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RESEARCH ARTICLE

DEVELOPMENT OF BREEDING POPULATIONS IN *MELIA* AND *EUCALYPTUS* THROUGH GRAFTING

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Abstract: Grafting for several species of genus melia and eucalyptus are carried out to produce new varieties through interspecific hybridization. Grafting is a horticultural technique whereby tissues of plants are joined so as to continue their growth together. The upper part of the combined plant is called the scion, while the lower part is called the rootstock. The success of this joining requires that the vascular tissues grow together. The study successfully established controlled clones deploying *Melia dubia, Melia composita and Melia azedarach*, these are established in the form of clone based breeding populations to develop hybrids with specific industrial utility similarly clonal plants were also established in eucalyptus deploying superior clones namely EH 02, EH05, and DF 97 which act as a breeding population to develop superior hybrids both for productivity and root quality. From this study, we observed that *Melia dubia* subjected to 47.16% mortality and *Melia azedarach* showed good survival with only 20% mortality. *Melia composita* showed very poor result with 88% mortality. Among the genus Eucalyptus, EH O2 showed very poor results with 95% mortality. EH 05 was successful with 53.3% mortality and DF 97 showed 40% mortality. The success rate of *Melia dubia* was 52.84% and *Melia azedarach* was the highest with 80%. *Meliacomposita* was very poor in survival with only 12% survival rate due to compatibility issues. EH 02 had problems in survival and showed only 5% survival. EH 05 showed convincing performance with 46.7% survival. DF 97 also showed good performance with 60% survival rate. The study is to mainly fulfill the objective of developing breeding populations in melia and eucalyptus to produce new varieties through grafting. Interspecific hybridization is the tool used to develop varieties which can meet up the current trends in demand and also improves the tree in terms of industrial utility.

Keywords: Melia, Eucalyptus, Grafting, Root stock, Scion

INTRODUCTION

In India, forests are shrinking under acute socio economie pressure. India's forests till recently are being dreaded at an alarming rate of 1.5 million hectare per year and has fortunately come down with the enactment of the Forest Conservation Act, 1980. The less forest area coupled with the low productivity of Indian forest has ushered in a total mismatch between the demand and supply of both domestic and industrial wood requirement besides creating environmental disequilibrium and destability (Parthiban, 2011).However, considering the acute shortage of suitable raw material, the industries have to establish plantation of suitable species with tree improvement programme to achieve maximum yield within a short rotation period.

The use of fast growing, elite trees enable early harvest and so it helps to improve yield. *Melia dubia* is one such fast growing tree species. However, wood property data is not available. Wood property profile is helpful for the identification of this species and rational utilization of wood. This is of great importance in the case of indigenous forestry and the information in this aspect with respect to this species is entirely lacking. Recently this species has become popular among both public and private-sector planters. An understanding of the wood properties and their variation with age provides a basis for assessing opportunities for value-added uses. However such information are not available in this species and there is no planned research attempt to characterize wood properties which demands intensive investigation. *Melia dubia* is an indigenous species to India, South East Asia and Australia. It is also called as Mahaneem or Forest neem or Malabar neem. Malabar neem is a fast-growing tree species naturally distributed in dry and moist deciduous forests of western ghats. The species has been naturally dispersed and is found sporadically distributed across farmlands in the hilly regions of Tamil Nadu and Karnataka and exhibits wider genetic variability. It is a large, deciduous tree with wide-spreading branches on a stout, straight and a clean bole. The tree grows to an average height of 35m. The bark of the tree exhibits wide variation

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ranging from rough to smooth. The tree finds wide range of multiple utility both for domestic and industrial purposes as a source of timber, firewood, fodder etc.

Melia azedarach is a deciduous tree upto 45 m tall; bole fluted below when old, upto 30- 60 cm (max. 120) in diameter, with a spreading crown and sparsely branched limbs. The generic name is derived from the Greek name/term 'melia' (the ash); the specific name comes from the Persian 'azzadirackt' (noble tree). *Melia composita*, a versatile tree with wide acceptability is commonly known as Burma dek in north Indian States, is a fast-growing tree occurring in tropical and subtropical forests/plantations and commercially valued for its multifarious uses. It is also regarded a native species due to its distribution in forests of Uttrakhand. Burma dek is a multipurpose tree and highly valuable for agroforestry/social forestry/urban forestry plantations. Historically, it is projected that the tree was introduced in YS. Parmar University of Horticulture and Forestry. NauniSolan (HP) in the seventies (an old phenotypically superior tree is still available near the old mist chamber on the way to Khalttoo) and thereafter a roadside plantation was established in Mohali by the Punjab State Forest Department.

Literature explains that *Melia composita* a synonym of *Melia dubia* but the characters of both the species explains them as two separate species. In north Indian states like Punjab, Haryana, J& K, Himachal Pradesh etc., the species has replaced *Melia azedarach and Melia compacta* from on- farm plantations. The species is capable of withstanding a wide range of climatic conditions and dek wood has dominated the furniture market of north Indian states. After poplar and eucalyptus, *Melia composita* is farmers' third choice for farm forestry plantations. As a result, plantations are progressively increasing over large areas in the northern states. However, fast growth, clear bole height, light wood, good pulping quality, ease of carpentry, etc. have generated interest among scientists, foresters and farmers and the species now finds its presence in many other states like Gujarat, Karnataka, Tamil Nadu, Madhya Pradesh, Rajasthan, Uttrakhand and Uttar Pradesh. Due to light colour, soft nature and ease of peeling, the species has become a potential alternate pulpwood species. It provides good shade during extreme summer months (May and June) and does not hinder sunlight during winter months.

Eucalyptus is among the most widely planted forest species in the world owing to its adaptability to a wide range of climatic and edaphic conditions and the utilization in the paper and pulp industry. The higher productivity the species generates in a short rotation of 6-7 years is the major driver in the utilization of species at the farming as well as commercial level in agroforestry. The genus Eucalyptus in this aspect is regarded as one best options among the fast growing tree species widely planted in the tropics mainly for grown for pulpwood and plywood and are utilized as the multi-purpose tree species especially in the agricultural and forestry industries (L. K. Behera, 2016). Trees like Eucalyptus can be harvested year-round and provide a living inventory of available biomass. Coming to the Indian context, mainly two species *Eucalyptus tereticornis* (red gum) and *Eucalyptus camuldulensis* (blue gum) have been planted extensively, owing to its fast growth, suitability to all types of soils, adoptability to varying climatic conditions and tolerance to water logging, salinity and sodicity (Singh *et al*., 2014) and for their economic, ecological values and high survival traits (Joshi *et al*., 2013). Eucalyptus can grow up to the soil pHof 11.0, 9.2 and 8.8 in sandy soil, clay and loamy soils respectively (Gupta *et al*., 1990). Eucalyptus is also being planted in farmlands because of its short rotation period and good economic benefits. Eucalyptus reported for utilization and and medicinal uses in Uttar Pradesh (Tomar 2015). In Indian conditions, the productivity ranged from 6 to 10 m3/ha/yr in seed route plantations (Lal, 1993) to 20 to 23 m3/ha/yr in rainfed conditions and 50 m3/ha/yr in clonal based managed farm plantations (Lal, 2001; Kulkarni, 2002), sometimes, it reached to 100 t/ha in pulp wood plantation (Kulkarni, 2002).

Hence Forest College and Research Institute (FC&RI) initiated an interspecific hybridization program in genus melia and eucalyptus to produce superior hybrids for meeting the global demand. Breeding populationsare produced through controlled cloning process called grafting. Under the genus melia, grafting is carried out in *Melia dubia, Melia azedarach and Melia composita*. Under genus eucalyptus, superior clones like EH 02, EH 05 and DF 97 are grafted. The grafted plants are utilized for interspecific hybridization as grafting induces early flowering. Grafting is a horticultural technique whereby tissues of plants are joined so as to continue their growth together. The upper part of the combined plant is called the scion, while the lower part is called the rootstock. The success of this joining requires that the vascular tissues grow together. For successful grafting to take place, the vascular cambium tissues of the stock and scion plants must be placed in contact with each other. Both tissues must be kept alive until the graft has "taken", usually a period of a few weeks. The scion becomes the new shoot system and the rootstock (under stock, stock) forms the root system of the grafted plant. Scions are selected based on yield related traits and are generally grafted over specific rootstocks having the ability to survive the biotic and abiotic components of the environment.

MATERIALS AND METHODS

The study is carried out in Forest College and Research Institute in 2023,which lies in altitude of 320 metres. The rainfall of this area is upto 922 mm annually. The minimum temperature is 38.2 degree celcius and the minimum temperature is 23 degree celcius. This institute comes under the agroclimatic zone of western zone of Tamil Nadu, the ultimate aim of this study is to produce interspecific hybrids with the available resources through grafting.

Five histological stages are reported to come about during graft union formation in rootstock scion combinations:

1. Formation and orientation of necrotic layers,
2. Callus cell proliferation,
3. Formation of callus bridge at the graft interface,
4. Vascular cambium formation and
5. Vascular tissue reconstruction between the stock and scion

The materials used and methods followed in the experiments concerned with the study are furnished below,

Experimental materials

- **Knife**

A good-quality carbon-steel knife, able to hold a sharp edge, is the key to grafting success. Although special grafting and budding knives are desirable, you can use almost any good pocketknife. Keep material to sharpen the knife handy.

- **Grafting-wax**

After the graft is made, some covering must be used to keep it from drying out. Either hand wax or brush wax may be used. A hand wax is most commonly used for home grafting. It is softened by the heat of the hand and can be easily applied. Heated waxes may be brushed on, but make sure the wax is not too hot. Heat could damage the tender cambial tissue.

- **Grafting-tape**

This is a special tape with a cloth backing that decomposes before girdling the plant can occur. Tapes may be used for binding grafts where there is not enough natural pressure. Electrical and masking tapes are also used. Masking tape is suitable where little pressure is required, as in the whip graft.

- **Pruning shears**

This is also called hand pruners (in American English), or secateurs (in British English), are a type of scissors used for plants. They are strong enough to prune hard branches of trees and shrubs, sometimes up to two centimetres thick.

- **Cutting tools**:

It is a good procedure to keep the cutting tool sharp to minimize tissue damage and clean from dirt and other substances to avoid the spread of disease. A good knife for general grafting should have a blade and handle length of about 3 inches and 4 inches respectively. Specialized knives for grafting include bud-grafting knives, surgical knives, and pruning knives. Cleavers, chisels, and saws are utilized when the stock is too large to be cut otherwise.

- **Tying and support materials**:

Adds support and pressure to the grafting site to hold the stock and scion together before the tissues join, which is especially important in herbaceous grafting. The employed material is often dampened before use to help protect the site from desiccation. Support equipment includes strips made from various substances, twine, nails, and splints

- **Telescopic pruner**

It is a gardening tool that literally extends the capabilities of pruning tools, both manual and motorised with the help of extensible pole. Branches at different heights can be cut
using the saw edge and also with the help of extendable poles

METHODOLOGY

Wedge grafting is the method throughout this project for both melia and eucalyptus. **Wedge graftinng** is a popular method which simple and requires less skill but can give adequate results. This technique was used for both genus melia and eucalyptus throughout the experiment. This method is widely used for tree species which is efficient and also no complications are seen.

Wedge grafting technique

Grafting branches provides a way to produce a tree or other plant that has exactly the look that you want. Wedge grafting, also known as cleft grafting, is a method of propagating new limbs on plants such as fruit trees or bushes by removing a healthy branch, known as a scion, and physically connecting it to the stock of another tree at the desired location. Wedge grafting can result in a custom tree that produces different colors, corrects deformities or changes the general appearance of the plant.A sharp, heavy, short bladed knife is used for making a V-wedge in the side of the stub or stock about 5cm long. Two cuts are made, coming together at bottom and as for apart at the top as the width of the scion.

These cuts extend about 2 cm deep into the side of the stub. The base of the scion is trimmed to a wedge shape exactly the same size and shape as the opening. With the two vascular cambium layers matching the scion is tapped downward firmly into place and slanting outward slightly at the top so that the vascular cambium layers cross.

After all scions are firmly tapped into place, all cut surfaces including the tips of the scion, should be waxed thoroughly. It is called raw-kerf because the cuts in the side of the rootstock can be made with a saw rather than the sharp knife.

Stages in wedge grafting

- Selection, cutting and preparation of the scion and rootstock and wedge-shaped cut at the base of the scion so that it can be fixed in the rootstock;
- Open slit in the rootstock for grafting;

- The scion with the wedge-shaped cut at the base is introduced into the open slit;
- Wrapping with plastic tape for union between scion and rootstock;
- The scion is covered with a transparent plastic bag to form a humid chamber and avoid dryness and
- Grafted plant ready for planting

Procedure involved in grafting

1. Selecting a Scion

Scions are the branches of healthy plants that will be grafted onto the host stock. It's important to select scions that are only from healthy, thriving plants that show no signs of disease. Grafting a diseased scion may result in the disease being transmitted to the host plant. You do not need to purchase special equipment for a successful wedge graft, but it is important that whatever knife or pruning sheers you use to cut your scion are very sharp. A smooth, clean cut is needed for best results.

2. Preparation of rootstocks

The rootstocks are developed in suitable medias and containers, they are cut perpendicular to the axis of the stem. The root stock and the scion should have same thickness. After cutting the rootstock the scion is ready to be inserted to make a graft union. A cleft is made upto 1 to 2 inches in the rootstock were the scion is going to be inserted

3. Collecting the scion

The scion is collected after selecting ideal flowering trees around the campus and the branches with young shoots are cut down with the help of telescopic pruner to prepare the scion materials for grafting the scion should be young and equal thickness of the root stock. The ideal thickness of the scion is 20 to 25 mm and the rootstock should have equal thickness in wedge grafting technique

4. Preparing the scion

The goal is to create a wedge that will fit into a horizontal cut on the host stock. The base of each scion and the rootstock should have equal diameter and a cleft upto 2 to 3 cm long is made in the rootstock were the scion is to be inserted and be about 10 to 15 cm long with at least three buds per scion.

5. Grafting the Scion

Physically connect the scion with the host stock. The stock should be cut horizontally and cleanly. Use a long, sharp knife to make a wedge-shaped cut down the center of the stock, leaving about a 1-inch V-shaped cut in the wood. Insert a clefting tool and gently pull back to separate the wedge. Place the pointed tip of each scion into the horizontal incision. Align the scion so that the bark of the scion matches the bark of the host stock. This will align the cambium of the scion, which is critical to a successful graft. Pour grafting wax or grafting paint over the entire exposed area of the graft. After about three months of growth, remove the scion that appears to have grown the least. This will give the most successful scion the best chance at growing.

6. Tieing up the grafts

The scion is inserted into the rootstock and they are tied together with a poly tape with limited pressure to secure the grafting site to prevent drying and entry of water.

7. Placing in poly-tunnel

After completing the steps in grafting the grafted individuals are kept under controlled conditions pf temperature and humidity in poly-tunnel with 30 to 35 degree celcius and 50 to 65 % humidity. Polytunnel provides ideal conditions for the grafts to produce new shoots faster and also prevents the grafts from pests.

8. Maintenance of the grafted plants

The grafted plants are watered immediately after placing into the polytunnel and left for a while. The individuals are watered once in 4 days in initial stages and once in a week after initiation of new leaves. The new shoots emerging from the rootstock should be trimmed regularly for proper survival of the scion.

9. Hardening

The process of hardening the grafted plants starts after 25 days inside the polytunnel, the individuals are taken out for hardening and kept in partial shade with controlled irrigation. After 2 weeks in partial shade they are subjected to direct sunlight to make them ideal for field planting.

RESULTS AND DISCUSSION

Root stock and Scion collection for Melia species

The scion species for grafting Melia species includes,*Melia dubia*, *Melia composita* and *Melia azedarach*. The rootstocks for grafting Melia species were *Azadirachta indica*(Neem). The root stock Neem developed in a polybag filled with soil, FYM, and sand, the seedlings are allowed to obtain ideal growth with proper care and management for upto 8 months.The scion materials for *Melia dubia* was collected from the agroforestry field and the scion for *Melia composita* was collected from multifunctional agroforestry field (Plate 1). The scion materials for *Melia composita* was very limited in the campus and also in the adjoining areas. The scion materials for *Melia azedarach* was found after a survey around mettupalayam taluk. The scion materials are collected from only flowering trees which can induce early flowering of offsprings (Table 1).

Melia dubia subjected to 47% mortality and *Melia azedarach* showed good survival with only 20% mortality. *Melia composita* showed very poor result with 88% mortality (Table 2). The success rate of *Melia dubia* was 52.84% and *Melia azedarach* was the highest with 80%. *Meliacomposita* was very poor in survival with only 12% survival rate due to compatibility issues (Table 3). The success rate of grafting for the study was varying due to various

reasons factors. The highest survival is seen in *Melia azedarach* with 80 % survival. *Melia dubia* also showed good survival and quick growth is observed. *Melia composita* showed very poor results due to imcompatibility issues. No proper source for *Melia composita* is found inside and outside the campus. The shoots of *Melia composita* are over matured which caused the failure of graft union, we have also tried to produce young shoots by pruning additional branches but the idea did not work for the limited time available. The scion source for *Melia azedarach* with flowering was found after a complete survey in mettupalayam. *Melia azedarach* scion are ideally young and hence showed very good results. All the individuals in genus Melia showed up new leaves in 6 to 9 days after grafting in controlled conditions. The grafted plants are taken out from the poly tunnel after 25 days and kept in partial shade for about 2 weeks. They are subjected to hardening in direct sunlight for upto 25 days which makes them ideal for planting.

Root stock and Scion collection for Eucalyptus species

The root stocks for *Eucalyptus alba*and EH02 was developed from clonal propagations nursery with controlled cloning processes. The above mentioned rootstocks are developed and utilized for the study to produce breeding populations through grafting technology. The scion of EHO2, EHO5 and DF 09 were collected from water use efficiency field inside the campus of Forest College and Research Institute (Table 1). Among the genus Eucalyptus, EH O2 showed very poor results with 95% mortality. EH 05 was successful with 53% mortality and DF 97 showed 40% mortality (Table 4). EH 02 had problems in survival and showed only 5% survival. EH 05 showed convincing performance with 47% survival. DF 97 also showed good performance with 60% survival rate (Table 5).All the sources of genus eucalyptus are collected in and around the campus. They showed up new leaves after 15 to 20 days in fully controlled conditions. Amongst all, the success rate of EH 02 is very low due to failure in compatibility. The scion sources collected from the field are matured and did not allow the cambium to fuse. EH 05 showed good results after repeated attempts. DF 97 also showed good results. .

After hardening the grafted plants will be subjected to interspecific hybridization for tree improvement to produce superior hybrids in Melia and Eucalyptus.The study successfully established controlled clones deploying *Melia dubia, Melia composita and Melia azedarach*, these are established in the form of clone based breeding populations to develop hybrids with specific industrial utility similarly clonal plants were also established in eucalyptus deploying superior clones namely EH 02, EH05, and DF 97 which act as a breeding population to develop superior hybrids both for productivity and wood quality.

SUMMARY AND CONCLUSION

The study successfully established controlled clones deploying *Melia dubia, Melia composita and Melia azedarach*, these are established in the form of clone based breeding populations to develop hybrids with specific industrial utility similarly clonal plants were also established in eucalyptus deploying superior clones namely EH 02, EH05, and DF 97 which acts as breeding populations to develop superior hybrids both for productivity and wood quality.The study is to mainly fulfill the objective of developing breeding populations in melia and eucalyptus to produce new varieties through grafting. Interspecific hybridization is the tool used to develop varieties which can meet up the current trends in demand and also improves the tree in terms of industrial utility.

The success of grafting mainly depends upon the fusion of grafts and incompatibility issues. *Melia azaderach and Melia dubia* are very successful throughout the study and can be utilized for further processes to produce new varieties. EH 05 and DF 97 are successfuland they are the superior clones demanded highly by the wood based industries. Hence this study was successful and established breeding populations for tree improvement through interspecific hybridization. The new varieties are mainly focused in the areas to meet the demand of wood and increase the quality of wood for specific industrial utility.

Table 1. Combination of scion and rootstock in Melia and Eucalyptus species

S.no	Scion	Rootstock
1.	*Melia dubia*	*Azadirachta indica*
2.	*Melia azedarach*	*Azadirachta indica*
3.	*Melia composita*	*Azadirachta indica*
4.	EH 02	*Eucalyptus alba*
5.	EH 05	EH 02
6.	DF 97	EH 02

Table 2. Mortality rate in genus Melia species

S.no	Scion	Rootstock	Total No.grafted	Total dead	Mortality rate (%)
1.	*Melia dubia*	*Azadirachta indica*	53	25	47
2.	*Melia azedarach*	*Azadirachta indica*	15	3	20
3.	*Melia composita*	*Azadirachta indica*	25	22	88

Table 3. Success rate in genus Melia

S.No	Scion	Rootstock	Mortality rate (%)	Success rate (%)
1.	*Melia dubia*	*Azadirachta indica*	47.16	53
2.	*Melia azedarach*	*Azadirachta indica*	20.00	80
3.	*Melia composita*	*Azadirachta indica*	88.00	12

Table 4. Mortality rate in genus Eucalyptus

S. No	Scion	Rootstock	Total grafted	Total dead	Mortality rate (%)
1.	EH 02	E. alba	20	19	95
2.	EH 05	EH 02	15	8	53
3.	DF 97	EH 02	5	2	40

Table 5. Success rate in genus Eucalyptus

S.No	Scion	Rootstock	Mortality rate (%)	Success rate (%)
1.	EH 02	E. alba	95	5
2.	EH 05	EH 02	53	47
3.	DF 97	EH 02	40	60

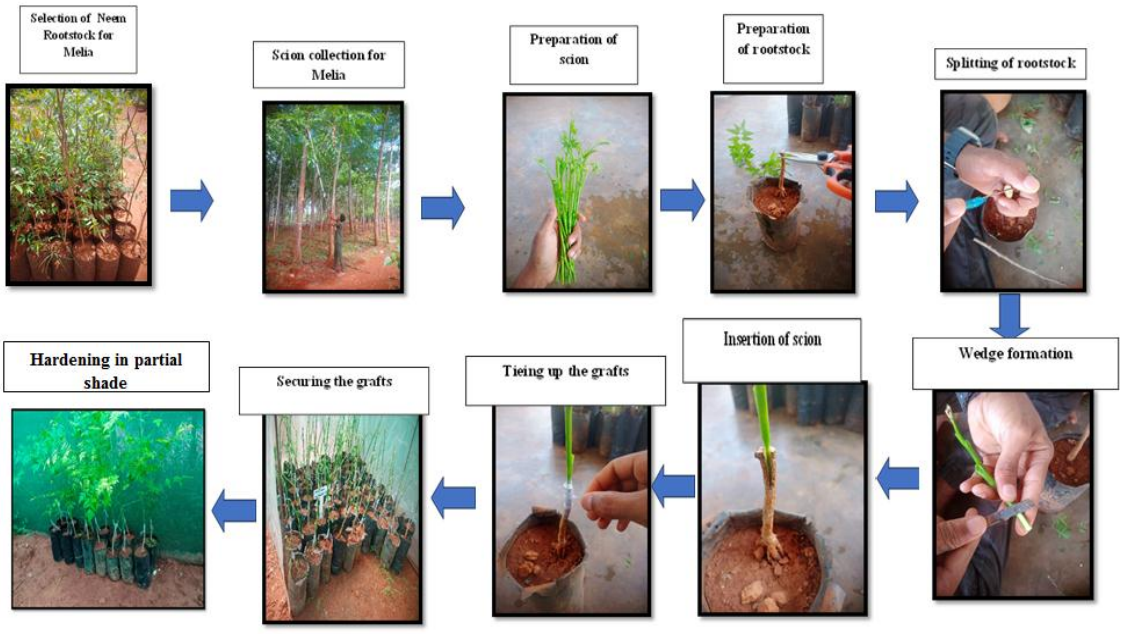

PLATE 1 : PROCEDURE INVOLVED IN GRAFTING

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