval 1.2 to 1.5 cm long. Seeds are recalcitrant, therefore, they cannot be stored for more than two months. The fruits are eaten by birds and wild animals as well as by local people. Its leaves are browsed by wild animals (deer), so it needs protection in the initial stage of growth.

Seed collection period	June - August
Number of seeds/kg	1,235
Seed viability	2 months
Pre-sowing treatment	Over night soaking in water gives better germination.
Germination period	5 to 20 days
Germination percentage	65
Seedlings obtained/kg seeds	800

Fresh and cleaned seeds are sown directly in polythene bags at a depth of 2 cm. Germination starts from 5 to 10 days after sowing and often completes within 20 days. Germination is hypogeal. Seeds germinate under optimum conditions and sowing should be done immediately otherwise germination percentage is reduced day by day. Seeds can also be sown directly in the field provided soil has sufficient moisture. Regular weeding and watering is done as and when required. Seedlings are kept in shaded beds to protect them from rain. Seedlings become ready for planting in the field by the next planting season. Root and shoot pruning (stumps) have been found successful in case of over grown seedlings or entire transplanting. It has good coppicing capacity.

Bischofia javanica (Urium)

A large deciduous tree with tall cylindrical trunk, sporadic crown which attains a height of 18 to 22 m. It is found up to 300 to 400 m elevations, generally along with moist shady ravines, river banks and in swamps. It is grown as an avenue tree and in tea and coffee plantations as a nurse tree. It is specially suited for afforestation of those areas which have high water table. Its leaves decompose immediately and retain good moisture when used in mulching. The wood is durable under water and specially used for the construction of bridges, house posts, pile foundation, wheels, boat and rafters. Fruit - 3 or 4 seeded globose berry, seeds 3 to 4 mm long, trigonous with one round and two flat sides, light brown and smooth with hard testa. Ripened fruit bunches are collected by plucking the tip of small branches, when its colour becomes brownish. Early and late collection of seed should be avoided. Fruits are kept in water for 2 days to allow the pulp to rot. Then fruits are macerated over wire mesh and washed with tap water to separate the seeds from pulp. Seeds are smooth and shining. Seeds loose viability rapidly and should not be stored for longer period. They should be sown immediately after the collection. It has good coppicing ability and produce vigorous shoots.

Seed collection period	December - January
Number of seeds/kg	1,05,000
Seed viability	6 months
Pre-sowing treatment	Not required
Germination period	10 - 30 days.
Germination percentage	76
Seedlings obtained/kg seeds	79,800

Sowing is done in proper shaded mother beds having a mix of sand, FYM and soil in 1:1:1 ratio. Seeds are sown at a depth of 0.5 to 0.8 cm in lines made at 8 cm distance and by keeping 4 cm distance between seed to seed. Seeds can be sown by broadcasting and about 70 g seed will suffice for one square meter bed. Mulching of bed hastens the germination. Germination is epigeal. It starts after 10 days of sowing and continues upto one month. .Adequate watering and time to time weeding is essential. Seedlings are transplanted in polybags after 15-20 days of germination. They become ready for plantation by the next rainy season. It can also be raised by planting out entire seedlings or by stump planting. Propagation through stump planting gives best results. Direct sowing can not be relied upon as the seeds are liable to be washed away by rains.

Bridelia retusa (Kuhir)

A medium sized deciduous tree with sporadic crown, having a height of 15 to 20 m and girth 1.2 to 1.7 m.. It is found in Himalayas from Nepal eastward to the hills of Assam, Meghalaya, Manipur and in Arunachal Pradesh up to 1500 m elevation. Its dark grey bark is used for tanning, and leaves as fodder. Fruit is drupe, sweetish, fleshy, edible, globose about the size of a pea, 0.8 cm diameter, purple black, seated on a hard-enlarged calyx. Each fruit contains one or two seeds with fairly thick bony shells. Ripened fruit bunches are plucked from trees by lopping of branchlets during December/ January. Seeds are extracted by macerating of fruit pulp in wire-mesh and washing thoroughly under tap water. The clean seeds are dried in light shade. Seeds loose viability rapidly.

Seed collection period	December - January
Number of seeds/kg	8,240
Seed viability	3 months
Pre-sowing treatment	Over night soaking in hot water.
Germination period	25 to 60 days.
Germination percentage	24
Seedlings obtained/kg seeds	1,980

Seeds are sown in well prepared mother beds at a depth of 0.6 to 1.0 cm in lines. The distance between lines is at 6 to 8 cm and between seed to seed at 5 cm. Germination is epigeal. It starts after about 25 days of sowing and continues up to 60 days. Seedlings are pricked at three leaves stage and transplanted in polybags under shade. Seedlings are watered once a day, weeding and spray of insecticides are carried out as per requirement. The seedlings growth at initial stages is very slow and they become ready for plantation after one year.

Elaeocarpus aristatus (Gohari sopa)

A large evergreen tree, up to 30 m height and 2 to 2.5 m in girth. The bark is grey, thick and rough, divided in rectangular scales. It occurs in tropical evergreen and moist mixed deciduous forests of Assam, Arunachal Pradesh, Meghalaya, West Bengal, Western Ghats and Andamans up to 500 m elevation. Fruit -drupe, 2 to 3 cm long, oblong, stone sharply pointed at both ends, compressed with a longitudinal ridge on each of the faces, one cell with one seed. Flowers appear in April-May. Ripened fruits are collected by lopping of small branchlets. The fleshy mesocarp is removed either with a sharp knife or by macerating fruits on wire mesh and washing of pulp under tap water. Seeds are dried in light shade. Fleshy mesocarp of fruit is eaten by the birds and wild animals.

Seed collection period	September - October
Number of seeds/kg	470
Seed viability	3 months
Pre-sowing treatment	Soaking of seeds in water
Germination period	20 to 50 days
Germination percentage	**52**
Seedlings obtained/kg seeds	238

Seeds are soaked in tap water for 24 hours, and then water is drained out. Pre-soaked seeds are sown vertically by keeping micropyle-end upward in shaded mother beds at a depth of 1.5 to 2.0 cm. Germination is epigeal, starts after three weeks of sowing and continues up to 50 days when seedlings attain 3 leaves stage. Juvenile seedlings are pricked after flooding of mother bed and transplanted in polythene bags under shade. Transplanted seedlings are kept in shaded mother bed. Mother beds after sowing of seeds, and later on transplanted seedlings are watered daily or as per requirements during rainy season. Seedlings become ready to plant in field after 8 months from transplaning in polybags.

In an experiment conducted at S.F.R.I, the clean seeds were treated with 0.5% and 1.0% KNO_3 solution for 24 hours, washed thoroughly in water and then sown in tray. Trays containing sand were kept in seed germinator maintained at 28 °C. The germination commenced on 16^{th} day of sowing with germination percentages recorded at the end of the test as 67% and 71% respectively.

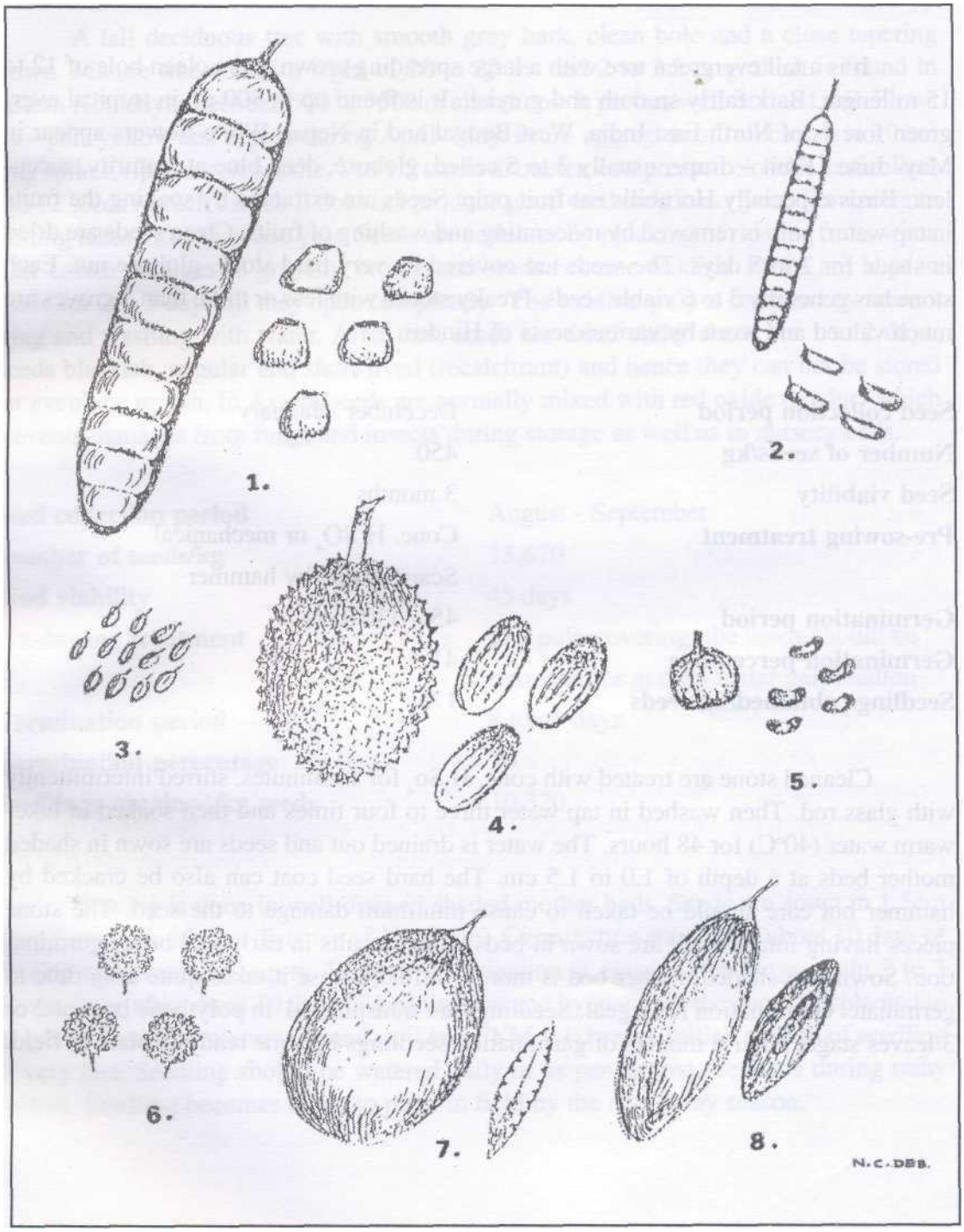
Elaeocarpus floribundus (Jalpai)

It is an evergreen moderate sized tree with spreading crown and clean bole of 12 to 16 m length. It occurs in evergreen forests of upper Assam, West Bengal and in Arunachal Pradesh up to 1500m elevation. The white flowers appear from the first week of July to the first week of August. Fruit- drupe, light green, 2 to 5 cm long and 1.5 to 2.5 cm in girth. Both ends of fruit are pointed, outer surface smooth having a mesocarp fleshy and pleasantly acidic, edible. Stone -3 celled, each having a spindle shaped seed. Despite hard seed-coat (stone),seeds are recalcitrant. It is often planted in home garden in North-East India for its fruits, which are used for pickle and also have medicinal value.

Seed collection period	December - January
Number of seeds/kg	490
Seed viability	75 days
Pre-sowing treatment	Acid treatment
Germination period	25 - 65 days.
Germination percentage	48
Seedlings obtained/kg seeds	230

Fresh Seeds are treated with conc. HCL for 10 minutes to scarify the seed coat, and washed 4 to 5 times with tap water. Then seeds are soaked in water for 24 hours. The pre-treated seeds are sown in shaded mother beds at a depth of 1.0 to 1.5 cm vertically. Germination is epigeal and starts after 25 days of sowing. Young seedlings are pricked after flooding of mother bed at 2-3 leaves stage and transplanted under shade in polybags. The polybags are kept under shade and watering is done as and when required. Initial growth of Seedlings is slow, which afterwards become normal. Seedlings become ready to plant in field after 6 months of germination or with the beginning of rainy season.

Fig.1



Elaeocarpus sphaericus = *E.ganitrus* (Rudraksha)

It is a tall evergreen tree with a large spreading crown and a clean bole of 12 to 15 m length. Bark fairly smooth and greyish. It is found up to 800 m in tropical evergreen forests of North East India, West Bengal and in Nepal. White flowers appear in May- June. Fruit - drupe, usually 3 to 5 celled, globose, deep blue at maturity, succulent. Birds especially Hornbills eat fruit pulp. Seeds are extracted by soaking the fruits in tap water, pulp is removed by macerating and washing of fruits. Clean seeds are dried in shade for 2 to 5 days. The seeds are covered by very hard stone, globose nut. Each stone has generally 3 to 6 viable seeds. Freaky stones with less or more than 5 groves are much valued and worn by various sects of Hindus.

Seed collection period		December - January
Number of seeds/kg		450
Seed viability		3 months
Pre-sowing treatment	Conc.	H_2SO_4 or mechanical Scarification by hammer
Germination period		45-330 days.
Germination percentage		**41**
Seedlings obtained/kg seeds		175

Cleaned stone are treated with conc. H_2So_4 for 15 minutes, stirred intermittently with glass rod. Then washed in tap water three to four times and then soaked in lukewarm water (40°C) for 48 hours. The water is drained out and seeds are sown in shaded mother beds at a depth of 1.0 to 1.5 cm. The hard seed coat can also be cracked by hammer but care should be taken to cause minimum damage to the seed. The stone pieces having intact seeds are sown in beds which results in early and better germination. Sowing in shaded mother bed is more fruitful because it takes quite long time to germinate. Germination is epigeal. Seedlings are transplanted in polythene bags at 2 or 3 leaves stage. After 8 months of germination seedlings become ready to plant in field.

Michelia kisopa (Chobsi)

A tall deciduous tree with smooth grey bark, clean bole and a close tapering crown. Mature tree attains a hight of 20 to 25 m and 2 to 2.5 m girth. It is found in eastern Himalayas between 500 to 1500 m elevations. It prefers well-drained soil. Flowers - pale yellow and appear during April- May. Fruit- aggregate of follicles, 5 to 10 cm long spikes, ripe carpels sessile, 1 to 1.5 cm in diameter, compressed closely, lenticelled, 2 to 12 seeds in each carpel. It does not produce good seed crop every year. Flowering to fruiting takes more than one year. Seeds are collected by plucking of ripened fruits when their colour changes to greyish- brown and seeds become reddish. Fruits are kept in shade for 2 to 3 days till they open completely. The reddish pulp is removed by macerating and washing with water. After that, seeds are dried under shade for 1 to 2 days. Seeds blackish, angular and short lived (recalcitrant) and hence they can not be stored for even one month. In Assam seeds are normally mixed with red oxide (sindur) which prevents damages from fungi and insects during storage as well as in nursery beds.

Seed collection period	August - September
Number of seeds/kg	13,670
Seed viability	45 days
Pre-sowing treatment	The pulp covering the seeds should be removed for getting better germination
Germination period	8 to 45 days
Germination percentage	76
Seedlings obtained/kg seeds	10,320

Sowing is done in well-drained shaded mother beds. Seeds are sown in 1.5cm deep furrows made at a distance of 10-12 cm. Germination starts after about 10 days of sowing and continues up to 45 days. Germination is epigeal. Seedlings attain 2 to 3 leaves stage after about 10 days of germination and by that time they are transplanted in polybags having a mixture of sand, soil and FYM 1:1:1 ratio. Initial growth of seedling is very fast. Seedling should be watered daily or as per the requirements during rainy season. Seedling becomes ready to plant in field by the next rainy season.

Mimusops elengi (Bokul)

A moderate sized evergreen tree with a close tapering crown and a height of 12 - 15 m. It is found in tropical evergreen forest and cultivated in Arunachal Pradesh. Timber is used for house building, bridge construction, carts, shafts, axles, naves of wheels, boats, cabinet works and walking sticks. It is one of the best trees for avenue plantation. Fruits-berry, ovoid, smooth, fleshy 2.5 to 3.8 X 1.3 to 1.7 cm, young fruits hairy, yellowish when ripe. Seed is solitary, 1.5 to 2.3 X 1.0 to 1.3 cm, blackish or brownish. Fruits are collected by plucking from branchlets. Seeds are extracted by maceration of fruit pulp and washing with water. Seeds are short lived and cannot be stored for long period.

Seed collection period	February - March
Number of seeds/kg	3950
Seed viability	3 months
Pre-sowing treatment	luke warm water
Germination period	12 to 50 days.
Germination percentage	68
Seedlings obtained/kg seeds	2,690

Before sowing seeds are soaked in luke-warm water for 24 hours, after that water is drained out. Pre-treatment of seeds in 0.5 to 1.0% solution of thio-urea significantly improved the total germination to 77 and 72%, respectively. Treated seeds start germination from 9th day. Seeds are sown in shaded mother beds at a depth of 0.5 to 1.0 cm covering of beds with dry straw maintained the moisture and enhanced the germination. Germination starts after 12 to 15 days of sowing and seedlings are transplanted in polythene bags after one month of germination. The growth of seedlings at initial stage is slow and it takes about one and half year to become ready for field plantation.

Phoebe cooperiana (Mekahi)

It is a tall tree with a compact crown and a clean bole of 15 to 18 m length. It is found in tropical forests up to an elevation of 600 m. Bark is greyish, reticulately furrowed, splitting in flakes. It is known for its quality timber and ripened fruits which are eaten by local people in Assam and Arunachal Pradesh. Now a days it is rarely seen in forests because of its selective felling for the valuable timber mainly by plywood industries. Fruit - berry, 2 to 3.5 cm long, ellipsoid mesocarp is aromatic. The ripened fruits are collected by lopping of branches. Fleshy mesocarp of ripened fruits is removed by macerating and washing of stone in tap water. Then seeds are dried under light shade for 2-3 days. The fruits are eaten by the birds and wild animals. Seeds are recalcitrant, therefore, they can not be stored for long period.

Seed collection period	September - October
Number of seeds/kg	155
Seed viability	65 days
Pre-sowing treatment	Removal of mesocarp is essential before the sowing of seeds. Then over night soaking in tap water to enhance the germination
Germination period	25 to 65 days
Germination percentage	57
Seedlings obtained/kg seeds	74

In an experiment conducted at S.F.R.I, the clean seeds were treated with 0.5% and 1.0 % solution of KNO_3 for 24 hours. The solution was drained out, seeds washed three to four times with tap water and then dried $^1/_2$ hrs under light shade. Treated seeds were sown in sand trays and kept in seed germinator at 27 °C . Germination started after 22 days of sowing. It was 59.5% and 68% in 0.5 and 1.0 % KNO_3 treatment respectively.

In another treatment, seeds were soaked in tap water for 12 hrs, drained out and dried for two hours under light shade. These seeds were sown directly in polythene bags by keeping the pointed end of seed upward. Germination was hypogeal, starting after about 25 days of sowing and continued for two months or so. The seedlings are ready for plantation by the next rainy season. It coppices and pollards well. Initial growth is very fast which slows down gradually.

Sapindus emarginatus (Ritha / Manisal)

A medium - sized to large deciduous tree with a globose crown and fine leathery foliage, usually reaching a height of 12-20 m and a girth of 1.8 m. It is native of China, Japan and cultivated throughout North India (up to 1500m) and in Assam (indigenous). The fruits are used as shampoo and also have medicinal properties. Fruits - drupe, globose fleshy, one seeded, 1.8 -2.0 cm across and 0.8 to 1.2 cm in diameter, black and loose in dry fruit. Ripened fruits are collected from the forest floor / ground under the tree, and dried in shade for 3 to 4 days. Gentle cracking of pericarp releases the seeds. Seeds are very hard, orthodox and hence they can be stored for about one year or more. It is cultivated in the home steads in North-East India for fruit pulp which is used as soap to wash hair and valuable cloths. Leaves are fed to the cattle.

Seed collection period	November - December
Number of seeds/kg	470
Seed viability	12 months
Pre-sowing treatment	Scarification on top of seed near micropyle is required to enhance the germination.
Germination period	25 to 45 days.
Germination percentage	74
Seedlings obtained/kg seeds	345

Owing to the hard seed coat, germination is very slow. Hence scarified seeds are sown in proper shaded mother beds at a depth of 1.2 to 1.5 cm vertically by keeping micropyle end upward. Germination is epigeal. It starts after 25 days of sowing and continues up to 45 days. Seedlings become ready for transplanting in polythene bags after one month of germination. One-year old seedlings attain a height of 30 - 40 cm which are suitable for plantations.

An experiment was conducted to enhance the germination in which following treatments were given. The details are given below:

Treatments	Germination period (in days)	Germination percent
Tl - Scarified the micropyle end on cement floor / sand paper until the surface become flat	20	86
T2 - Scarified the Micropyle end with sand paper and then soaked in water for 24 hrs. Drain the water and dried in shade for two hours.	16	93
T3 - Seeds were treated with 50% H_2SO_4 for 5 min then washed 3 to 4 times with tap water	22	79

Schima wallichii (Makari-sal)

A large handsome, evergreen tree with close tapering crown, attaing a height of 24-30 m and a girth of 3 m or more. It is found from Nepal, eastwards through Sikkim, Bhutan, West Bengal to Assam, Arunachal Pradesh, Nagaland, and Manipur. It is also found in Meghalaya and in dry deciduous forests of upper Assam. It is common in foothills up to an elevation of 1500 m mixed with *Shorea robusta* and other miscellaneous species. It has a great demand as a plywood timber. It is evergreen, though sometimes shedding its leaves and becoming almost leafless by the end of March. It flowers in April - May, (flower- similar to tea plant) and fruits in February-March. In Assam, the flowering and fruiting takes place one or two month later. Fruits - capsule, five celled, 1.3 to 1.8 cm in diameter, supported by the persistent calyx at maturity. Each fruit has 2 to 6 seeds in each cell, flat, pale greyish - brown, surrounded by a papery wing. Fruits are collected by lopping the branches before they open, dried in sunlight, and seeds are released by gentle thrashing of dried fruits. Seeds are recalcitrant and can be stored in airtight containers for 4 months. Good seed years appears to be common.

Seed collection period	February - March
Number of seeds/kg	2,00,000
Seed viability	4 months
Pre-sowing treatment	Not Required.
Germination period	10 to 25 days
Germination percentage	**45**
Seedlings obtained/kg seeds	90,000

Seeds are sown in raised and shaded mother bed soon after the collection, either by broadcasting or in furrows at a depth of 0.4 to 0.6 cm. Germination is rather poor and starts after 10 days of sowing. Seedlings are pricked out at two leaf stage after about 30 days of germination when they attain 5 to 7.5 cm height for transplanting in polythene bags. The initial growth is slow. Transplanted seedlings are kept in shaded bed. The species is best raised by planting out seedlings in June-July when they are 10-15 cm height. Natural seedlings collected from the forests are equally successful. The tree is moderate light demanded It coppices well. Direct sowing in forest generally result in failure.

Spondias pinnata (Amra)

A moderate sized to large deciduous tree with a pleasant aromatic smell. It attains a height of 15 to 30 m and a girth of around 1.2 to 3.0 m with spherical crown. It is widely distributed throughout the country in the tropical wet evergreen and tropical dry deciduous forests. The species occurs up to 3000 feet elevation. The leafless trees are distinctly visible during March - May when inflorescences of whitish flowers cover the trees. Fruits - drupe, 3 to 5 cm long, ovoid or oblong, greenish- yellow when ripe, pulp soft. The stone is semi-woody, fibrous outside and pitted with cavity. Each stone has 2 to 5 seeds but only one is perfect. Completely ripened fruits are collected by lopping the small branches. Fruits are heaped for 2 to 5 days to allow the pulp to rot. Then macerated the pulp and washing under the tap water to clean the stones. The seeds collected from such heap and the fruits discarded by deer after eating the pulp germinated well. Viability of seeds decrease by 50% after one year of storage. Fruits are eaten by the wild animals (monkey, pigs, deer etc.) and it has been noticed that the local people make a machan near the tree to hunt the animals which come to eat the fruits. In Assam, people plant it in their compound to get fruits as well as leaves for fodder. Leaves have aromatic smell, sour taste and eaten by the local people.

Seed collection period	December - January
Number of seeds/kg	**260**
Seed viability	3 months
Pre-sowing treatment	Clipping of seeds break the dormancy,enhance the germination and reduce the germination period
Germination period	20 to 60 days
Germination percentage	**40**
Seedlings obtained/kg seeds	105

Seeds are sown directly in polythene bags vertically by keeping micropyle end upward at a depth of 1.5 to 2.0 cm. Germination is hypogeal. It starts after about 20 days of sowing and continues for 60 days. One to three seedlings may emerge from the same stone. Seedlings become ready for plantation after one year of sowing. Stump planting has also been reported equally successful as seedlings planting in field.

However, sowing in mother beds is advantageous because the process of germination of seedlings and maintenance of seedlings up to transplanting stage can be easily and effectively cared. Labour and wastage of polythene bags can be saved in case of poor germination direct sowing of seeds in field gives better result than planting out seedlings or stumps.

Fig.2

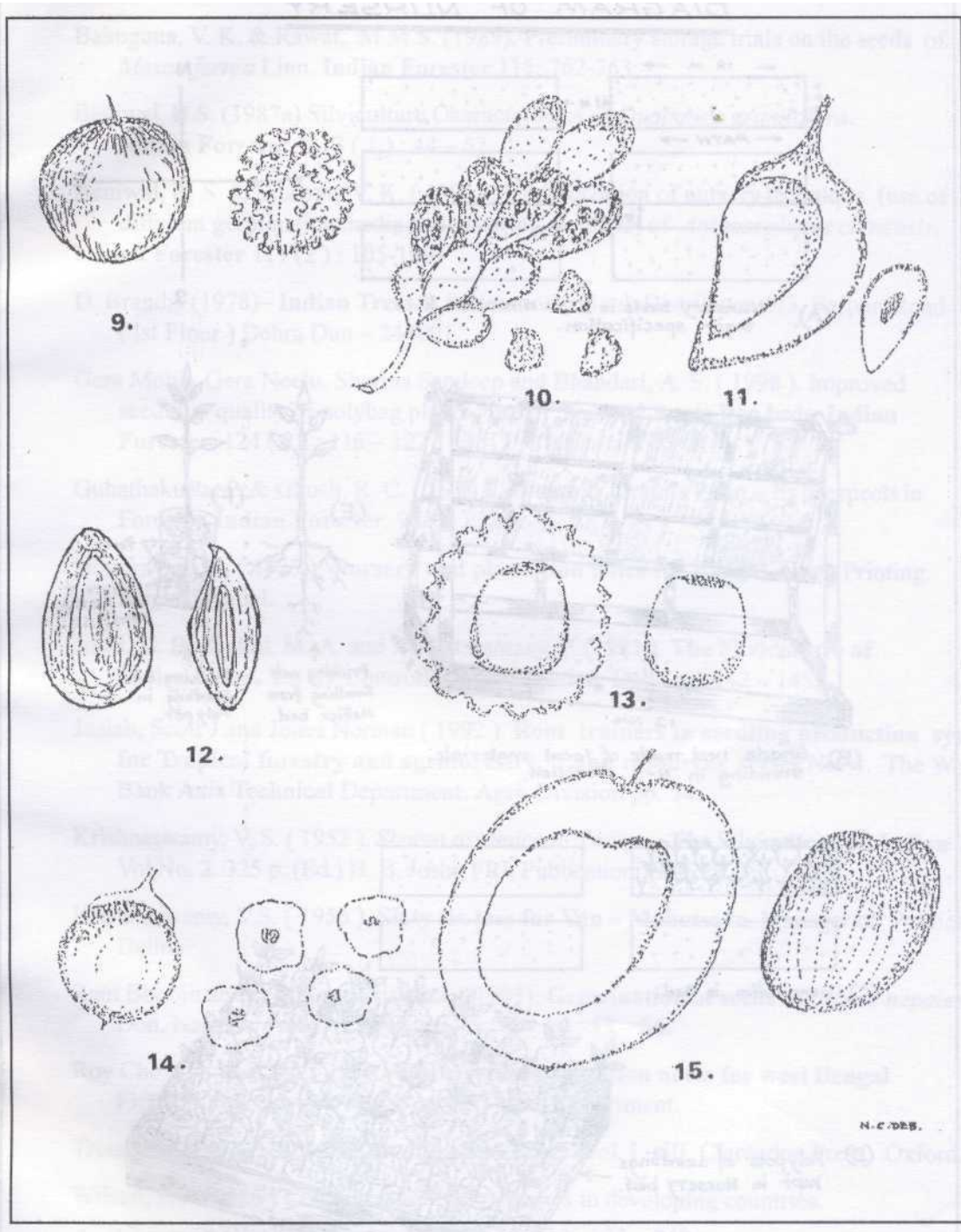
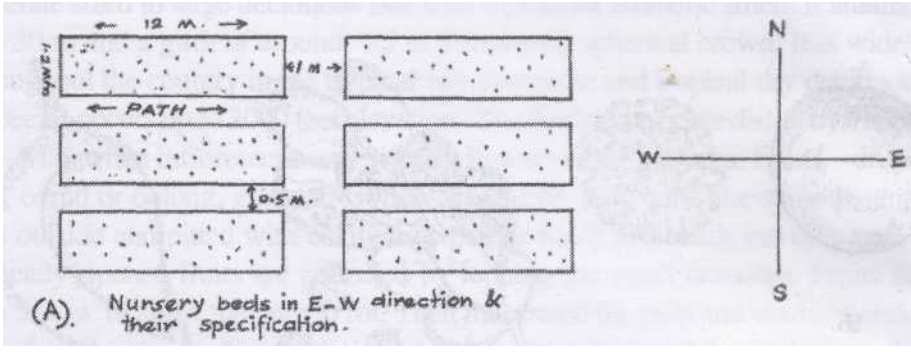
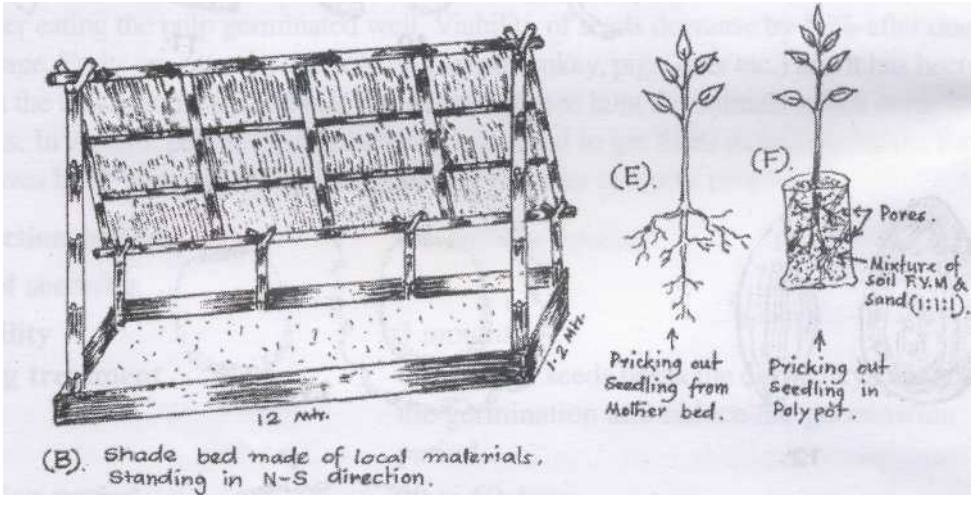


Fig.3

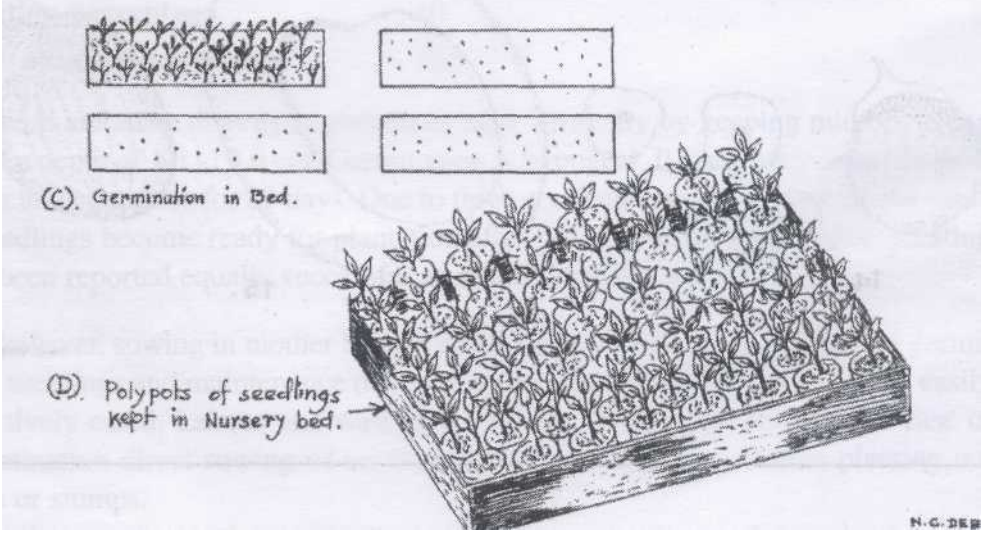
DIAGRAM *OF NURSERY*



(A). Nursery beds in E-W direction & their specification.



(B). Shade bed made of local materials, Standing in N-S direction.



Further Reading :

Bahuguna, V. K. & Rawat, M.M.S. (1989). Preliminary storage trials on the seeds of *Mesuaferrea* Linn. Indian Forester 115: 762-763

Beniwal, B.S. (1987a) Silviculture Characteristics of *Duabanga grandiflora.* • Indian Forester. 113 (1): 44 - 52

Beniwal, B. S. & Dhawan, V. K. (1991) Standardization of nursery technique (use of different germination media and watering methods) of *Anthocephalus chinensis.* Indian Forester 117 (2): 105-109.

D. Brandis (1978)- Indian Trees - International Book Distributor, 9/3, Rajpur Road (1st Floor) Dehra Dun - 248001.

Gera Mohit, Gera Neelu, Sharma Sandeep and Bhandari, A. S. (1998). Improved seedling quality of polybag plants : use of mounted Angle Iron beds. **Indian** Forester. 124(2): 116-122.

Guhathakurta, P. & Ghosh, R. C. (1972). *Ailanthus grandis* Prain - Its prospects in Forestry. Indian Forester. 98 (5): 261 - 270.

Homfray, C. K. (1937). Nursery and plantation notes for Bangal. Govt Printing, Alipur, Bengal.

Joshi, H. B, Rashid, M. A. and Venkataramany, P. (1981). The **Silviculture of** Indian Trees. Vol III. Controller of Publication. Delhi pp. 142 - 145.

Josiah, Scott J and Jones Norman (1992). Root trainers in seedling **production systems** for Tropical forestry and agroforestry. Land resources series No. 4. The World Bank Asia Technical Department. Agri. Division pp. 54.

Krishnaswamy, V. S. (1952). *Shorea assamica* in Troups - The **Silviculture of Indian Trees.** Vol No. 2. 325 p. (Ed.) H. B. Joshi, FRI, Publication 1980.

Krishnaswamy, V.S. (1956). Sixty six tees for Van - Mahotsava. Manager of Publication Delhi.

Ram Bhoojh and P. S. Ramakrishnan, (1981). Germination of seeds **of** *Alnus nepalensis* Don. National Acad. Sci. Letters, Vol. 4 (2): 53 - 56.

Roy Chowdhury, K. C. (1960) Nursery and plantation notes **for** west **Bengal.** Fifth Edition Govt of West Bengal, Forest Department.

Troup, R.S. (1921). Silviculture of indian Trees. Vol. I - III. Clarendon Press, Oxford.

Wilson, P. J. (1986) Containers for tree nurseries in developing countries. Common Wealth Forestry Review. 65 (3): **233 - 240.**

Michelia kisopa seedlings in open nursery bed

Adenanthera pavonina seedlings in nursery open bed

Experiment on nursery containers Bel:-
(*Aegle marmelos*) seedlings transplanted in root trainers

Seedlings transplanted in polypots from mother-beds and kept in shade bed in Forest nursery

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