Vegetative Propagation of Acacia Hybrid - A User Friendly Technology

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ABSTRACT

To improve the productivity, foresters have faced many problems to establish; plantations of desired characteristics. Normally forest trees are raised through seed route origin seedlings, which have lot of variation because of cross-pollination. This variation is desirable from the point of view of the pest and disease resistance, but the variation results in lower yields. If selected phenotypes are multiplied asexually, the yields can be increased. If enough care is taken to widen the genetic base of plants raised through vegetative means, risk of pest and disease can be controlled simultaneously with increasing yields. Recently, vegetative cuttings have also been tried in the plantations of Eucalyptus and Acacia in several countries and increase in yield up to 100% have been obtained.

The various methods of vegetative propagation are adopted for different species; but prove to be costly because of investments in infrastructure and chemical etc.

The paper describes about the cost effective, user-friendly technology for vegetative propagation of Acacia hybrid, which will help the farmer in enhancing the yield when grown on their unproductive agricultural land. Farmers themselves can produce quality seedlings by using this method for further planting.

INTRODUCTION

To improve the yield, Foresters have faced many problems to establish forests of desired characters. It is difficult to have the desirable characters of parent trees in the progeny. Normally forest trees are planted through seed route origin seedlings. Most tree species are cross-pollinated. Seedlings, therefore, show variation in growth and other characters. This variation is desirable from the point of view of pest and disease resistance but the variation results in lower yields. If selected phenotypes could be multiplied asexually, the yields can go up. If enough care is taken to widen the genetic base of plants raised through vegetative means, risks of pests and diseases can be controlled simultaneously with increasing yields. Recently, vegetative cuttings have also been tried in plantations of Eucalyptus and Acacia in several

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countries and increase in yields up to 100% have been obtained in such cases of Eucalyptus in Brazil, Congo etc., due to superior and uniform cloning material. The method is generally called the clonal propagation. A clone is defined as "all plants (ramets) reproduced asexually from a common ancestor and having identical genotypes". Though any part of the tree can be used for cloning but desirable plants are obtained only from either the coppice shoots or one-year-old cuttings, which can be multiplied. Though the methods may need slight modifications from species to species but generally the method used for cloning Eucalyptus is also applicable to most tree species like Acacia and Casuarina.

There was no genetic improvement in the earlier days because to a large extent foresters depended on natural regeneration, which did not favour genetic improvement. The study of genetics brought about efforts to conduct provenance trials and selective breeding, so as to ensure that desirable trials of selected parents could be replicated in the progeny through seed. Even so, howsoever carefully this selection and cross fertilisation was carried out, aberrations could not be quite ruled out. Trees unlike agricultural crops, are difficult to improve genetically, because of their long generation time and the prevalence of out breeding. Although some genetic gains have been achieved by tree breeding including hybridisation, foresters have traditionally improved yield. Most of the forest tree species are out-breeders (naturally cross pollinated) with various degree of self-compatibility and so there is a large plant-to-plant variability noticed. In order to reduce this variability to a great extent and at the same time also ensure an increased productivity it is desirable to use the principles of genetics to produce improved planting stock.

Today, a number of techniques for vegetative propagation of tree species are being used, and still others being experimented with, ranging from such simple methods as planting simple branch cuttings to sophisticated techniques such as tissue culture in Acacia hybrid, Casuarina, Eucalyptus and Bamboo.

In tree improvement work we seek to recognise desirable individuals in nature, multiply them as such vegetatively, while at the same time attempts to combine useful trails of different individuals into a synthetic hybrid. In many case the resulting improved individual may further have to be clonally multiplied to preserve its complex genetic make-up. Even when a good genotype has been found which produces seed of dependable heritability, it may have to be clonally multiplied to have mass production of planting material.

VEGETATIVE PROPAGATION

Vegetative propagation serves as an important tool in tree improvement programme used for multiplying desirable trees without genetic segregation. Clonal option for species amenable to cost effective vegetative propagation, with due safeguards, offers fastest gains in the short run. Combination of cloning and long-term breeding strategies provides immediate benefits, requisite genetic diversity and rich long terms gains.

ADVANTAGES OF CLONAL OPTION

Clonal planting stock obtained through rooting of cuttings of tested outstanding clones offers substantial advantages compared to seed based plants, e.g., higher land productivity, faster growth rates, greater uniformity, better quality of timber and higher economic returns from plantations. It is possible to identify specific clone(s), most adapted to different site qualities, to make maximum advantage of positive genotype environment interaction and optimise silvicultural practices, including spacing weed control and fertiliser application. Clonal technology facilitates rapid selection of outstanding genotypes through field-testing of clonal stock of candidate plus trees and quick gainful exploitation of heterosis of desirable hybrids.

The following are the merits and demerits of seedling and clonal plantations.

Hepburn and Shim discovered Acacia hybrid in1972 (Pinso and Nasi 1991) in roadside stand in Sook, Sabah, Malaysia. Four years later, Tham (1976) documented that A. mangium and A. auriculiformis can cross-pollinate, resulting in a hybrid that grows much faster than the parent trees.

CHARACTERISTICS OF ACACIA HYBRID

General Features:

- Hybrid Acacia is a medium-size leguminous tree.

Phyllode

- In A. mangium, the phyllode is 6-8 cm wide and 12-25 cm long. The four leaf veins are easily observed.

SEEDLING PLANTATIONS (SP)		CLONAL PLANTATIONS (CP)	
ADVANTAGES/BENEFITS			
1	When seedlings are used, variations from plant to plant are a normal feature.	1	Uniform rate of growth, thereby higher yield per unit area and supply of uniform material.
2	Considered safer from the point of wide genetic base and hence less vulnerable to to pest and disease outbreaks.	2	Apart from improving quality of stand, avoiding the risk of collection of seeds, storage, viability of seeds.
3	Seedling plantations have inherent variability, especially in species where cross-pollination is a rule.	3	It also eliminates danger from cross-pollination and can play very useful role in regeneration of species, which are otherwise difficult to be raised by seeds.
		4	Ensures fast growth and a rapid multiplication of desirable phenotypes.
DISADVANTAGES			
1	The variability in a seedling plantation is a desirable character but it does not ensure high productivity.	1	It is very risky to propagate the planting material of a few clones from few trees.
		2	The clones should be prepared from trees, which are from different genetic origin. Wide genetic base must be maintained and the clones should be frequently changed.
		3	There is a rise of transmission of latent viruses or other diseases through vegetative propagation.
		4	Sophisticated clonal propagation facilities are expensive compared to seedling stock.

- In A. auriculiformis, the phyllode is 2.5-3.0 cm wide and 15-28 cm long. There are three veins, however, the vein next to the outer edge of the crescent is not easily observed.
- In hybrid Acacia, the phyllode is 4-6 cm wide and 15-20 cm long. The four veins are similar to those of A. mangium, with the exception that the vein on the outer edge of the crescent, as is also the case with A. auriculiformis, is not easily observed.

Inflorescence

- In A. mangium, flowers are creamy or whitish and arranged in a straight spike 10-12 cm long.
- In A. auriculiformis, flowers are greenish yellow to dark yellow and arranged in a bending spike 6-7 cm long.
- In Acacia hybrid, flowers are creamy to whitish and arranged in a straight or slightly bent 8-10 cm long spike.

Flowering

- In A. mangium, flowering peaks depend on the region. In peninsular Malaysia, for instance, flowering peaks in June-July,whereas in Thailand it peaks in September. In India it peaks in November.
- In A. hybrid and A. auriculiformis, there are two flowering peaks, one in July and the other in November.
- It has been observed that, if the parent species are growing close together, the overlapping flowering period may result in an open-pollinated hybrid.

Seeds

- Seeds of A. mangium are smaller and weigh less than seeds of A. auriculiformis.
- Seeds of Acacia hybrid are similar in appearance to those of A. auriculiformis with the exception that their funicles are not as dark and during development they are only partly attached to the seeds.

Acacia auriculiformis seeds - 40000 per kg.

Acacia mangium seeds - 90000 per kg.

Acacia hybrid seeds - 70000 per kg.

Bark

- When the hybrid Acacia tree is young, the bark is greenish white, similar to the bark of Acacia auriculiformis. It has no angles or ribs, as has the bark of Acacia mangium.
- when the hybrid Acacia tree is old, the bark turns brown or greenish brown. It is as smooth as the bark of Acacia auriculiformis.
- when Acacia mangium trees are old, the bark is scaly and has deep furrows.

Branching

- In Acacia mangium, the main Stem is straight with many branches remaining attached to it for several years.
- In Acacia auriculiformis, branching is generally heavy only when the tree reaches a height of 1-3 m, at which point it takes on a bushy appearance.
- The branching behaviour of Acacia hybrid is its major differentiating feature. The main stem, though not as straight as the main stem of Acacia mangium, is much straighter than the main stem of Acacia auriculiformis. It has many small and light branches that can be easily pruned and has got natural pruning capacity.

Coppicing

- Acacia mangium does not pollard well, especially if it is older than 4-5 years.
- Acacia auriculiformis has very poor pollarding ability.
- Acacia hybrid pollards well.

METHOD OF VEGETATIVE PROPAGATION

CREATION OF HYDRO PITS

Hydro pits are pits dug in compact soil, generally of standard size of 12 meters length, 1.3 meters breadth and 27 cm depth. The inner edge of the pit on all the side should be completely packed with bricks in vertical position at a single layer. The sand and pebbles layer has to be put at the bottom up to 7 cms thickness. The water will be filled in the pit up to 2-inch height or the water is filled in channels of 6-inch width and 9 inch depth on all four sides. There will be a controlled microenvironment within which water modified into moisture with manipulated light and temperature. These have to be kept under constant observation without any costly equipment the fog collected on the inner surface of the polythene sheet willreduce the temperature and drops formed due to condensation will fall on the leaf laminae and continues to keep the surface wet. By this method we allow the earth itself to form and function like uniform moisture releaser and moisture container, whenever covered by cheap protective material like polythene sheets, over arched steel rod ribs or bamboo ribs for laying polythene sheets to allow defused sunlight.

STERILISATION OF PITS

To make the bed free from fungus, it needs sterilisation. 250 cc of commercial formalin mixed with 4 litres of water has to be sprayed on the bed and left for 5-6 days. Then the bed can be charged.

PLANT MATERIAL

Superior high productive trees are selected in advance and market for felling. The height of the stump should be 1 meter from the ground. To minimise the risk of donor tree drying after felling partial felling is recommended letting stem and stump partially attached. The abundant coppicing shoots were found on the stump and on the stem. these shoots had a high rooting rate. After felling when the coppice proliferated the same may be excised from the stumps within a period of 30/50 days of growth. They must be tender or young plant stems without wood formation. The leaves may have light colouration and

glabrous structure due to meristematic activities. Once the coppice shoots are collected they should be brought to the processing place without any delay, desiccation and drying up.

PREPARATION OF PLANTING MATERIAL

Once the coppice shoots are brought to the processing centre, they must be washed first in running water and then in mild detergents. Sections of the shoots with a minimum level of 10 cms containing one complete inter node is essential or the epical shoot, so that 2 potential auxiliary buds are available for bud initiation. In order to reduce the transpiration of water from the cuttings, the leaf laminae may be reduced in size by cutting a part of leaf. It is observed that the epical cuttings take less time compared to nodal cuttings for rooting.

Plant hormones (IAA, IBA, NAA) are usually beneficial in increasing the percentage and speed of success. These hormones are applied as powder, paste or solution mixture of different concentrations at the lower end of the cutting. When using the solution the lower ends of the cuttings are dipped in the container for different time period. Exact concentration usually does not matter but the most important factor for rooting remains the same, the ability of rooting.

TREATMENT OF CUTTINGS

As a precautionary measure against fungal infection it is essential to treat the cuttings with a fungicide. The 2% solution of carbodenzine may be used for this purpose. The prepared cuttings may be given a thorough soak in this solution and bundles of 15/20 pieces may be made and set aside for surface drying. Sterilised cutting instrument may be used. To initiate rooting Indole Butyric Acid (IBA) or Naphthalene Acetic Acid (NAA) is used as auxin. From the past experience it is seen that 2500 to 3000 ppm of IBA or NAA is ideal for stimulating rooting in Acacia hybrid. The bundle of cutting, which were set aside for surface drying, is now given a rapid dip in the IBA or NAA solution. The dip should not last longer than 2/3 seconds.

ROOTING RESPONSE OF CUTTING OF ACACIA HYBRID

Sl. No.	Plant growth hormone concentration (PPM)	Total number of cuttings transplanted	No. of cuttings rooted	%
	I.B.A.			
1	1000	480	88	18.30
2	2000	480	152	31.66
3	2500	480	356	74.16
4	3000	480	272	56.66
5	3500	480	208	43.33
	N.A.A.			
1	1000	480	96	20.00
2	2000	480	132	27.50
3	2500	480	416	86.66
4	3000	480	360	75.00
5	3500	480	212	44.16

MYCORRHIZAL ASSOCIATIONS

The mycorrhizal association is considered crucial for the survival and growth of majority of plant species in natural echo system. The role of mycorrhizae in enhancing water and nutrient uptake especially phosphorus zinc and copper is well known. They also help in protection of root against pathogens and environmental stress.

It is found that the Glomuss fasciculatum and Gigaspora margarita are found beneficial to the Acacia hybrid and mangium plants. The inoculation of mycorrhizae was done in the seedling stage and observed that the root nodules formation was more and growth of seedlings was good and healthy.

CONTAINERS

6" x 4" size poly bags with 4 drain holes at the bottom or root trainer may be used as containers.

MEDIA

2:1 ratio media may be used with sand and red soil and the bags may be filled compactly

TRANSPLANTING OF CUTTINGS INTO CONTAINER

The media filled poly bags or root trainers may be arranged inside the pits completely and uniformly. The poly bags may be drenched uniformly. The cuttings after I.B.A. or N.A.A. dip may be planted in the centre of the poly bag surface, so that at least 2 cms of the cut end may be embedded in the soil deeply and compactly.

A small stick should make a hole since pressing down the stump itself may injure the end of the cutting. Once the entire stock of poly bags are transplanted displaying a uniform exposed stem height, a light covering may be given. The polythene sheets, which are semi-transparent, may be spread over the entire hydro pit on the arched grids and the bottom is secured by putting weights. Thus, sealing the hydro pits totally free from atmospheric contact.

HUMIDITY GENERATION AND CONTROL

The hydro pits are designed in such a way that using the natural phenomena of uniform and continuous evaporation released from the soil saturated with water because of the water stagnated at the bottom or at the channels on all four sides of the hydropit to create the humidity. As the diurnal temperature raises with the progress of sun, the rate of evaporation increases and the moisture thus generated gets trapped within polythene covers free from atmospheric contact. It is found that by midday the entire interior surface in the polythene sheets gets totally fogged by moisture. Thus, bringing the relative humidity within 70 to 80%. In such an atmosphere the cuttings and leaf laminae remains constantly moist and never gets dried.

ROOTING PROCESS

Within a period of 10/15 days, the embedded end of cutting would form callus and would sprout roots, which will indicate by either a noticeable development in the bud and also live colours of the stump and the leaf. In this stage the polythene sheets may be opened for fresh air as well as inspection of fatalities in the poly bags, which may be replaced then and there or may be taken out for replacement of casualty.

Since the pit has got all bottom surface packed with pebbles and sand, the pit bottom would always remain wet with a water level constantly maintained 1 cm above the drain hole of the container or in the channel. In 20/25 days the cuttings would have already rooted and would initiated bud development into an auxiliary shoot or terminal shoot as the case may be. It will commence function like an independent plant. At this stage when the developed shoot is more than 5 cm length, the container may be removed from the hydro pit and stacked systematically under partial shade. Direct exposure to the sun may be permitted after 45 days till they are ready for planting. Generally, 60/75 days plantlet will be good for field planting.

PERQUISITE FOR IBA/NAA INITIATED ROOTINGS

I. The poly bag container with the cutting must be under constant moisture condition and never allowed to get dry.

II. A minimum sun shine with a locus of 800/ 1500 is essential which means the polythene sheets can filter out such light received from direct sun shine due to its semi transparent nature.

III. Hydro pits must be sealed for first 10/15 days and should be opened only for monitoring and observation for small period only.

IV. Water level within the pit/channel must be maintained.

PULPING CHARACTERISTICS	ACACIA HYBRID 2 Yr.	EUCALYPTUS 2 Yr.
Bulk Density	220	230
AA% as Na_2O	14.00	16.00
AQ% on Chips	00.05	00.05
Unbleached Pulp Yield %	55.20	48.80
Rejects %	00.30	00.35
Unbleached Pulp Brightness	44.00	35.00
Unbleached Pulp Viscosity CP (CED)	22.60	16.00
Kappa Number	19.00	18.30

V. All infected cuttings may be removed without any delay and replaced with fresh one.

VI. The epical cuttings are easy to root than the nodal cuttings.

PULPING PROPERTIES

2 1/2 year old plantation of Acacia hybrid was harvested and following pulp results obtained are shown in the above Table.

From the above results it appears that Acacia hybrid requires 2% lower chemicals at comparable kappa number. When compared Eucalyptus hybrid about 6% more yield and over all higher strength

STRENGTH PROPERTIES OF UNBLEACHED PULP

Bulk, cm^3/g	01.38	01.45
Breaking length, km	04.95	05.30
Burst Factor	37.80	39.30
Tear Factor	73.50	69.30
Double folds	69.00	37.00
Strength Index	1720.00	1630.00

(strength index 1720 as against 1630 of Eucalyptus hybrid).