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Reforestation with *Bombacopsis quinatum* (Jaq.) Dugand (Bombacaceae) in Costa Rica by means of vegetative reproduction.

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Abstract: *Bombacopsis quinatum* is found in northern South America and in Central America as far north as Honduras. In these areas, this tree is esteemed for its lumber.

This paper deals chiefly with the promise of planting this species easily, economically and on a large scale by means of vegetative propagation. Indications are that this technique might serve as a novel system of reforestation, especially in abandoned areas in scrub, second growth or marginal sites such as those under poor pasture management.

Some important food crops, including the banana and plantain (*Musa* sp.), potato (*Solanum tuberosum*), cassava or yuca (*Manihot esculenta*) and sugar cane (*Saccharum officinarum*), are reproduced vegetatively. Many other horticultural species are also propagated by this technique, as described in standard texts (Adriance & Brison 1955). Even such familiar tropical tree crops as the breadfruit (*Artocarpus communis*) are propagated vegetatively (Purseglove 1968). During the late 1940's and early 1950's and based on the example of work conducted in Trinidad (Murray 1955), one of the promising and common means of reproducing highly selected cacao (*Theobroma cacao*) plants was by means of rooted cuttings or "cuttage".

In the temperate zone, the principal system for establishing poplar (*Populus*) and willow (*Salix*) plantations for pulp, poles and lumber is by means of rooted cuttings (Barneoud *et al.*, 1982). This is a technique of considerable importance for large areas of land planted each year. The system consists of producing nursery trees from cuttings, raising these to suitable size and transplanting them to the field.

The practice of planting entire branches of trees to produce living fence posts has long been known in many tropical countries. Allen (1956) lists *Bursera simaruba, Diphysa robinioides, Erythrina costaricensis, Ficus goldmanii, Gliricidia sepium, Spondias purpurea* and *Tabebuia chrysantha* as being species which are easily rooted and utilized for this purpose in southern Costa Rica. Indeed, *Gliricidia sepium* is the most planted tree in Costa Rica at the present time, almost all by means of vegetative reproduction (Gerardo Budowski pers. comm.). Sauer (1979) has described the use of many different plants for living fence posts in Costa Rica, particularly those which are reproduced vegetatively.

In an attempt to discover which species of tree might best serve as a support for such horticulturally important tropical vines as "Parchita" or "Maracuyá" (*Passifloria edulis*), Vanilla (*Vanilla fragrans*) and Black Pepper (*Piper nigrum*), a series of trials were established at Finca "La Tirimbina" near the town of La Virgen de Sarapiquí in northeastern Costa Rica.

Included in this trial were branches of a tree of *B. quinatum* recently felled at this farm. They grew so rapidly in this enviroment that a further trial was planned in which stakes of *B. quinatum* were to be planted to determine their performance as potential timber trees.

In this paper, I report on studies which indicate a potential for reforestation in the tropics by means of "cuttage" utilizing branches of the tree *B. quinatum*.

Natural History of *B. quinatum*.

B. quinatum, known by a variety of names (Record & Hess, 1943; Robyns, 1964) including "cedro espino" in Honduras and Nicaragua, "pochote" in Costa Rica, "cedro espinoso" in Panama and Colombia and "caoba bastardo" in Venezuela is a common timber in these countries in regions of plentiful rainfall. It is reported to be of two main forms: those with smooth bark and those with spines. The material in this esperiment was exclusively of the latter kind.

Individuals can reach a height of 30 meters. If there is little competition with other plants, such as when planted in fence rows, this species tends to have a short bole and a crown of heavy spreading branches. It is often buttressed and the bole and some of the branches covered with spines or thorns. Pittier (1957) described this tree from the Pacific side of Costa Rica as having an excellent wood similar to cedar (*Cedrela*). Kluge (1926) states that in Panama "this well known tree is distributed very generally over the region, growing very well on the barren hilltops." Robyns (1964) writes that it is to be found "along the Pacific coast from Nicaragua to Panama, north of Colombia and Venezuela; a characteristic tree of the deciduous forests, occasionally in evergreen forests and dense thickets".

During late November or early December (coinciding with the initiation of the dry season) the trees lose their leaves. Shortly trereafter, white or pink, showy, star-shaped flowers are formed and eventually turn into capsules which burst when mature, scattering small brownish seeds enveloped in a brown, wool-like covering; presumbly an aid in dispersal. This event usually takes place just at the end of the dry season and the beginning of the wet. New leaves reappear soon after seed fall.

One of the characteristics of *B. quinatum* is that its wood, once cut, dries extremely slowly. According to Pittier (1920) this is due to the fact that this contains a hygroscopic gum which keeps the lumber perpetually moist. One of the reasons it is much used and prized as a lumber is that it is resistant to insect attack and decay (Wolcott 1948). Bultman & Southwell (1976), following a series of extended field trials, state that "the combination of high termite resistance, desirable structural properties, trunks suitable for producing timbers and relatively light wood makes "cedro espino" a very suitable wood for terrestrial use, though long term service may be limited by fungal infection".

The lumber is quite often sent to sawmills in the form of squared logs. Where still available, it is utilized in almost every form of construction and carpentry. The wood, which is sometimes substituted for Spanish cedar (*Cedrela mexicana*) is easy to work and has a soft texture. It was often selected (when plentiful) for the construction of boats and dugouts.

Beginning in the early 1960's investigators at the Universidad de los Andes in Mérida, Venezuela, initiated research on the use of rooted cuttings of *B. quinatum* in their plant improvement program. Since one of the problems associated with the reproduction of this species is obtaining a sufficient quantity of seed from selected trees, and since the seed of this genus does not have a long period of viability (Piccolo 1981), the solution was to propagate selected trees by means of cuttings and to maintain them as a seed source since some cuttings produced flowers and seed within a year after planting (Melchior 1972, Melchior & Quijada, 1972). It was determined that utilizing branches between 5 cm and 25 cm diameter and 80 cms in length, at least a 50% take was obtained. Thus, the result of this work did not focus on lumber but rather on seed production.

A taxonomic revision of the family (Bombacaceae) was prepared by Robyns (1963, 1964) and a bibliography of the species *B. quinatum* was completed by Morales and Witmore (1978). This included references, observations and data up to 1975.

At a time when the literature is replete with articles (Myers 1979; Abelson 1983; Iltis, 1983, Budowski 1984) drawing our attention to the problem of disappearing tropical forests, a scheme for easy, rapid and economic reforestation which the most humble farmer can carry out was deemed desirable. Nicholaides *et al.* (1985) indicate that "using indigenous and sometimes imported tree species is important for the shifting cultivators of the Amazon Basin". This should be true as well in other tropical areas under heavy population pressure.

MATERIAL & METHODS

A hillside at Finca "La Tirimbina" which had been cleared of forest fifteen years previously and maintained in low grade pasture since

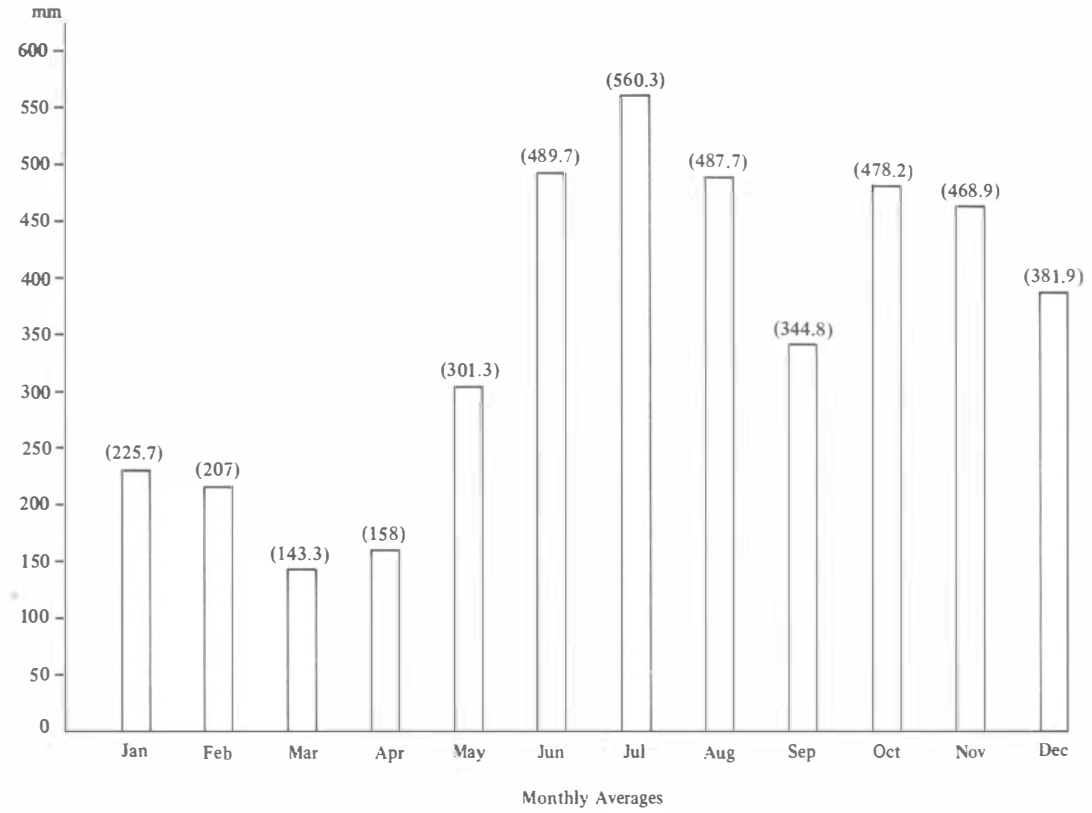

Fig. 1. Average Rainfall (9 years) at Servicio Meteorológico Station No. 39586 - "La Tirimbina". La Virgen de Sarapiquí, Costa Rica.

that time was selected for the trial. The vegetation was typical for the type of management and of the area. "Jengibrillo" (*Paspalum notatum*) was the principal grass. Bracken fern (*Pteridium* sp.), numerous melastomes, the sensitive plant *Mimosa pudica* and many other early successional species were also in abundance

This site, which is 220 meters above sea level and some 70 kilometers inland from the Caribbean, receives an annual rainfall of approximately 4,250 mm as measured over a ten year period at Station No. 39586 of the Servicio Nacional Meterológico at the same farm. The months of March, April and September are drier than the rest but none receives less than about 100 mm of rain (Figure 1). Temperatures average 24.5 C. with minimums seldom less than 18 C. and maximum rarely over 35 C. during the year.

The land where the trials were conducted is undulating with reddish acid oxisols (pH 4.2 – 4.5) on old andisite. The physical structure of the soil is excellent but the chemical composition is strongly in the direction of pedalfers with little in the way of base exchange capacity. Except in fresh forest soils the organic content is low (Table 1). At the beginning of the trial, in May of 1982 all vegetation was cut to ground level and left to rot in place. At the same time, 2.5 meter lengths of branches from *B. quinatum* averaging 8 cms in thickness (all branches tapered from base to tip) were prepared for the planting. Workers insisted that for best results. the stakes be cut and planted during the waning moon "menguante" (see Kirkpatrick & Simmonds, 1958)! To avoid any difficulties, therefore, both stakes and seedling trees were planted during the "menguante" of June, 1982 in a 3 x 3 meter grid.

The seedling trees were produced from seeds collected in the spring of 1981 from trees along roadsides near Liberia in the western part of Costa Rica. These had been planted in plastic

TABLE 1

Range of soil characteristics of 9 samples from Finca "La Tirimbina" in Northeastern Costa Rica

pH	Al	Ca (meq/100 ml. soil)	Mg	K	P	Zn (–ug/ml. soil)	Mn	Cu
4.2 – 4.6	1.6 – 2.7	1.0 – 3.0	0.4 – 1.1	0.18 – 0.5	5 – 7	1.6 – 5.6	6 – 19	11 – 29

bags and raised in a nursery until the following year when they averaged a meter in height.

Holes were dug to a depth of almost a meter. The individual stakes, which had been cut diagonally at a 45 degree angle at the base, were placed to a depth of 50 cm in these holes and the earth packed carefully around them. The seedling trees were removed from their plastic bags and also planted in pre-prepared holes so that the level of the earth in the bag equalled that in the field.

Weeding, by machete and the elimination of any vines or lianas was carried out in the stake-planted part of the trial three times during 1982 - 1983; twice during 1983-1984, 1984-1985 and 1985-1986. The area planted with seedling trees required more attention.

In order to compare the wood properties of this species grown in the more humid Caribbean area of Costa Rica with that native to the drier Pacific region, the log cut to provide branches for the original comparison trial of living support posts was sent to the Laboratory at the Facultad de Ingeniería at the University of Costa Rica in San Pedro for analysis and testing.

RESULTS

Trees were deciduous in January-February of 1983, 1984 and 1985, with flushing occurring each April. In the spring of 1984 three of the trees formed from stakes produced some flowers. In the spring of 1985, the majority ten to fifteen flowers each. None of the trees from seed had reached this state of maturity.

Four years following the initiation of this test, six out of the 500 stakes planted did not survive (1.2%). In the case of the seedling plants, 5 out of the hundred planted did not survive (5%). It appeared to make little difference where the branches were taken (base, lateral or tip) from the parent trees. However the stouter and less damaged (bark cut. bruised or destroyed) branches had a higher and more rapid take.

By the third year the vegetatively propagated trees had the appearance of normal seedling trees and had straight boles. In addition, by the second year they had formed branches to a degree that provided almost complete shading of the planted area. There was a noticeable difference in the growth of weeds in this area of the test site compared to where the nursery trees had been planted. The latter area required two extra cultivations each year. This was largely due to the increased amount of shade cover provided by the vegetatively propagated trees which were greater in size. This important relation between growth and its leaf area has already been described by Lojan (1968).

Measurements of growth were taken in April of 1984, 1985 and 1986 or two, three and four years following planting (Table 2). In Figure 2, the average growth curves of these trees are compared with the growth curves described by Morales & Witmore (1978) for trees planted at Turrialba, Costa Rica as well as one planting resported from Esparza, Costa Rica (Elevation 200 M. Rainfall 2,300 mm).

Results of laboratory tests on the wood properties of the trunk from the Atlantic site as well as from specimens from the Pacific lowlands of Costa Rica are given in Table 3.

DISCUSSION AND CONCLUSIONS

Trees from vegetatively propagated stakes of *B. quinatum* planted at Finca "La Tirimbina" show growth and survival characteristics superior to seedling plants of the same species.They also show superior growth curves to those reported from Turrialba and Esparza even when fertilizers were used on seedling trees planted at Turrialba. This difference may be due, in part, to the fact that the planting at Turrialba was amost 400 meters higher in elevation and with a mean annual temperature of 21.4 C, significant-

TABLE 2

Growth of B. quinatum *planted as seedlings and from stakes in three different locations in Costa Rica*

	Diameter Breast Height (DBH) in cm.		
Location A. "La Tirimbina" – Sarapiquí Elevation 220 m; Av. Rainfall 4250 mm Av. Temp. 24.5°C	*April 1984*	*April 1985*	*April 1986*
2.5 m stakes cut & planted June 1982 3 x 3 m grid	13.2	14.9	17.7
Nursey plants from seed obtained and sown in 1981. Planted in field June 1982 on a 3 x 3 m grid	9.8	11.07	13.2
Location B. Turrialba – Elevation 600 m Av. Rainfall 2985 mm. Av. Temp. 21.4°C		*1962*	*1975*
Seedling plants established in 1946 on a 5 x 5 m grid		31.5	41.5
Seedling plants established in 1960 on a 3 x 3 m grid			16.6
Seedling plants established 1967 on a 3 x 3 m grid. Fertilized			17.5
Location C. Esparza – Elevation 200 m Av. Rainfall 2300 mm; Av. Temp 25°C			
Seedling plants established in 1961 Presumed on a 3 x 3 m grid			20.7

ly lower than that of the Sarapiquí area. Furthermore, the annual rainfall was over a meter less in Turrialba than in Sarapiquí. The poorer growth of *B. quinatum* at Esparza, even at a lower elevation with a more favorable ambient temperature may have been due to the fact that this part of Costa Rica receives only 2,300 mm rainfall annually and has a marked dry season.

The data further suggest that had stakes been planted at the Sarapiquí site at a distance of 5 x 5 meters they might have performed even better, so far as growth is concerned, than at the 3 x 3 meter spacing.

An argument may be made as to the influence of different size characteristics at the initiation of the test, the stakes were already 2.5 meters in length and 8 cms thick when planted while the seedlings averaged only a meter in height and were considerably thinner. At the same time, however, the seedling plants already had a well defined root system and were a year old as a tree. A clear advantage of the trees produced from stake is more rapid growth of leaf area, which not only aids in growth but also reduces potential weed competition through more intensive shading.

The important consideration is that planting stakes rather than seedlings has the following advantages: (a) more rapid growth, (b) no costs for nursery work and care, (c) production of straight boled trees with abundant leaf shade (d) because of more rapid growth, less effort is required for care and management of plantings.

The wood characteristics of *B. quinatum* grown in this humid region of Costa Rica show that it can produce a lumber of quality equal to that grown in drier areas. This may not, however, be the most recommended habitat for this species. A lowland tropical area with a drier and definitely "monsoonal" type of climate appears more conducive to the production of wood of more desirable timber qualities.

It is furthermore suggested that once superior trees of *B. quinatum* have been identified from the standpoint of precocity and growth or wood characteristics, they can be rapidly reproduced using the technique of vegetative reproduction.

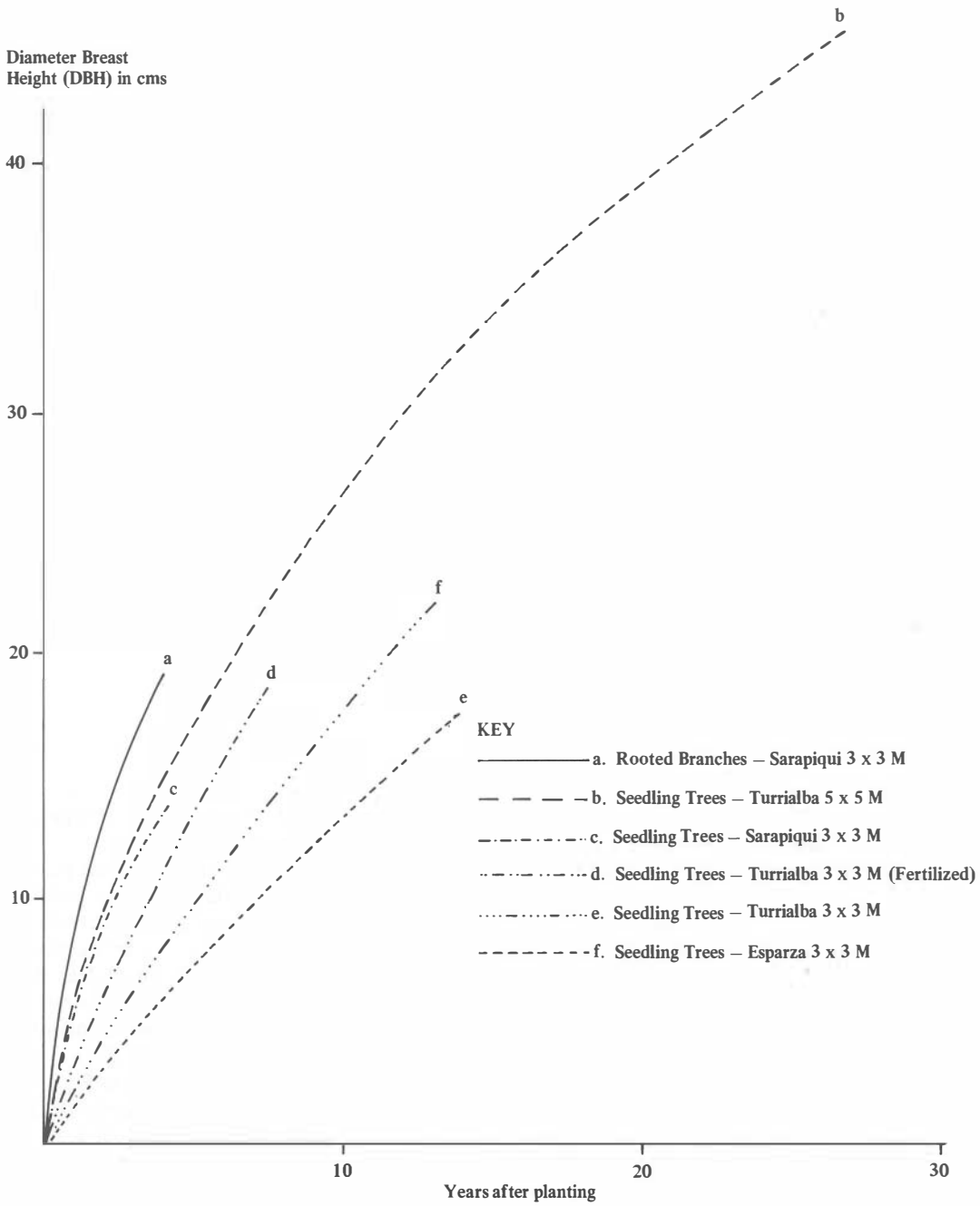

Fig. 2. Growth curves of *B. quinatum* planted as seedlings or from stake in three different locations in Costa Rica.

It is concluded that the technique of planting live branches of *B. quinatum* instead of seedling trees provides a potential for reforestation by means of an accepted planting technique, at a lower cost and with earlier returns.

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RESUMEN

Bombacopsis quinatum (Bombacaceae) se distribuye desde la parte norte de América del Sur hasta Honduras, donde es apreciado por su madera.

Este trabajo presenta información sobre la plantación de *B. quinatum* por medio de propagación vegetativa de manera sencilla y en áreas grandes. Se sugiere que se puede usar esta técnica para restablecer bosques en terrenos abandonados, en charrales y en potreros degradados.

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