Plantation technology for selected indigenous trees in the Indian peninsula

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Figure 1.
Garcinia gummi-gutta (L.) Robson.
Photo C. García.

The technology developed can help for establishing plantations of five indigenous tree species with multiple end-uses: *Calophyllum polyanthum* (Clusiaceae), *Dysoxylum malabaricum* (Meliaceae), *Garcinia gummi-gutta* (Clusiaceae), *Melia dubia* (Meliaceae) and *Vateria indica* (Dipterocarpaceae). It can be useful either in the context of resource enhancement or as part of site or forest-type rehabilitation programmes.

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RÉSUMÉ

TECHNIQUES DE PLANTATION POUR DES ESSENCES AUTOCHTONES SÉLECTIONNÉES DE LA PÉNINSULE INDIENNE

Les techniques à utiliser en pépinière et en plantations pour cinq essences à usages multiples, endémiques de l'Inde – *Calophyllum polyanthum* Wall. (Clusiacées), *Dysoxylum malabaricum* Bedd. (Méliacées), *Garcinia gummi-gutta* (L.) Robson (Clusiacées), *Melia dubia* Cav. (Méliacées) et *Vateria indica* L. (Diptérocarpacées) – sont issues de travaux (1999-2002) fondés sur des essais en laboratoire, pépinière et sur le terrain. Ces essences produisent du bois d'œuvre, sauf *G. gummi-gutta* utilisée pour le bois de feu. Peu d'informations sont disponibles sur la régénération artificielle de ces essences, qui sont en voie de disparition rapide dans leurs milieux naturels. Les aspects liés aux semences, à la croissance en pépinière et à la plantation ont ainsi été définis pour régénérer ces essences. Ils incluent les données sur la collecte, le traitement et le stockage des fruits et graines ainsi que sur la germination, les aspects phytosanitaires, les facteurs agissant sur les taux de survie et de croissance des plants au champ. Ces données originales peuvent faciliter la régénération artificielle de ces essences en Inde, pour valoriser les ressources ou dans des programmes de réhabilitation de sites forestiers, nécessaires sous les tropiques, afin de maintenir les écosystèmes et leurs ressources.

Mots-clés : plantation, essence sélectionnée, Inde.

ABSTRACT

PLANTATION TECHNOLOGY FOR SELECTED INDIGENOUS TREES IN THE INDIAN PENINSULA

Nursery and plantation techniques for five selected, multiple end-use trees that are endemic or indigenous to peninsular India were generated during, based on laboratory, nursery and field trials. The species investigated –*Calophyllum polyanthum* Wall. (Clusiaceae), *Dysoxylum malabaricum* Bedd. (Meliaceae), *Garcinia gummi-gutta* (L.) Robson (Clusiaceae), *Melia dubia* Cav. (Meliaceae) and *Vateria indica* L. (Dipterocarpaceae)– produce timber, except *G. gummi-gutta*, which is used for firewood. Only very little information is available on the artificial regeneration of these five species, which are getting fast depleted in their natural habitats. Therefore, in order to regenerate these species efficiently, the seed, nursery and plantation aspects were worked out. These aspects include data on collection, processing, storage and germination, on pest and disease problems in fruits and seeds and their control, as well as, vegetative propagation methods and root-trainer technology for large scale production of planting stock. Planting technology, the influence of various factors such as survival and growth rates, pest and disease information, etc. on the field-planted seedlings were also examined. The first-hand information and data generated for these species can facilitate their artificial regeneration, either in the context of resource enhancement or as part of site/forest-type rehabilitation programmes, much needed in the tropics to sustain the diverse ecosystems and their resources.

Keywords: plantation, selected tree species, India.

RESUMEN

TÉCNICAS DE PLANTACIÓN PARA ESPECIES AUTÓCTONAS SELECCIONADAS DE LA PENÍNSULA INDIA

Las técnicas que han de utilizarse en vivero y plantación en cinco especies de usos múltiples, endémicas de la India –*Calophyllum polyanthum* Wall. (Clusiáceas), *Dysoxylum malabaricum* Bedd. (Meliáceas), *Garcinia gummi-gutta* (L.) Robson (Clusiáceas), *Melia dubia* Cav. (Meliáceas) y *Vateria indica* L. (Dipterocarpáceas)– proceden de trabajos (1999-2002) basados en ensayos de laboratorio, vivero y de campo. Estas especies producen madera de construcción, excepto G. *gummi-gutta* utilizada para leña. La información sobre la regeneración artificial de estas especies, en vías de desaparición rápida en sus medios naturales, es escasa. Para regenerar estas especies, se definieron los aspectos relacionados con semillas, crecimiento en vivero y plantación. Se incluyen los datos sobre recogida, tratamiento y almacenamiento de frutos y semillas así como la germinación, los aspectos fitosanitarios, los factores que influyen en el índice de supervivencia y en el crecimiento de las plántulas en el campo. Estos nuevos datos pueden facilitar la regeneración artificial de estas especies en la India, ya sea para valorizar los recursos o en programas de rehabilitación de áreas forestales, necesarios en los trópicos, para mantener los ecosistemas y sus recursos.

Palabras clave: plantación, especie seleccionada, India.

Introduction: native forest species of interest to India

The monsoon forests of the Indian peninsula are very rich in indigenous tree species with a variety of end-uses. However, this rich biological resource is now becoming fast depleted, for a number of reasons including habitat destruction and over-exploitation. It has therefore become essential to regenerate these species artificially, in order to secure the continued availability of products derived from them also, and to preserve their ecological functions. As pointed out by Evans (1982), the main practical difficulty of cultivating indigenous species on a large scale is the lack of proven technologies. To address this problem, plantation technologies for five such species, namely *Calophyllum polyanthum* Wall. (Clusiaceae), *Dysoxylum malabaricum* Bedd. (Meliaceae), *Garcinia gummi-gutta* (L.) Robson (Clusiaceae) (Figure1), *Melia dubia* Cav. (Meliaceae) and *Vateria indica* L. (Dipterocarpaceae) were standardised (Figure 2). All these tree species yield timber for various end-uses, in addition to products like Camboge (*G. gummi-gutta*), medicinal oil (*D. malabaricum*), lamp oil (*C. polyanthum*), White Dammar and a seed-fat called Piney tallow (*V. indica*), linoleic and oleic acids and butter-oil (*M. dubia*). In the literature, Troup (1921) and revised editions (Fri, 1975-1985) and Luna (1996) give only very scanty information on the artificial regeneration of selected Indian trees, in which the species dealt with here are either not included or not studied in detail. Similarly, Dent (1948) gives only partial data on the storage of seeds while Sengupta (1937), who standardised seed weights and germination rates for a number of indigenous Indian species, does not provide sufficient data with regard to the species investigated in this experiment. Earlier, Nair *et al.* (1991) also investigated the plantation aspects of six indigenous Indian tree species, namely *Albizia odoratissima, Grewia tiliaefolia, Haldina cordifolia, Lagerstroemia microcarpa, Pterocarpus marsupium* and *Xylia xylocarpa,* but these were not the same as the species used in this experiment. A detailed treatise on plantation technology for the species used in this experiment is available in Nair *et al.* (2002).

Production and planting of the selected species

Data on the fruiting season of the different species in their natural stands were gathered from specimens in regional and national herbaria in India, and also from the literature. Seed characteristics and methods for seed collection and processing were generated from fresh samples collected from natural stands. Pests and diseases in fruits and in fresh and stored seeds were monitored, the organisms responsible were identified and control or management strategies were developed. Nursery techniques for the production of propagules by seeds and vegetative methods were standardised using fresh seed samples and juvenile shoot cuttings collected from natural stands. For nursery experiments, trials were carried out with seed-beds 12 x 1.2 m in size and root-trainer technology. The standard potting medium of 3 parts soil to 1 part sand was used in the nursery beds and a 1:1 vermiculite and coir-pith compost was used in plastic 10 x 5 cm root-trainers. The rooting hormone Indole Butyric Acid (IBA) was tried in three concentrations: 3000 ppm, 4000 ppm and 5000 ppm. A mist chamber was used to study the rooting of treated juvenile stem cuttings. The propagules issued from seed and vegetative propagation techniques were maintained in the nursery, with 75 per cent shade-net cover and watering once a day, until the beginning of the planting season during the South-West monsoon in June-July. Pest and disease problems in sown seeds and seedlings raised and maintained in the nursery were also monitored, and management strategies to protect them were standardised.

The sites for planting out were selected within the natural habitat of the species tested. Evergreen forest areas were selected for *C. polyanthum* and *D. malabaricum,* and moist deciduous forest areas for *G. gummi-gutta, M. dubia* and *V. indica*. The areas were cleared of ground vegetation, and staked into rows 2 m x 2 m apart. The seedlings were planted out in 30 cm x 30 cm x 30 cm pits, the stakes being left by the planting pits as markers to facilitate data collection. Planting was done during the first monsoon season in June-July and casualties were replaced after three months. Data to determine the survival and growth rates of the field-planted seedlings were collected at three-monthly intervals. Data on pests and diseases potentially affecting the fruits, seeds and seedlings in the nursery and field-planted propagules were generated and control measures were standardized.

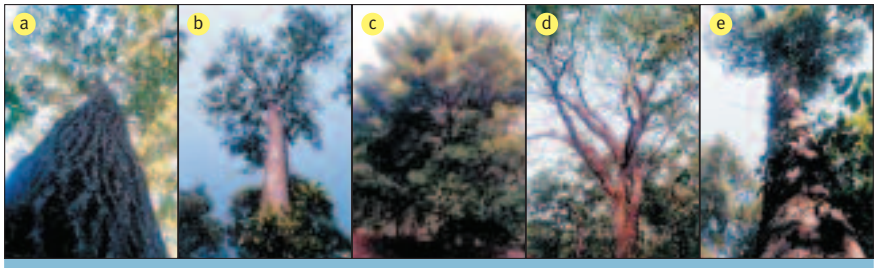

Figure 2.
Specimens of the five indigenous species studied in their natural habitat:
(a) *Calophyllum polyanthum;* (b) *Dysoxylum malabaricum;* (c) *Garcinia gummi-gutta;* (d) *Melia dubia;* (e) *Vateria indica*.
Photos K. K. N. Nair.

Figure 3.
Seeds of the five tree species: (a) *C. polyanthum;* (b) *D. malabaricum;* (c) *G. gummi-gutta;* (d) *M. dubia;* (e) *V. indica.*
Photos K. K. N. Nair.

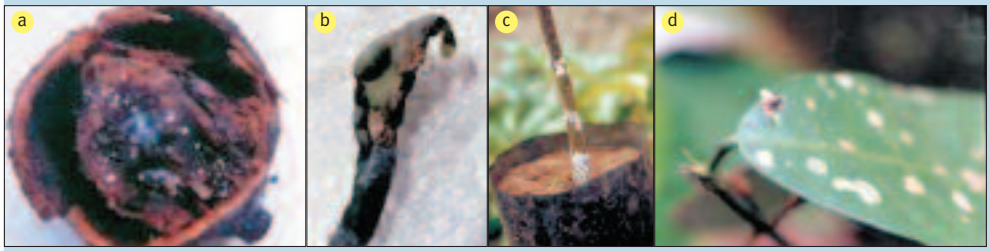

Figure 4:
(a) *Daccus* pest attack in the fruits of *D. malabaricum;* (b) *Diptera* pest attack on the leaves of *G. gummi-gutta;* (c) Mealy bug infection in the seedlings of *M. dubia;* (d) Bag worm attack on the leaves of *V. indica.*
Photos K. K. N. Nair.

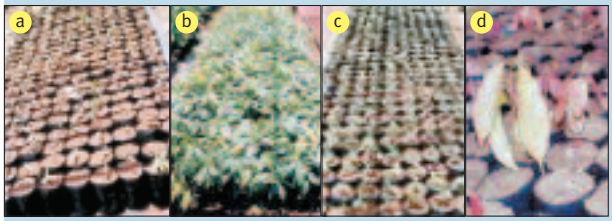

Figure 5.
Seedlings in the nursery: (a) *C. polyanthum;* (b) *D. malabaricum;* (c) *G. gummi-gutta;* (d) *V. indica.*
Photos K. K. N. Nair.

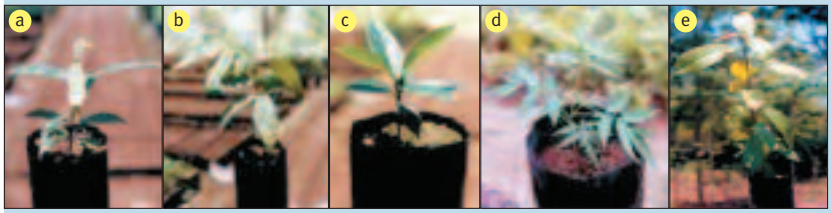

Figure 6.
Potted seedlings: (a) *C. polyanthum;* (b) *D. malabaricum;* (c) *G. gummi-gutta;* (d) *M. dubia;* (e) *V. indica.*
Photos K. K. N. Nair.

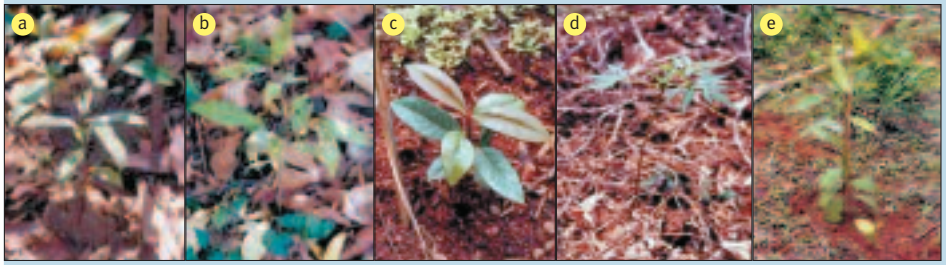

Figure 7.
Field-planted seedlings: (a) *C. polyanthum;* (b) *D. malabaricum;* (c) *G. gummi- gutta;* (d) *M. dubia;* (e) *V. indica.*
Photos K. K. N. Nair.

Observations and results

Seed collection, processing and storage

Seeds of *C. polyanthum* and *D. malabaricum* (Figure 3) are available from June to August and from May to July, respectively, in evergreen forest stands of the Indian peninsula, where the species grow naturally. In the case of *G. gummi-gutta, M. dubia* and *V. indica*, fruiting seasons are from May to September, November to February and May to August. The seeds of *C. polyanthum* are often eaten by monkeys and other wild animals while those of *D. malabaricum* are severely affected by a *Daccus* pest (Figure 4 a), even when they develop on the mother trees. In the case of *V. indica,* weevils damage the fruits. In these cases, care must be taken to collect damage-free seeds for germination. Details on the characteristics of fruits and seeds, on the pests and diseases affecting them and on the storage period before sowing are given in Table I.

Nursery techniques

The results of the germination trials, conducted in standard nursery beds and in root-trainers (Figure 5), are given in Table II. The best results of vegetative propagation trials using shoot-cuttings treated with indole butyric acid (IBA) at 3 000, 4 000 and 5 000 ppm concentrations are given in Table II. In the case of *M. dubia,* where the percentage of seed germination was very low (14 %), the vegetative propagation method, using rooted cuttings raised by dipping the cut end of juvenile stems in 4 000 ppm IBA, was more promising (50 %). Removing the seed coat can substantially enhance the germination rate of *G. gummi-gutta*. In the case of *D. malabaricum,* the germination rate for fallen pest-free fruits with green cotyledons was 20 per cent or more. The seedlings of all the species were potted (Figure 6) and watered once in a day in the shaded nursery until the June-July planting season. In 10 per cent of *G. gummi-gutta* seedlings maintained in the nursery, there was a mild Diptera attack (Figure 4 b), but no pest control measures were needed. The nursery seedlings of *M. dubia* were attacked by a mealy bug (Figure 4 c) causing mortality, which we were able to control by applying a 0.05 per cent solution of Nuvacron 36 EC (Monocrotophos). The young nursery seedlings of *V. indica* were mildly infected with bagworm (*Pteroma plagiophleps)* (Figure 4 d). This can attain pest status requiring standardised control measures.

Plantation technology and seedling growth

The survival and growth of seedlings planted out in June-July, at the start of the South-West monsoon season, are given in Table III. Shade and watering to prevent damage from drought are essential for all the species (Figure 6). In the case of *Garcinia gummi-gutta,* grazing of field-planted seedlings by wild animals has to be controlled to ensure the survival and growth of the seedlings.

Table I.
Seed characteristics, pests and diseases and storage periods.

Species	Fruits		Seeds					
	Type	Shape	Average size (cm)	Shape	Number per kg	Pest/ protection	Disease/ protection	Storage period
C. polyanthum	Drupe	Ovoid	2.2 x 1.5	Elliptic	800-850	Shot-hole borers/ screening in field	Spermoplane fungi/ Dressing with Captan	Less than six months
D. malabaricum	Capsule	Pyriform	3.5 x 2.4	Sub-globose	390-410	*Daccus* pest/ Screening in field	Spermoplane fungi/ Dressing with Captan	No storage period
G. gummi-gutta	Berry	Globose	3.3 x 1.5	Ovoid	590-600	Nil	Nil	Nil
M. dubia	Drupe	Ovoid	2.5 x 1.1	Ovoid	800-850	Nil	Spermoplane fungi/ Dressing with Captan	More than one year
V. indica	Capsule	Ovoid-ellipsoid	4.6 x 3.3	Ovoid	42-44	Weevil	Spermoplane fungi/ Dressing with Captan	Less than one year

Table II.
Data on seed pre-treatments and nursery experiments.

Species	Seed pre-treatment	Sown in seed beds		Root trainers/polypots		Vegetative propagation	
		Seeds (kg/bed)	Germination (%)	Seed/ capsule	Germination (%)	IBA (ppm)	Rooting (%)
C. polyanthum	Drying for 5-10 days in shade	1	47	Two	45.5	4 000	75
D. malabaricum	Drying for 5-10 days in shade	35	20	One	17.3	3 000	12.45
G. gummi-gutta	Removal of seed coat	1.83	82.5	One	71	4 000	54
M. dubia	Seeds soaked in farmyard manure for 7 days	1.33	14	One	3	5 000	50
V. indica	Drying in shade for 3-5 days	11.4	5	One	81	4 000	6

Table III.
Plantation technology and survival and growth of seedlings.

Species	Habitat for planting	Survival after 3 months (%)	Growth after 12 months (cm)	Pests/control	Diseases/ control for two years	Tenting operations
C. polyanthum	Evergreen forests	89.62	20	Leaf-feeding caterpillars; mild but may attain pest status	Leaf-spot (not potential)	Mulching, shade and watering during summer
D. malabaricum	Evergreen forests	97	34.3	Nil	Shot-hole and Sooty-mould (not potential)	Mulching, shade and watering during summer
G. gummi-gutta	Moist deciduous forests	65	23	Nil	Nil	Prevent grazing; mulching and watering during summer
M. dubia	Moist deciduous forests	62.5	27	Nil	Die-back due to drought	Mulching, shade and watering during summer
V. indica	Moist deciduous forests	90.5	85	Nil	Nil	Mulching, shade and watering during summer

Conclusions

In tropical countries, lack of availability of suitable technology is the main constraint for establishing plantations of indigenous tree species, which often have multiple end uses. It is partly for this reason that most forest plantations in India are of exotic, pulpwood species, except for teak, which is native to the region. Technology developed to raise plantations of five tree species that are indigenous or endemic to the Indian region is therefore of considerable importance and represents a major change from the conventional practice of raising plantations of exotic species, mainly for the pulp and paper industries, with no consideration for local demand for various timber and non-timber products. The technology developed can help to counteract the depletion of natural growing stock and consequently the dwindling supply of various products derived from indigenous tree species, some of which also need protection to prevent them from becoming scarce, endangered or even extinct. The major challenge is to disseminate the technology among the various stakeholders, including planners and policy makers, practising foresters... To achieve this, Information Bulletins on the technology have been prepared and circulated, while the trial plantations established can also serve as demonstration plots. Because they are environmentally compatible and their products well accepted in the region, plantations of indigenous trees species could be successfully established in their natural habitats, i.e. in countries and vegetation types in the tropics, where they grow as part of natural ecosystems.

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