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PRODUCING VEGETATIVE PROPAGULES IN THE NURSERY

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ABSTRACT

Propagation of *Eucalyptus* spp. by rooting of cutting is a method of which foresters can make substantial gains in the establishment of forests composed by superior clones, permits setting up of clonal banks and seed orchards without risk of rejection, and makes it possible to do research work that calls for maximum homogeneity.

Success in using the method requires proper planning, review of the literature, suitable equipment, personal follow-up during the period of adaptation of the method, and adequate control of the results. It is also necessary to render the method feasible of adaptation to commercial planting, and adapting it to local conditions.

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INTRODUCTION

The purpose of this presentation is to discuss the method of producing propagules of *Eucalyptus* spp. by rooting of cuttings on a large-scale (10,000,000 units a year).

Vegetative propagation is extensively used in horticulture, floriculture, fruit growing and farming, and there has recently been an increase in the interest in employing this method for the establishment of forests and in research programs that deal with: improvement, soil treatment, and nutrition of trees, phytopathology, entomology, lumber technology, etc.

The method here is presented in quite pragmatic terms, going into all of the details involved. It is of recent adoption, going back for only the past three years, and is still in course of development.

THE METHOD AND ITS APPLICATION FOR *Eucalyptus* spp.

Vegetative propagation of *Eucalyptus* by rooting of cuttings is affected by using youthful vegetative materials obtained from stump coppices.

How Coppices are Obtained

To get the coppices, the tree must be hewed down slightly above soil level (approximately 12 cm). Twigs and coppices arising at points distant from the soil, from about the fifteenth bud onwards, do not root, or rarely root. *E. deglupta* is an exception, as even the twigs and leaves are capable of rooting.

Capacity and intensity of coppice regeneration vary from species to species and within a single species. This is an characteristic of great importance for those planting eucalypts because a number of crops can be obtained from a single planting. When the intention is to propagate *Eucalyptus* by rooting of cuttings, therefore, there must be proper selection for coppice regeneration.

The coppices are produced in clonal multiplication areas. The ratio of clonal multiplication area to planting area is 1:100. In other words, to plant 100 hectares you need one hectare of clonal multiplication, taking into account that the number of plants per hectare in the clonal multiplication area should be the same as for the related commercial planting area.

Gathering and Transportation of Coppices

Coppices need to be gathered in a clearly defined stage of growth, so as to ensure success in the operation, as this is one of the limiting factors in the process. If harvesting is too early the number of cuttings is small. If, on the other hand, it is done too late, the material becomes ligneous and its rooting capacity diminishes.

Hence the coppices must be sufficiently succulent and the proper time of harvesting is connected with the climatic conditions prevailing in each region.

Under the climatic conditions prevailing at Aracruz, the first harvest is collected 45 to 55 days after the tree has been hewed down. The second one takes place 30-40 days after the first. The numbers in question are averages, since they vary the time of year (summer or winter), water in the soil, age of the tree, and plant genotype.

Some of the characteristics of the Aracruz region are as follow:

Latitude	19°48'S
Longitude	40°17'W
Altitude	5 to 50 m
Average annual rainfall	1,364 mm
Average annual temperature	23.6°C
Average maximum temperature	29.3°C
Average minimum temperature	19.1°C
Relative humidity	80%

In each region, tests should be made for a year on the coppice regeneration capacity of the plants, age for harvesting coppices, number of coppices obtained per stump, and rooting capacity. Every one of these factors is strongly affected by the climate. System adaptation is based on the results.

This observation is valid for all phases of the method, inasmuch as a technology involving living matter cannot be transferred pure and simple.

The coppices are removed by cutting with pruning shears about 2 cm above the stump. As the stump must remain alive for future production of coppices or wood, one or more well-placed and vigorous regenerated coppices should be retained so as to generate a new tree. With regard to the positioning these coppices should be well attached to the stump so as to avoid breakage and hence cause the death of the roots. The number of coppices retained will depend on local experience. Normally one to three are preserved.

The coppices are placed in a bucket of water, deep enough to cover the bases so as to avoid fading.

The buckets of coppices must be taken right away to the nurseries for production of the cuttings. It is recommended that no more than one hour elapse in doing this, though up to a four-hour interval may be acceptable.

If the distance between the point of coppice harvesting and the nursery is such as to call for use of a vehicle, it should be protected against direct sunlight, too much wind, and excessive heat.

At the nursery the buckets are put in a shady place and the coppices are irrigated with water sprays while awaiting processing of cuttings.

Production of 100,000 cuttings, working eight-hours a day, takes a team of eleven (10 workers and one supervisor) to collect coppices.

How the Cuttings are Prepared

The coppices are cut up with shears into cuttings, each containing one or two pairs of leaves. Cuttings without leaves do not root. If a cutting with a single pair of leaves loses one of them, rooting and formation of the seedling takes longer.

Coppices with lengthy interbud distance should be used to produce cuttings with only a single pair of leaves, because lengthy cuttings hamper planting in the containers.

If a cutting has twigs, these should be cut off close to the leaf axila. At that point, there are dormant buds. This way a new bud will develop.

Cuttings with very large leaves should have the leaf area diminished by cutting off a part of the leaves. There are two reasons for this:
a) to reduce the leaf weight so as to avoid falling off;
b) to avoid leaf overlapping.

The prepared cuttings should be treated right away with fungicide (benlate) so as to avoid rooting. The solution should be used at a concentration of 200 ppm, and the treatment last 15 minutes. The bases of the cuttings to a height of 3 cm should be immersed in the solution.

It takes forty workers under one supervisor to prepare 100,000 cuttings per eight-hour day.

Planting of Cuttings

The harvested coppices must be transformed into cuttings and planted in the container the same day they are collected. The growing medium must be irrigated. Make a hole in the growing medium for insertion of the cutting base. The diameter of the hole should slightly exceed that of the cuttings and the hole should be about 4 cm deep.

The base of the cutting (to a distance of about 2 cm) is treated with indolebutyric acid (IBA) diluted with talc powder. This stimulates rooting. The concentration used at Aracruz is 6,000 ppm. It is recommended that the concentration be tested, as it varies from climate to climate and from species to species. As the base of the cutting is damp, due to the benlate treatment, the talc + IBA mixture readily adheres to it. Excess mixture is removed by a light tap with the cutting on the edge of the rooting stimulation container. The base of the cutting is then stuck into the hole and the growing medium is pressed up against the cutting with the fingers so as to secure it in the vertical position.

This operation is normally performed in the shade house. The planted container is then submitted to intermittent mist propagation because the leaves must remain damp so as to absorb water, until formation of the roots.

It takes twelve workers and one supervisor to plant 100,000 cuttings in the containers, working eight-hours a day. And, if automatic irrigation is not available, there must be a man on stand-by duty during the remaining sixteen hours of the complete daily cycle.

Rooting Ability

Rooting ability from species to species and within a particular species may vary from 0 to 100%.

Cutting rooting tests have been run at Aracruz for a number of species and hybrids of *Eucalyptus*. Though having different percentages of

rooting, the following species gave positive results: *E. pilularis, E. brassiana, E. microcorys, E. pellita, E. tereticornis, E. urophylla, E. resinifera, E. robusta, E. alba, E. torelliana, E. grandis, E. acmenioides, E. saligna* and *E. deglupta*, and the following hybrids: *E. torelliana* x *E. citriodora* and *E. grandis* x *E. urophylla*.

Negative results (failure to produce roots) occured with the following species: *E. propinqua, E. cloeziana, E. maculata,* and *E. citriodora*.

For production in large quantities, it is important for the species or hybrid to have good rooting capacity. At Aracruz, the minimum percentage of acceptable rooting when clones are selected is 70%.

Formation of Propagules

Development of the cuttings up to complete formation of the new plant entailes two different phases, namely:

a) a first phase lasts about five weeks, in which the cuttings are kept in the shade house until trey develop a good root system and the growth buds start to develop. In the fourth week, the cutting receives the following mineral fertilization: 3 kg of NPK (5-17-3) are dissolved in 100 liters of water. This solution, sufficient for 15,000 cuttings, is applied in the form of hand irrigation.

b) The second phase starts in the sixth week and lasts five to seven weeks. The cuttings are removed from the shade house (first selection) and laid out in an adjacent area, in full sunlight. In this selection, the dead individuals are discarded and a second fertlizing operation is effected, just like the previous one. From that week on, the kind of irrigation provided is that normally used to produce seedlings from seeds.

For the first selection, with 100,000 rooted cuttings, 16 workers and one supervisor are required, working an eight-hour day.

During the eighth to the tenth week, the second selection takes place, and the rooted cuttings are separated into two different classes by size, discarding defective or dead individuals. Cuttings usually develop more than one bud. So in this selection, the surplus coppices are cut away from the larger rooted cuttings, leaving only the larger and better positioned coppice in place. These rooted cuttings can then be planted in the field. Smaller rooted cuttings are fertilizer again and should be ready by the twelfth and thirteenth week, at which time the surplus coppices are cut away. The second selection activity takes 26 workers and one supervisor, working eight-hours a day.

Losses due to defects or death, in the two selections made, usually amount to about fifteen percent of the cuttings originally planted. The time referred to for formation of the rooted cuttings is an average figure and there may be a variation of more or less one week depending on the particular clone used.

Summary of Phases for Formation of Rooted Cuttings

PHASE	WEEK	OPERATION
1	1	Planting of cutting
	2	Insecticide application
	3	Fertilization; Insecticide application
	4	Insecticide application
	5	Insecticide application
2	6	Rooted cuttings withdrawn from shade house; Fertilization; Insecticide application
	7	Insecticide application
	8	Selection; Insecticide application
	9	Selection; Insecticide application
	10	Selection - planting of larger rooted cuttings; Insecticide application
	11	Fertilization of smaller rooted cuttings; Insecticide application
	12	Planting of remaining rooted cuttings; Insecticide application

Shade House

The shade house should be suitable for the climatic conditions of the region, so as to provide environmental conditions for formation of roots and development of cutting coppices. In the Aracruz climate, the greenhouse is actually a shade house. It is constructed in a simple and efficient manner. Steel wire is stretched and help up with round wooden stakes treated to prevent rot. The shade house is 2.20 meters high. The shade screens are spread over the stretched wires, and the piping fitted with the sprays for producing mist from the water under pressure are hung from the wires. The sprays are located in the spaces between the beds. In this manner, dripping into the cuttings can be avoided.

Shading, or reduction in the intensity of the sunlight is achieved by using nylon or polyethylene screen. Screens are available for various degrees of shading, 18%, 25%, 30%, 40%, 50%, 60%, 70% and 80%, and must be tried out under different conditions. As there are differences in light intensity from season to season during the year (especially between summer and winter), it is desirable that the right kind of screen be selected for the local summer conditions. In winter time, the screens should be left in place to protect the rooted cuttings for five to seven days and then removed. This provides the cuttings with better conditions for physiological activity.

For the side portion of the shade house, the same screening is used, so as to protect the rooted cuttings from wind. If the area in question is very windy, two screens should be used, one on top of the other, or a denser screen should be selected.

Other materials may also be used, depending on the climate in the region and the desired level of environmental control, such as glass, plastic sheeting, and fiberglass.

Facilities of this kind call for specialized equipment for conditioning

the environment in regard to temperature, humidity, and ventilation. In certain cases, the growth medium has to be heated so as to stimulate development of the roots.

Irrigation

The main purpose of watering inside the shade house is to keep the leaves wet all the time until roots form. The irrigation procedure takes the form of intermittent mist propagation controlled by automatic equipment if electric power is available at the site. Otherwise, hand-controlled equipment is used. The leaves should never be left without water on them. If they are, the cuttings will not form roots.

There are a number of ways to water the plants by mist propagation, with automatic control. Here are a few examples of what can be done:

a) pressurization of the water in a ground-level deposit and release by means of a solenoid valve controlled by an electronic leaf;

b) use of water tank 20 to 30 meters above the level of the greenhouse (shade house) which provides sufficient pressure for mist propagation. A solenoide valve controlled by an electronic leaf release the water;

c) the water can be pressurized at the moment of use, by means of an electric pump controlled by an electronic leaf or other suitable control unit.

At Aracruz, the shade house is of modular construction. Each module holds 125,000 cuttings in an area of 500 m^2, with mist propagation by a 5 hp electric pump using 80 spray units. Water should be of good quality, and be suitable filtered. When electric power is used, it is important to have a diesel-powered stand-by unit to be put into operation in case of a power breakdown. If this occurs, mist propagation will be effected under manual control.

Growing Medium

Another key factor in the production of rooted cuttings of eucalypts is the growth medium. It should have good water retaining capacity, drain off excess water, be aerated, and light in weight so as to facilitate operations.

A good growth medium is vermiculite, which embodies the whole of the desired qualities. Good results in rooting of cuttings cannot be obtained with media containing organic matter (manure, organic earth, peat, etc.), because they cause rotting of the cuttings even when treated with benlate fungicide. Aracruz has been using sub-soil earth as a growing medium, but is changing to vermiculite at present.

Container

The container performs a number of functions of considerable importance from the point of view of both rooted cuttings (or seedlings) formation and for the future tree, such as:

. containment of a substrate fostering sound growth and nutrition of roots;

. protection of roots from mechanical damage and dehydration;

. fostering of good root system formation;

. causing the growth medium to remain in contact with the root system

during the period of formation in the nursery and after planting so as to permit maximum survival and good initial seedling growth;

. wrapping and involvement of the seedling;

. provision of uniformity of shape;

. ease of handling in the nursery, in transportation and in the field, up to planting time.

If the container is made of polyethylene or polypropylene, it should be removed before planting.

The containers Aracruz uses are composed of polyethylene bags, but these have a series of disadvantages. At the present time, a shift to conical polyethylene tubes is taking place and these containers are placed in polystyrene trays. This system of tubes is being used for eucalypts in both Hawaii and Florida.

Growing Care

A close watch should be kept to detect the appearance of pests in both the shade house (first phase) and the open (second phase).

Insect attack occuring at Aracruz in handled by means of preventive treatment. Hence insecticides is applied once a week, thus avoiding egg-laying or killing the insect in the larval phase.

N. B.: The procedure described is valid for the Aracruz region. It is important to bear in mind, however, that the method needs to be suitably adapted to each particular region.

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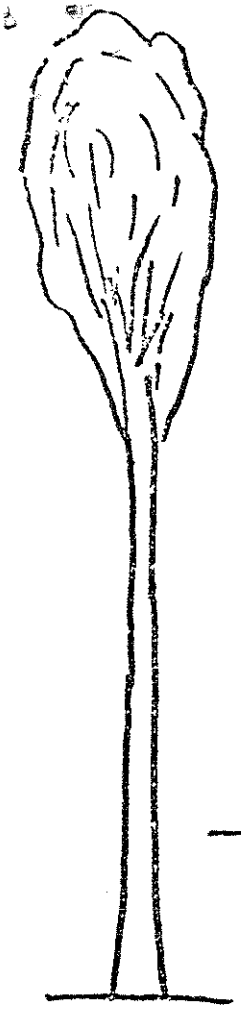
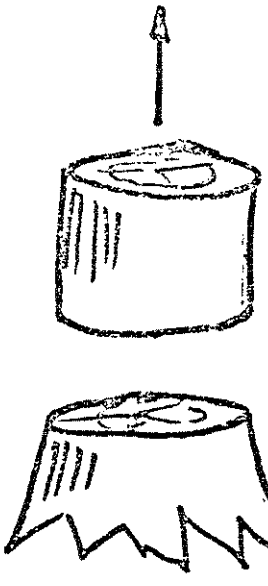
PRODUCING VEGETATIVE PROPAGULES

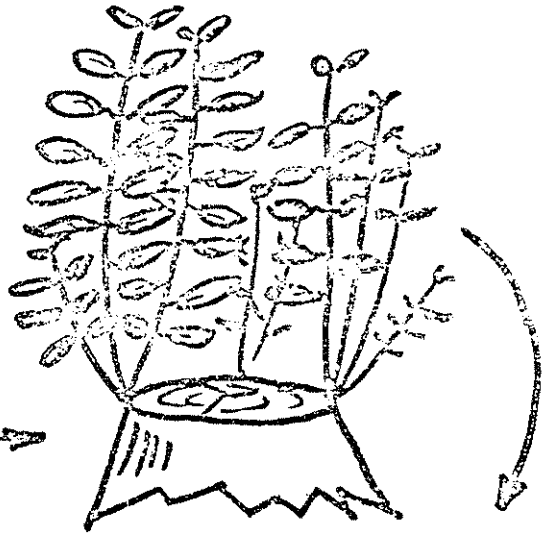


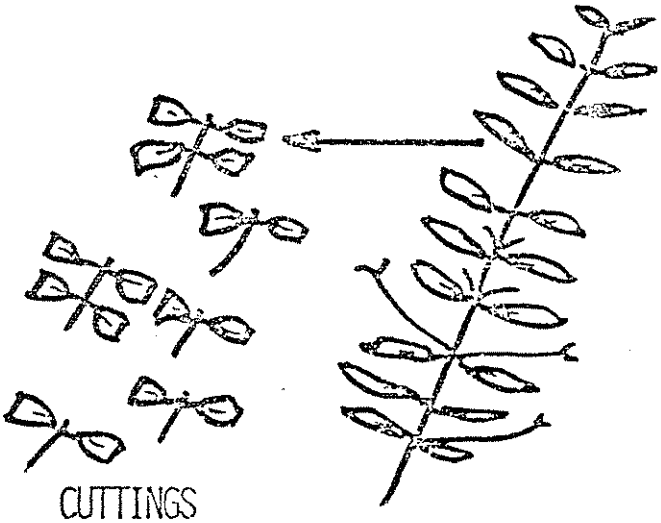
SELECT TREE

WOOD FOR ANALYSIS

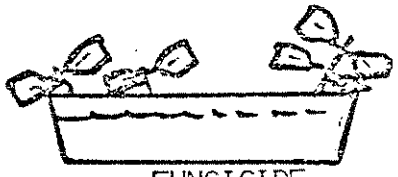


COPPICE FOR CUTTINGS PRODUCTION





CUTTINGS



FUNGICIDE

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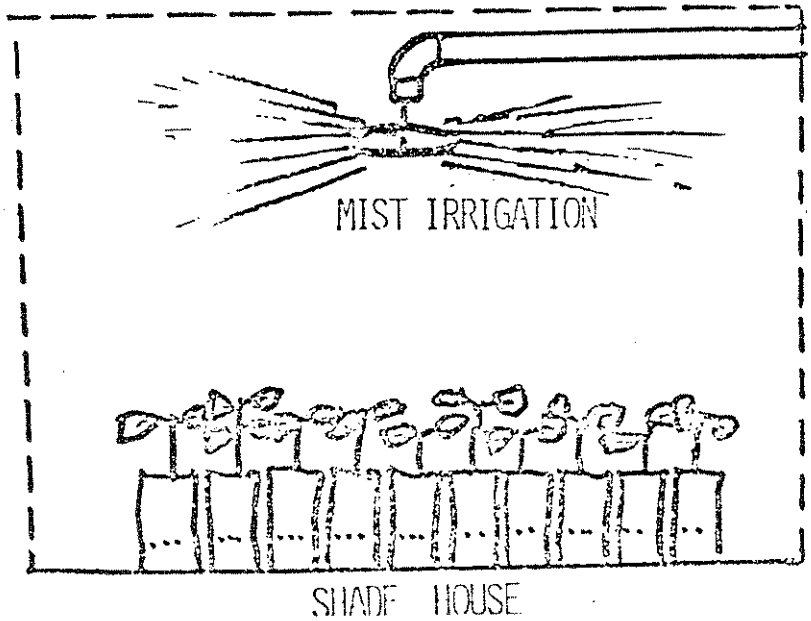

MIST IRRIGATION

SHADE HOUSE