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CONTENTS

1885 DORLE, UP; KULKARNI, AR. 1984. **Anther culture for production of pollen haploids in *Tropaeolum majus, Linn*.** *Curr. Sci.*, 53: 16, 867-868; 3 ref.

1886 NGUYEN, R. 1986. ***Encarsia lahorensis (Howard)* a parasite of *Dialeurodes citri (Ashmead)* (*Hymenoptera: Aphelinidea*).** *Entomology Circular*, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, No. 290: 2 p.; 7 ref.

Information is given on the history of the introduction of *Encarsia lahorensis*, a specific parasitoid of *Dialeurodes citri*, from California to Florida, and on the morphology, biology and distribution of the aphelinid in India, Pakistan and the countries to which it was introduced (including Italy, Israel and several southern states of the USA). After an abortive introduction of the parasitoid in 1911, releases in 1977 resulted in its establishment in 2 counties of Florida, where it eliminated aleyrodid populations on *Viburnum* and *Gardenia* and was distributed on gardenia plants in pots to 66 counties, in 9 of which it became established. Heavy mortality of overwintering immature stages occurred in northern Florida.

1887 OHRI, D; KHOSHOO, TN. 1983. **Cytogenetics of garden *Gladiolus*. III. Hybridization**. *Zeitschrift fur Pflanzenzuchtung*, 91: 1, 46-60; 35 ref.

Intra- and interploidal crosses (using tetraploid, triploid and diploid hybrid and garden cvs) and one intergeneric cross (cv. La Paloma X *Acidanthera bicolor*) were made. Only 2 of the progeny of self and cross combinations involving tetraploid cvs were not tetraploid. The progeny essentially showed the same meiotic behaviour as the parents, with predominant bivalent formation. The 4x X 2x cross was successful only when a tetraploid was used as the female parent; 28 of 29 plants were triploid. *A. bicolor var.* murielae (2n = 30) could be crossed only with the *Gladiolus* cvs La Paloma and Pacifica (2n = 60) when these were used as female parents. *Gladiolus psittacinus* hybrids (5x) and garden cvs (4x) could be crossed reciprocally; bivalent formation was most usual in progeny but other configurations were observed.

1888 PANDA, N; DEBATA, BK; DAS, P. 1989. **In vitro regeneration of *Mussaenda erythrophylla cvs.* 'Queen Sirikit' and 'Rosea' from callus cultures**. *Orissa Journal of Horticulture*, 17: 1-2, 18-22; 7 ref.

Leaves takes from field-grown ornamental shrubs were washed in 2% Teepol for 5 m. The lamina was removed and the midrib and petiole surface were sterilized in 0.1% HgCl2 for 15 min. Segments (0.3-0.5 mm) of midrib and petiole were inoculated onto agar-gelled MS medium containing 30 g sucrose/litre and supplemented with IAA, NAA, BA, adenine sulphate and ascorbic acid, alone or in combination. The cultures were incubated under cool white fluorescent light at 25 ± 2°C. The best callusing response was observed with 0.5 mg BA + 10 mg ascorbic acid/litre. Shoot regeneration was best following subculture on MS medium supplemented with 3 mg BA + 2 mg IAA + 10 mg ascorbic acid/litre. Excised shoots were multiplied by culturing nodal cuttings on MS with 40 mg adenine sulphate/litre. Rooting was best on MS with 0.5 mg NAA/litre. On transfer to field conditions, after hardening, >80% of plants survived.

1889 RAHMAN, SH; HOSSAIN, M; ISLAM, R; JOARDER, OI. 1992. **Micropropagation of *Delonix regia* through immature embryo derived shoot tips.** *Pakistan J. Botany*, 24: 60-63.

1890 SHARMA, DR; YADAV, NR; CHOWDHURY, JB. 1988. **Somatic embryogenesis and plantlet regeneration from shoot tip calli of *Phoenix sylvestris Rox*.** *Ind. Jour. Exp. Biol.* 26: 854-857.

1891 SOMANI, VJ; JOHN, CK; THENGANE, RJ. 1989. **In vitro propagation and corm formation in *Gloriosa superba L.*** *Indian Journal of Experimental Biology*, 27: 6, 578-579; 15 ref.

1892 VIJAYARAGHAVAN, MR; BHAT, U. 1983. **Synergids before and after fertilization**. *Phytomorphology*, 33: 1/4, 74-84; 42 ref.

In this review, synergids are regarded as active and highly polarized cells. Their micropylar half is occupied by a nucleus and many organelles. In most genera the wall is thickest towards the micropylar end of the cell but towards the chalazal end only a plasma membrane is present. The wall stains for carbohydrates and proteins and contains significant amounts of pectin. The filiform apparatus is a highly convoluted extension of the micropylar portion of the wall. Cytoplasm surrounding it is rich in various organelles. The synergids play a role in pollen tube growth and its direction into the embryo sac, in pollen tube discharge, and also function as transfer cells.

FORESTRY

1893 AGRAWAL, V; GUPTA, SC. 1991. **In vitro plantlet development from explants of 25-year-old**

trees of *Populus* X *euramericana* - a hybrid poplar. *Plant Science Limerick*, 78: 1, 99-105; 32 ref.

Nodal and internodal segments of young branches of *Populus* X *euramericana [P. canadensis]* differentiated adventitious multiple shoots within 3 weeks of inoculation on MS medium. They developed directly at the cut ends in both explants, in the lenticel regions of internodes and in the axils of leaves on nodal portions. The highest frequency of in vitro organised shoots forming roots was 44% on MS medium with 10.7 μM NAA and 0.75% activated charcoal within 15 days of subculture. The rooting response was enhanced to 79% by subculturing shoots on the same medium in 100 ml conical flasks instead of 15 X 2.5 cm test tubes. The addition of 100 mg glutamic acid/litre to the rooting medium effectively controlled yellowing of leaves and their abscission in tissue culture-raised plantlets. These plantlets were successfully transferred to soil. Thus, 5-15 plantlets can be produced from each internodal explant within 60 days.

1894 AHMAD, ZAHEER; ZAIDI, N; SHAH, FH. 1990. **Micropropagation of *Melia azedarach* from mature tissue**. *Pak. J. of Botany*, 22: 2, 172-178.

Proliferating shoot cultures were established from nodal bud segments excised from a mature (40-yr-old) tree. The highest proliferation rate was observed in Murashige & Skoog (MS) medium supplemented with BAP ([benzyladenine] 1.0 mg/litre). Some shoot formation occurred in media supplemented with kinetin, but the shoots did not proliferate on subculturing; GA3 promoted only callus formation, while 2iP either did not promote shoot growth or (in some cases) caused formation of thin and delicate shoots with no photosynthetic capacity. Rooting of shoots in vitro was achieved in MS medium containing 1.0-2.0 mg/litre of IBA, while IAA was ineffective. The phenotype of the plantlets was similar to that of the plant from which the explants were obtained.

1895 BAJAJ, YPS; TREMBLAY, FM; PERINET, P; LALONDE, M; SAKAI, A. 1986. **Biotechnology in agriculture and forestry 1. Trees I.** Berlin, German Federal Republic: Springer-Verlag, 515 p.

Various micropropagation techniques and the uses of micropropagation are discussed. Of particular forestry interest are sections on micropropagation of *Pinus radiata*, *Picea abies*, *Araucaria spp.*, *Cryptomeria japonica*, *Juniperus polycarpos*, *Ulmus spp.*, *Eucalyptus spp.*, *Santalum album*, *Acacia koa*, *Morus alba* and *Castanea spp.*, and chapters on Tissue culture of *Alnus spp.* with regard to symbioses (by F.M. Tremblay, P. Perinet and M. Lalonde) and Cryopreservation of germplasm of woody plants (by A. Sakai).

1896 BHATNAGAR, SP. 1991. **Embryology of the *Santalaceae***. *International symposium of parasitic weeds: Proceedings*. (Nairobi, Kenya: 5th: 1991). CIMMYT, Mexico. p. 43-45.

Embryologically the family *Santalaceae* has many interesting features. The anther wall is formed of an epidermis, fibrous endothecium, few middle layers and glandular, uni or multinucleate tapetum. Microspore tetrads are tetrahedral, decussate or isobilateral. Pollen are two or three celled, tricolpate with smooth exine. Placenta may be straight or twisted with pendulous, hemianatropous or anatropous ovules wich may be undifferentiated or unitegmic. In Exocarpos there is no differentiation of ovule from the placenta. Embryo sac development conforms to polygonum type except for Buckleya and Iodina where it is bisporic, Allium type. The embryo sac may become extra-ovular as in Leptomeria, Mida and *Santalum*; a chalazal caecum is usually present. In Comandra, the caecum is lateral. Both synergid and antipodal haustoria develop in Quinchamalium. Endosperm is cellular or helobial with a chalazal haustorium may be uni or multicellular. Secondary endosperm haustoria occur in Comandra and Mida. Suspensor may or may not be present in the embryo. Suspensor polyembryony occurs in Exocarpos. Pericap is differentiated into epicarp, mesocarp and endocarp. It would be worthwile to investigate the embryology of more genera to gain information on the placental ovular complex, embryo sac and endosperm. Histochemistry, ultastructure and biochemical studies would yield useful data that could reveal the structure and function of female gametophyte and endosperm, and their haustoria. Extra ovular nature of embryo sac can be an important tool to study the biochemistry of nutrition in some of these parasitic plants.

1897 CHATURVEDI, AN. 1987. **Tissue culture of forest trees**. *J. of Trop. Forestry*, 3: 3, 239-241; 4 ref.

It is argued that at present tissue culture is not a useful technique for the mass propagation of forest trees, and that before it can become a practical method a great deal more research is required. A particularly useful development would be the possibility of tissue culture propagation from mature plus trees.

1898 CRUZ, C. 1988. **Potential impact of biotechnology research for multipurpose tree species**. *Multipurpose Tree Species Network Research Series Paper*, No. 3: 58 p.; 28 ref.

The basic objective of this study was to assess the potential socioeconomic effects of biotechnology research on multipurpose trees (MPTS), with particular reference to resource management problems in the forestry sectors of the Philippines, Thailand and Nepal. Three research areas were identified for investigation: (1) tissue culture for the production and enhancement of planting material; (2) tissue culture for genetic improvement; and (3) the use of microorganisms to enhance performance. Research into areas (1) and (3) is classified as applied, and has short-term returns, while (2) is classified as strategic, with long-term returns. The problem of deforestation in the countries concerned is discussed, and an analysis made of the potential sectoral beneficiaries of biotechnology research on MPTS. The forest resource management problem is examined and emerging strategies for sustainable development and equity discussed. An assessment is made of MPTS biotechnology research in the context of prevailing forest management strategies, analysing each of research areas (1)-(3) in turn. Costs and benefits are considered and the implications for government strategies in reforestation and participatory agroforestry discussed.

1899 D'SILVA, I; D'SOUZA, L. 1992. **Micropropagation of *Ailanthus malabarica DC.* using juvenile and mature tree tissues**. *Silvae Genet.*, 41: 6, 333-339.

1900 DUBE, A; BHARTI, S; LALORAYA, MM. 1993. **Inhibition of anthocyanin synthesis and phenylalanine ammonia-lyase activity by CO2 ion in leaf disks of *Terminalia catappa***. *Physiologia Plantarum*, 88: 2, 237-242.

1901 HOSSAIN, M; HOSSAIN, SN; HAKIM, L. 1995. **In vitro multiplication of woody legume *Samanea saman (Jacq.) Merr***. *Annual Pl. Tissue Cult. Conf.* (Dhaka University, Dept. of Botany: 1995: March 19).

1902 JAHN, SAA. 1989. ***Moringa oleifera* for food and water purification - selection of clones and growing of annual short-stem**. *Entwicklung + Landlicher Raum*, 23: 4, 22-25; 9 ref.

M. oleifera is a tropical multipurpose tree which is readily propagated from seeds or cuttings. Both in India, its country of origin, and in other areas of cultivation, the yield and quality of seeds is highly variable, ranging from 1500 to 2000/year in Java (cuttings) to 20 000 to 24 000/year in Tamil Nadu, India (seed-propagated). The latter large-seeded clones were collected in the kitchen garden of a college and the nursery of a horticultural research station. A sample from Burundi was derived from trees planted by Zaire fishermen and subsequently abandoned. Clones were small-seeded in Indonesia where *Moringa* is primarily grown for its leaves. By contrast, trees in the Antilles and Central America had been selected for oil yield, leading to many large-seeded genotypes. Comparative water treatment experiments, in which powdered seed extracts are used to purify drinking water, indicated that seed size does not affect purification efficacy. Mature seeds gave more satisfactory results than sun-dried green seeds of equal size. The annual short-stemmed *M. oleifera* variety from Kudumiamalai, Tamil Nadu, is suitable for consumption, oil extraction and water purification. Recommendations on its cultivation are presented.

1903 JAISWAL, PL; WADHWANI, AM; SINGH, RAJINDER; CHHABRA, NN; HALLAN, S. 1983. **Genetical research in India.** Indian Council of Agricultural Research, Publications and Information Division, New Delhi, India. x, 358 p.

One of four volumes describing genetic and related research in India and published to mark the XV International Congress of Genetics held at New Delhi on December 12-21, 1983. There is one paper of forestry interest: Kedharnath, S. Genetics and forest-tree breeding. 18-190 [37 ref.] Tree breeding strategies employed in India include the exploitation of natural variation and the testing of hybrids (inter- and intra-specific and interprovenance). Work on teak, semul (*Bombax ceiba* [*B. malabaricum*]), eucalypts and chir pine is described briefly.

1904 KAPOOR, ML. 1989. **Tissue culture and its genetic aspect in forestry biomass production**. *Indian Forester*, 115: 10, 696-705; 41 ref.

A short review of tissue culture work with forest trees and related species (palms), including a list of species which have been regenerated by this technique. Brief accounts are given of the major systems and techniques and their applications: callus culture; anther culture; meristem culture - including virus eradication, micropropagation using shoot apex cultures, and the storage of genetic resources as shoot tips; protoplast technology; and mutation breeding with cell suspensions. The composition of culture media, the cultural environment, and problems in clonal propagation are discussed.

1905 KAUR, R; SHARMA, DR; SRIVASTAVA, DK. 1993. **Micropropagation of *Alnus nepalensis***. *Ind. Jour. forestry*, 16: 162-164.

1906 KHOSLA, PK. 1982. **Propagation of trees (Session 3).** *Symposium proceedings: Improvement of*

forest biomass. (Solan: H.P. Agricultural Univ., S.N.S. Nagar-173 230, Solan, India), p. 153-214; 101 ref.

Nine papers: Chauhan, P.S.; Sehgal, R.N. Propagation of forest trees by stem cuttings. 155-159 [5 ref.] Jain, M.K. Some physiological aspects of rooting of cuttings[s] in forest trees. 161-168 [6 ref.] Pal, M. Interaction between auxins and ethrel in root formation on stem cuttings of *Populus robusta Schneid [P. robusta]* 169-173 [8 ref.] Sharma, G.K.; Raina, V. Propagation techniques of *Moringa oleifera Lam*. 175-181 [7 ref.] Data on seed storage, treatment and germination and propagation by stem cuttings. Parmar, C.; Kumar, J. Studies on sexual and vegetative propagation of *Murraya koenigii L. Spreng*. 183-186 [5 ref.] Chauhan, P.S.; Dua, I.S. Effect of growth hormone on air-layering of some forest trees of sub-Himalayan tract. 187-191 [6 ref.] Nagpal, R.; Puri, S.; Khosla, P.K. Propagation of *Olea europaea* by air-layering. 193-199 [7 ref.] Singh, R.P.; Sharma, S.D. Standardization of propagation methods for top working of wild olive trees (*Olea cuspidata Wall.*) 201-203 [4 ref.] A comparison of 5 methods of budding and grafting. Bajaj, Y.P.S. Cryopreservation of germplasm of forest trees. 205-214.

1907 KHOSLA, PK. 1982. **Tree biology (Session-6).** *Symposium proceedings: Improvement of forest biomass*. Dep. Fty., H.P. Agricultural Univ., S.N.S. Nagar-173 230, Solan, India, p. 329-434; 250 ref.

Ten papers; one of which (by Madan, M. et al.) is noticed separately in FPA: Dhawan, A.K.; Malik, C.P. Effect of various growth regulators and light conditions on the activities of pollen oxido-reductases in *Pinus roxburghii Sarg*. 331-363 [47 ref.] Dua, I.S.; Chark, K.S.; Dhir, K.K.; Khosla, P.K. Potentiality of using plant growth regulating substances in flowering manipulation of some forest trees. 365-378 [95 ref., 1 pl.] Kohli, R.K.; Tandon, P. Biochemical adaptations in *Pinus kesiya Royle ex Gord* population growing at different altitudes. 379-385 [9 ref.] Iqbal, M.; Ghouse, A.K.M. Environmental influence on growth activities of *Prosopis spicigera*. 387-393 [22 ref.] The effect of temperature on cambial activity. Khosla, P.K.; Goverdhan Singh.; Sehgal, R.N. Pollen plant pollinator interactions and pollination energetics of *Bombax ceiba* [*B. malabaricum*] 395-401 [17 ref.] Ramakrishnan, P.S.; Shukla, R.P. On the relation among growth strategies, allocation pattern, productivity and successional status of trees of a sub-tropical forest community. 403-412 [19 ref.] The results of studies in a humid community at Lailad, NE India, developed after slash and burn agriculture. Khurana, D.K.; Bhanwara, R.K. Ontogeny of catkin-drop and embryology of *Populus ciliata* and its crosses with *P. deltoides*. 413-418 [19 ref.] Bhandari, A.R.; Chauhan, P.S. Effect of zinc on the growth of seedlings of *Pinus roxburghii* Sarg. 419-422 [7 ref.] Chauhan, P.S.; Bhandari, A.R. Effect of micronutrient application on the growth of *Pinus roxburghii* seedlings 423-427 [9 ref., 1 pl.]

1908 MASCARENHAS, AF; KHUSPE, SS; NADGAUDA, RS; GUPTA, PK; KHAN, BM. 1988. **Potential of cell culture in plantation forestry programs.** *Genetic manipulation of woody plants*/edited by JW Hanover, DE Keathley. New York: Plenum Press, p. 391-412; 68 ref.

Results are summarized of field evaluations in India of plantlets produced by tissue culture of material from mature trees of *Eucalyptus tereticornis*, *E. torelliana*, *E. citriodora*, *Tectona grandis* and *Salvadora persica*. Economic and other benefits of these procedures are discussed.

1909 MASCARENHAS, AF; MURALIDHARAN, EM. 1989. **Tissue culture of forest trees in India**. *Current Science*, 58: 11, 606-613; 115 ref.

Studies on the subject are briefly reviewed and presented in a tabulated form. Many of the studies are directed at large scale micropropagation of economically important species.

1910 MATHEW, G; MOHAMED-ALI, MI. 1987. **Microbial pathogens causing mortality in the carpenterworm, *Cossus cadambae* Moore (Lepidoptera, *Cossidae*), a pest of teak (*Tectona grandis Linn. f.*) in Kerala (India)**. *Journal of Tropical Forestry*, 3: 4, 349-351;3 ref.

Six species of pathogenic organisms were isolated and identified from field and laboratory specimens of *C. cadambae*, a wood borer found in teak [*Tectona grandis*] plantations in Kerala: *Aspergillus flavus* from larvae, pupae and adults; *Paecilomyces fumosoroseus* from larvae and adults; and *Serratia marcescens*, *Pseudomonas sp.*, *Penicillium citrinum* and *Fusarium solani* from larvae. Pathogenicity tests were carried out on larvae for the first 4 of these; mortality was 57, 57, 83.3 and 28.5% respectively after topical application or by inclusion in the diet.

1911 NANDA, KK; ANGRISH, R. 1982. **Culture of shoot meristematic organs as an aid to understanding the physiology of growth and development of woody plants**. *Journal of Tree Sciences*, 1: 1/2, 112-119; 25 ref.

1912 PAILY, J; D'SOUZA, L. 1986. **In vitro clonal propagation of *Lagerstroemia flos-reginae Retz.*** *Plant Cell, Tissue and Organ Culture*, 6: 1, 41-45; 12 ref.

Seed germination in *L. flos-reginae [speciosa]* is slow and vegetative propagation is normally difficult. Multiple shoots were obtained from explants of nodal segments from young (non-flowering, 4-year-old) and mature (30-year-old) trees following culture on Murashige and Skoog (MS) nutrient agar medium with 7.50-20 mg BA/litre. Rooting was achieved when the shoots were transferred to MS medium with 1 mg IBA/litre and the plantlets were successfully transferred to soil. Explants from mature trees required 15 mg BA for maximum production of multiple shoots, compared with 7.50 mg for those from young trees; shoot production was also lower and took longer.

1913 PAL, A. 1983. **Regeneration of a tree - *Leucosceptrum canum Sm.* through meristem culture.** *Current Science*, 52: 24, 1198-1199; 6 ref.

Buds were collected from a 40-ft tree in Gantok, Sikkim. Apical portions (1-1.5 cm) and small (about 1.5 cm) stem segments at nodes with axillary meristems were washed, treated with 5% teepol and sterilized in 0.1% mercuric chloride sol. before washing again. The apical and axillary meristems were cultured in MS basal medium supplemented with various concn. of benzylaminopurine (BAP) or kinetin alone or with IAA or IBA. Best responses were with BAP at 2.5 mg/litre or at 0.5 mg/litre with IBA at 0.1 mg/litre, when leafy shoot buds developed within 7 days. Formation was slightly delayed using axillary meristems, but many subcultures were possible from both types. No roots were formed when shoots with 6-10 leaves were transplanted to MS basal medium without added growth regulators but formed well on medium with half strength macrosalts supplemented with NAA or IBA at 1-3 mg/litre. Root initiation from shoots also occurred and was maintained over 4 passages in medium supplemented with BAP at 0.5 mg/litre plus IBA at 0.1 mg/litre; shoot initiation also occurred from the basal portion of the main shoot in this medium. Roots also developed from the nodes of regenerated plants, although adventitious roots do not form in vivo. Such roots produced shoot buds on media supplemented with BAP (1 or 2.5 mg/litre) alone or with IBA at 0.1 mg/litre, and the shoot buds could be processed to develop roots as already described. Various methods can, therefore, be used for mass propagation of the tree. The compact brown callus produced in all media containing BAP did not itself produce roots or shoots in any media.

1914 PATRI, SARITA; BHATNAGAR, SP; BHOJWANI, SS. 1988. **Preliminary investigations on micropropagation of a leguminous timber tree: *Pterocarpus santalinus*.** *Phytomorphology*, 38: 1, 41-45.

In vitro shoot multiplication was obtained from single node and terminal cuttings derived from aseptic seedlings and shoots differentiated from cotyledon callus of *Pterocarpus santalinus*. MS medium (1/4 salts) + benzyladenine (3 μM) + adenine (0.4 mM) was better than other media combinations. Adventitious shoot formation from the cotyledonary callus occurred on MS+benzyladenine (3 μM) at 28$\pm$2°C.

1915 RATHORE, TS; DEORA, NS; SHEKHAWAT, NS. 1992. **Cloning of *Maytenus emarginata (Willd.) Ding Hou* - a tree of the Indian desert, through tissue culture.** *Pl. Cell Reports*, 11: 9, 449-451; 10 ref.

An in vitro method for cloning and mass multiplication of *M. emarginata*, a highly drought resistant tree, was developed. Shoot segments harvested in March and July-August from 30-year-old plus trees (selected on the basis of their straight and solid bole and large size) were cultured to produce multiple shoots (10-15 shoots/explant) on MS medium containing 0.1 mg IAA and 2.5 mg BAP [benzyladenine]/litre. In vitro produced shoots were subcultured on shoot proliferation medium with 1.0 mg of BAP/litre for further shoot multiplication. Isolated individual shoots were cultured on a filter paper bridge in half-strength MS liquid medium containing 25 mg IBA/litre for 72 h in the dark at 28 $\pm$ 2°C for root induction. About 70-80% of shoots rooted. The treelets were hardened and transferred to pots. Around 20,000 plants were obtained from a single explant within a period of 6 months. The protocol is highly reproducible and efficient.

1916 RISHI, ND; SHAH, KA. 1985. **Survey and bioecological studies on the natural enemy complex of Indian gypsy moth, *Lymantria obfuscata Walker (Lepidoptera: Lymantriidae)*.** *Journal of Entomological Research*, 9: 1, 82-93; 14 ref.

A survey of the natural enemies of *Lymantria obfuscata*, a potential pest of deciduous fruit and forest trees in Kashmir and Himachal Pradesh, India, was conducted in 1980-83. Developmental stages of the pest were collected from infested trees of *Salix babylonica*, *Populus nigra*, apple, *Prunus* communis [P. dulcis] and walnut at various localities. A complex of 47 species of parasites and predators was reared from the different developmental stages of the pest. The biology of the most promising natural enemies, the eupelmid *Anastatus kashmirensis*, the tachinid *Exorista rossica*, the braconid

Apanteles indiensis and the carabid *Calosoma himalayanum*, was studied in the laboratory and field. These species were widely distributed in all host-inhabited niches and their numbers remained markedly stable. The biotic potential and possibilities of their integration as biological control agents in a pest management programme of *L. obfuscata* is discussed.

1917 ROY, SK. 1995. **In vitro micropropagation technique for high quality planting stock of some timber trees**. *Annual Plant Tissue Culture Conference*. (Dhaka University, Dept. of Botany: 1995: March 19).

1918 ROY, SK; ISLAM, MS; SEN, J; HADIUZ-ZAMAN, S. 1993. **Shoot tip, an alternative to seed as a source for conservation and propagation of forest trees**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: Dec 19-21).

1919 SEN, J; ISLAM, MS; ROY, SK; HADIUZ-ZAMAN, S. 1992. **Micropropagation of juvenile and adult *Gmelina arborea***. *Plant Tissue Cult.*, 2: 2, 89-95.

Successful propagation of juvenile and mature plants of *Gmelina arborea Roxb.* has been achieved by in vitro methods. Multiple shoot formation was obtained by culturing shoot tips and nodal explants of juvenile source on MS medium containing 1.0 mg/l BA and 0.1 mg/l NAA. Explants from mature plants required higher concentrations of BA (1.4 mg/l) and NAA (0.2 mg/l). For inducing axial growth in regenerated shoots, the concentration of BA and NAA were lowered and casein hydrolysate (CH) at 100 mg/l and coconut milk (CM) at 10% were added to the medium. 100% rooting was achieved on 1/2 MS medium with 1.0 mg/l each of IBA and NAA in microshoots of juvenile plant source and 2.0 mg/l each of IBA and NAA in those of mature plant source. About 75% of these plants survived.

1920 SEN-SARMA, PK; THAKUR, ML. 1988. **Insect factors in the management of forest resources**. *Myforest*, 24: 2, 99-113; 22 ref.

A brief review, describing insect pests of Indian forest nurseries, natural forests and forest plantations (data are tabulated on the most important pests, giving the host species, and distribution), and their management (cultural practices in nurseries, silvicultural practices, and biological and chemical control). Future research approaches are discussed and include the improvement of stands by tree breeding, the development of microbial control techniques, and exploitation of the natural antibiotic characteristics of resistant species by grafting them onto susceptible species.

1921 UNNIKRISHNAN, SK; PRAKASH, L; JOSE-KUTTY, PC; BHATT, PN; MEHTA, AR. 1991. **Effect of NaCl salinity on somatic embryo development in *Sapindus trifoliatus L.*** *Journal of Experimental Botany*, 42: 236, 401-406; 28 ref.

The effect of NaCl salinity on growth and development of somatic embryos from young leaves of *Sapindus trifoliatus* (soapnut tree) was examined. Incorporation of 25 and 50 mol/m3 NaCl into the medium greatly increased growth and development of somatic embryos and both these concentrations favoured the production of secondary embryoids. However, supplementation with 100 mol/m3 NaCl did not have any significant effect on growth and development of somatic embryos. Culturing proembryo structures in medium containing 200 mol/m3 NaCl resulted in complete death within 7 d of salt exposure. Analysis of somatic embryos revealed that, upon salinization, they accumulated Na and Cl in significant amounts but the content of Na was much less than that of Cl. Addition of NaCl (up to 50 mol/m3) to the medium resulted in a considerable increase in K content of somatic embryos. Proline in somatic embryos, however, increased substantially in response to salinization. Free sterols, steryl glycosides, steryl esters, and phospholipids also increased to higher values in salt-affected somatic embryos. The results suggest that somatic embryos of *S. trifoliatus* can tolerate concentrations of NaCl up to 100 mol/m3 without affecting growth and that they have sufficient cellular mechanisms to tolerate salinity at relatively high levels.

1922 VIJAYAKUMAR, NK; FERET, PP; SHARIK, TL. 1990. **In vitro propagation of the endangered Virginia roundleaf birch (*Betula uber*) using dormant buds**. *Forest Science*, 36: 3, 842-846; 14 ref.

Dormant buds collected from greenhouse and field-grown trees of *Betula uber*, the endangered Virginia round-leaf birch, were used for micropropagation. A nutrient medium containing the mineral salts of Murashige and Skoog supplemented with organic nutrients and growth regulators supported bud break, elongation and limited multiplication. Shoots were 2-3 cm in height with 3-4 leaves in 4 wk. They developed roots in vivo in 4-6 wk in peat pellets under high humidity with 16 h photoperiod at 20°C. Explants from all (4) trees behaved uniformly in culture. This study showed the potential to generate a large number of plants without the intermediary of callus, and therefore the genetic stability of the plantlets is expected to be high.

Acacia

1923 DEWAN, A; NANDA, K; GUPTA, SC. 1993. **In vitro micropropagation of *Acacia nilotica subsp. indica Brenan* via cotyledonary nodes**. *Plant Cell Reports*, 12: 1, 18-21.

1924 MATHUR, I; CHANDRA, N. 1983. **Induced regeneration in stem explants of *Acacia nilotica***. *Current Science*, 52: 18, 882-883; 3 ref., 1 pl. APB.

Young stem segments about 10-20 mm long and including portions of an internode and a node were collected from young twigs. The leaf bases and axillary buds were removed and the segments washed in distilled water and surface sterilized with 0.1% (w/v) mercuric chloride sol. After further washing the segments were implanted in MS medium supplemented with various growth regulators, and incubated under diffuse light at 26±2°C. Segments grown with different combinations of auxin and kinetin produced a yellow, friable and slow-growing callus which turned brown; in many cases a brown or purplish substance leached into the medium. Formation of phenolic compounds was not prevented by the addition of PVP. When segments were cultured on MS + IAA (0.5-1 mg/l) 1-4 shoot buds developed from nodal portion and roots emerged from the opposite pole after 10-15 days incubation. Explants from other organs (leaf, cotyledon etc) grown with various combinations of growth regulators only showed callus formation.

1925 MITTAL, ARADHANA; AGARWAL, RINA; GUPTA, SC. 1989. **In vitro development of plantlets from axillary buds of *Acacia auriculiformis* - a leguminous tree**. *Plant Cell, Tissue and Organ Culture*, 19: 1, 65-70; 14 ref.

Multiple shoots of *A. auriculiformis* were only obtained from axillary buds; although roots and some calli were induced under hormone influence, other explants (seedling leaves, cotyledons and hypocotyl segments) failed to differentiate shoots. Parent explants with multiple shoots, when transferred to a basal medium and suppl. with IAA or NAA, developed roots within 50-60 days.

1926 RAO, GVR; PRASAD, MNV. 1991. **Plantlet regeneration from the hypocotyl callus of *Acacia auriculiformis* - multipurpose tree legume**. *Journal of Plant Physiology*, 137: 5, 625-627.

Albizia

1927 GHARYAL, PK; RASHID, A; MAHESHWARI, SC. 1983. **Production of haploid plantlets in anther cultures of *Albizzia lebbeck L.***. *Plant Cell Reports*, 2: 6, 308-309; 12 ref.

Anthers on B5 medium (BM) supplemented with kinetin (2 mg/l) and 2,4-D (0.5 mg/l) showed callus initiation from microspores. Differentiation of embryoids and shoots was obtained on BM + BA (1 mg/l)+IAA (0.5 mg/l) and of roots on BM. Root tip squashes of the regenerated plantlets showed the haploid chromosome number (n=13), confirming the microspore origin of the regenerants.

1928 HOSSAIN, SN; HOSSAIN, M; HAKIM, L. 1995. **Morphogenic responses of shoot tip of *Albizia procera (Roxb.) Benth.* following different hormonal treatment**. *Annual Plant Tissue Culture Conference*. (Dhaka University, Dept. of Botany: 1995: March 19).

1929 PHUKAN, MK; MITRA, GC. 1983. **In vitro regeneration of *Albizzia odoratissima Benth.*, a shade tree for the tea plantation of north-east India**. *Two and a Bud*, 30: 1/2, 54-58; 10 ref.

Culture of *A.* [*Albizia*] *odoratissima* shoot tips 7-10 mm long in Murashige/Skoog (MS) medium with 1 mg/litre benzylaminopurine (BA) produced elongation and 8-10 shoot-bud primordia. Increase in BA concn. progressively reduced shoot bud numbers. Isolated shoot buds grew on in the same way as mother shoot tips such that approx. 1000 buds were regenerated from a single shoot bud after 3 successive culture generations. Regenerated shoots with 3-4 unfolded leaves were excised and grown on in MS medium with 1% sucrose and 1 mg/litre IAA or IBA, giving 70-80% rooting within 1 month. Rooted shoots were then grown on in successive cultures with gradual reductions in auxin and sugar concn. in preparation for transplanting into field soil. Trials with explants of root, leaf, cotyledon and hypocotyl tissues showed that only hypocotyl cultures regenerated shoot buds (in MS + 0.5 mg/litre NAA + 4 mg/litre BA) with 50% of the resultant shoots producing roots in MS + 2 mg/litre IBA + 1 mg/litre kinetin.

1930 SINHA, R KUMAR; MALLICK, R. 1993. **Regeneration and multiplication of shoot in *Albizia falcataria***. *Pl. Cell, Tissue & Org. Cul.*, 32:2, 259-261.

1931 VARGHESE, TM; KAUR, AMARJEET. 1988. **In vitro propagation of *Albizzia lebbeck Benth.***. *Current Science*, 57: 18, 1010-1012; 9 ref.

Seeds of *Albizia lebbek* were surface sterilized and germinated on agar medium in the dark. Hypocotyl,

cotyledon, root, leaf and rachis segments were excised from 7 to 10-day-old seedlings and cultured on MS medium (pH 5.8). Benzyladenine and kinetin (1-4 mg/l) and auxins (NAA and IAA at 1-2 mg/l) were also incorporated. Callus was subcultured after 15-20 days. The different types of explant initiated callus after different lengths of time, ranging from 7-9 days for hypocotyls to 12-15 days for leaves. Shoots were induced earliest in hypocotyl callus (after 40-45 days) and latest in leaf callus (70-80 days). Regenerated plants displayed variation in plant height, leaf type and branching. Some regenerants were dwarf with short internodes.

Bamboos

1932 HASAN, SM. 1980. **Studies on the structure and growth of bamboo buds in the light of their probable use in tissue culture**. *Bano Biggyan Patrika*, 9: 1/2, 1-16; 22 ref.

A study of rhizome, culm and branch buds from clumps of 19 species and 2 varieties growing in the Forest Research Institute Arboretum at Chittagong in 1972-76.

1933 MUKUNTHAKUMAR, S; MATHUR, J. 1992. **Artificial seed production in the male bamboo *Dendrocalamus strictus L.*** *Plant Science Limerick*, 87: 1, 109-113; 15 ref.

Artifical seeds were prepared by encapsulating somatic embryos, obtained on MS medium containing 3.0 mg 2,4-D and 0.5 mg kinetin/litre, in calcium alginate beads. A germination frequency of 96% and 45% was achieved in vitro and in soil, respectively. The in vivo plantlet conversion frequency was increased to 56% following an additional coating of mineral oil on the alginate beads. Germinated artificial seeds could be raised into plantlets.

1934 NADGAUDA, RS; PARASHARAMI, VA; MASCARENHAS, AF. 1990. **Precocious flowering and seeding behaviour in tissue-cultured bamboos**. *Nature*, 344: 6264, 335-336; 10 ref.

Segments 3-4 cm long of the coleoptiles of *Bambusa arundinacea* and *Dendrocalamus brandisii* were cultured in liquid MS medium containing 2% sucrose at 28°C under light on a rotary shaker. Shoots which developed were subcultured on MS medium with various supplements. The best response, obtained on medium containing 2% sucrose, 0.5 p.p.m. benzylamino-purine [benzyladenine] and 5% coconut milk, resulted in 15-20 shoots per culture vessel. After 3 consecutive subcultures on this medium, 70% of *B. arundinacea* and 40% of *D. brandisii* cultures developed panicles of normal spikelets. Rooting was induced in White's liquid medium and the plantlets were transferred to soil. About 50 normal seeds were obtained from each culture of *B. arundinacea* whereas each *D. brandisii* culture produced about 5. This technique overcomes the problem of unpredictable, gregarious flowering in bamboo, which only occurs after 12-120 years, and is thought to have potential for breeding and seed production.

1935 NADGIR, AL; PHADKE, CH; GUPTA, PK; PARSHARAMI, VA; NAIR, S; MASCARENHAS, AF. 1984. **Rapid multiplication of bamboo by tissue culture**. *Silvae Genetica*, 33: 6, 219-223; 17 ref.

Multiple shoots of *Dendrocalamus strictus* were obtained from seedlings in shake flasks on a liquid medium containing Murashige & Skoog's medium (MS) supplemented with benzylaminopurine (BAP) and coconut milk. Rooting of these shoots was obtained on half-strength liquid MS after treatment with IBA for 48 h in the dark. The rooted plantlets were transferred to the field, where survival was 70-80%. No morphological abnormalities were observed after 15 months. Fifteen subcultures have been carried out from seedling explants at 6-7 wk intervals without any reduction in the capacity for shoot or root formation. By this method of subculture it is estimated that 10 000 plantlets can be obtained from one seedling in a year. Multiple shoots were obtained from nodal segments of mature trees of *D. strictus*, *Bambusa arundinacea* and *B. vulgaris* on MS supplemented with coconut milk, kinetin and BAP. Rooting of the shoots of *D. strictus* was obtained on half-strength MS with activated charcoal after treatment with IBA for 96 h in the dark.

1936 RAHMAN, MA; KHISA, SK; BASAK, AC. 1983. **Some facrors related to the regeneration and mortality of two bamboo spcies in Bangladesh.** *Bano Biggyan Patrika*, 12: 1&2, 6-11.

1937 RAO, IU; RAO, IVR; NARANG, VIBHA. 1992. **Rapid propagation of bamboos through tissue culture.** *Rapid propagation of fast growing woody species: Proceedings of a symposium*. (Wallingford: 1989)/edited by FWG Baker. CAB International, Wallingford, UK. p. 57-70; 32 ref.

In vitro propagation methods include: somatic embryogenesis, nodal explants and multiple shoots from seeds. Rearing, potting and acclimatization of plantlets is discussed.

1938 RAO, IVR; RAO, IU; ROOHI, FN. 1992. **Bamboo propagation through conventional and in**

vitro techniques. *Rapid propagation of fast growing woody species: Proceedings of a symposium*/edited by FWG Baker. CABI, Wallingford, UK. p. 41-56; 44 ref.

Conventional propagation methods include: division, macro-proliferation, rhizomes, offsets, layering, marcotting, and culm and branch cuttings.

1939 RAO, UI; RAO, IVR; NARANG, V. 1985. **Somatic embryogenesis and regeneration of plants in the bamboo *Dendrocalamus strictus*.** *Plant Cell Reports*, 4: 4, 191-194; 14 ref.

Callus cultures were obtained from the embryonal end of caryopses cultivated on B5 medium supplemented with 2,4-D. Chlorophyllous embryoids differentiated from the callus, and on transfer to a germination medium 40% of them developed into plantlets. Further development of the plantlets occurred on half-strength B5 liquid medium supplemented with sucrose, IBA and NAA.

1940 SAXENA, SANJAY. 1990. **In vitro propagation of the bamboo (*Bambusa tulda Roxb.*) through shoot proliferation**. *Plant Cell Reports*, 9: 8, 431-434; 22 ref.

Shoots from 3-week-old aseptically grown seedlings were used to initiate cultures. Multiple shoots were obtained on liquid MS medium supplemented with benzyladenine (8 X 10-6 M) and kinetin (4 X 10-6 M). Continuous shoot proliferation at a rate of 4-5 fold every 3 weeks was achieved through forced axillary branching. More than 90% of shoots were rooted on a modified MS medium containing IAA (1 X 10-5 M) and coumarin (6.8 X 10-5 M). Following simple hardening procedures, the in vitro raised plants were transferred to soil with an >80% success rate.

Bauhinia

1941 KUMAR, A. 1992. **Micropropagation of a mature leguminous tree - *Bauhinia purpurea*.** *Plant Cell, Tissue and Organ Culture*, 31: 3, 257-259.

1942 MATHUR, JAIDEEP; MUKUNTHAKUMAR, S. 1992. **Micropropagation of *Bauhinia variegata* and *Parkinsonia aculeata* from nodal explants of mature trees**. *Pl. Cell, Tiss. & Org. Cult.*, 28: 1, 119-121.

In vitro propagation protocols were established for 2 leguminous trees, *B. variegata* and *P. aculeata*. In each case axillary shoot proliferation was achieved from nodal explants from mature (6-8 year-old) trees using MS medium supplemented with 2.22-31.1 μM benzyladenine. Subsequent rooting of the regenerated shoots was achieved on medium containing 2.46-14.8 μM of IBA. Transfer of the regenerants to soil was successful.

Cassia siamea

1943 GHARYAL, PK; RASHID, A; MAHESHWARI, SC. 1983. **Androgenic response from cultured anthers of a leguminous tree, *Cassia siamea Lam.*** *Protoplasma*, 118: 1, 91-93; 17 ref.

Pollen-derived callus was obtained on B5 medium supplemented with coconut milk (15% v/v), 2,4-D (2 mg/l) and kinetin (0.5 mg/l). Callus cells had n = 14 chromosomes.

1944 SHIVAPPA SHETTY, K; BALASUBRAMANYA, RH; SIDDARAME GOWDA, TK; PATIL, RB. 1974. **Studies on the disease of *Cassia siamea Lam.* caused by *Fusarium*.** *Mysore J. Agric. Sci.* 8: 384-390.

Conifers

1945 DHAWAN, VIBHA. 1989. **Applications of biotechnology in forestry and horticulture**. New York: Plenum Press, 385 p.

This book is the proceedings of an international workshop organized by the Tata Energy Research Institute on 14-16 January 1988 in New Delhi, India. The 29 chapters, many referring to India, are in 5 sections: Current status of forestry (5 chapters); Applications of tissue culture in forestry and horticulture (11); Commercial exploitation of tissue culture in horticulture (6); Nitrogen fixation studies in forestry (3 on the micropropagation and nodulation of tree legumes, the role of mycorrhizas in forestry and the effects of mycorrhizas and glyphosate on nodules of *Alnus glutinosa*); and Genetic engineering of forest species (4). The final chapter, Concluding remarks, includes recommendations following deliberations. A taxonomic index is included.

1946 GUPTA, PK. 1988. **Advances in biotechnology of conifers**. *Current Science*, 57: 12, 629-637; 60 ref.

A review, describing micropropagation methods used for conifers, and genetic engineering *studies*. *Micropropagation* is generally done in three ways: enhancement of axillary bud break (the main method used for clonal propagation of herbaceous ornamentals, fruit trees, and some broadleaved forest trees); adventitious budding (production of shoot primordia on tissue such as cotyledons, leaves, stems etc.); and somatic (or asexual) embryogenesis from tissue (direct somatic embryogene-

sis), and from cells or protoplasts (indirect somatic embryogenesis). The latter method offers great potential for the large-scale production of plants at lower costs. Aspects described are: explant source; culture conditions; somatic embryo delivery systems (encapsulating embryos to produce artificial seeds); freeze preservation of embryonal cells; and protoplast isolation and culture. The brief discussion of genetic engineering includes an account of tumour induction in, and transfer of kanamycin resistance to, micropropagated shoots of Douglas fir (*Pseudotsuga menziesii*) and of direct gene transfer, here described for Douglas fir and loblolly pine (*Pinus taeda*) protoplasts.

1947 GUPTA, PK; DANDEKAR, AM; DURZAN, DJ. 1989. **Genetic transformation system in Douglas fir *Pseudotsuga menziesii*.** *Applications of biotechnology in forestry and horticulture* /edited by Vibha Dhawan. New York: Plenum Press, p. 339-347; 26 ref.

Tumours were induced in micropropagated shoots and seedlings grown in vitro, using 2 strains of *Agrobacterium tumefaciens*. These strains contain a derivative of the wild type Ti plasmid PtiA6 which contains a chimeric bacterial gene for resistance to kanamycin. Excised tumours grew on medium without phytohormones and synthesized octopine, demonstrating that the cells were transformed by *Agrobacterium* T-DNA. Transformed cells demonstrated the transcription of the kanamycin resistance gene and its translation into an active protein. The luciferase gene from *Photinus pyralis* was directly transferred by electroporation to protoplasts from an embryonal suspension culture of Douglas fir.

Dalbergia sissoo

1948 BHANDARY, SBR. 1988. **In vitro propagation of *Dalbergia sissoo*.** *Banko Janakari*, 2: 1, 31-33.

Excised cotyledons from germinated seeds of *D. sissoo* were successfully cultured on Murashige and Smoog medium with added casein hydrolysate and benzylaminopurine [benzyladenine]. The shoots produced were rooted in sand beds. The plants produced performed similarly to those of seedling or shoot cutting origin in a field trial in 1985 at Godavari, near Kathmandu.

1949 DATTA, SK; DATTA, K. 1983. **Auxin induced regeneration of forest tree - *Dalbergia sissoo Roxb.* through tissue culture**. *Current Science*, 52: 9, 434-436; 17 ref.

Plantlets were successfully grown over 60 days using nodal explants taken from a mature tree and cultured in MS (Murashige and Skoog) medium supplemented with IAA or IAA and NAA. IPA (indolepropionic acid) and 2,4-D did not stimulate callus or plantlet formation.

1950 DATTA, SK; PRAMANIK, TK. 1984. **In vitro response of exogenous growth regulators on endogenous IAA induced xylogenesis and regeneration potentiality of timber tree - *Dalbergia sissoo Roxb.*** *Pacific Regional Wood Anatomy Conference: Proceedings*. (Ibaraki, Japan: 1984: Oct 1-7)/edited by S Sudo. Forestry and Forest Products Research Institute, Ibaraki, Japan. p. 126-128; 12 ref.

Nodal explant calluses were grown on a medium containing 2,4-D, BAP (benzylaminopurine), 2,4-D plus BAP, TIBA (triiodobenzoid acid) or a combination of BAP and TIBA. Xylogenesis was stimulated by both 2,4-D and BAP. However, some tracheary cells were present in the controls, which received no exogenous growth regulator and it is concluded that endogenous IAA may have induced some xylogenesis. TIBA, an anti-auxin, reduced xylogenesis and also seemed to reduce the amounts of endogenous IAA measured in the culture.

1951 DATTA, SK; PRAMANIK, TK. 1983. **Xylogenesis in *Dalbergia sissoo Roxb.* A model system in elucidating cytodifferentiation and regeneration of plants through tissue culture**. *Journal of Tree Sciences*, 2: 1/2, 49-53; 8 ref.

Nodal explants (10-15 mm long) were collected from a mature tree in an active stage of growth and after sterilization, inoculated into MS medium supplemented with various combinations of auxins and cytokinins. Callus initiation occurred after 7-20 days, and initiation of xylem tissue (the formation of tracheary cells) at varying intervals after this. The most effective auxin for inducing xylogenesis was 2,4-D, followed by IAA, IBA and NAA. NAA gave an early response - after 8 days of culture. In almost all the auxin treatments xylogenesis was inhibited after 40 days because of de-differentiation; with NAA the inhibition occurred at 30 days. The most effective cytokinin for inducing xylogenesis was BAP [BA] which was effective after 14 days, kinetin was less effective. TIBA [a growth inhibitor] induced hardly any xylem cells. Both auxins and cytokinins induced shoot and root formation. Root formation was more frequent where there was a high percentage of tracheary cells.

1952 DAWRA, S; SHARMA, DR; CHOWDHURY, JB. 1984. **Clonal propagation of *Dalbergia sissoo Roxb.* through tissue culture**. *Current Science*, 53: 807-809.

1953 GILL, SS; GILL, RIS. 1993. **Mass vegetative multiplication of *Dalbergia sissoo* through tissue culture**. *Annals of Biology*, 9: 1, 28-33.

1954 KUMAR, A; TANDON, P; SHARMA, A. 1991. **Morphogenetic responses of cultured cells of cambial origin of a mature tree - *Dalbergia sissoo Roxb*.** *Plant Cell Reports*, 9: 12, 703-706; 23 ref.

Regeneration of plantlets was achieved from cell suspension derived calluses of cambial origin from mature elite trees of *D. sissoo*. Callus proliferation occurred on the cambial tissue pieces cultured on MS medium supplemented with 2 mg 2,4-D and 0.1 mg benzyladenine (BA)/litre. Suspension cultures were obtained by transferring and agitating callus lumps in liquid medium of the same composition as above. Aggregates of about 30 cells were plated on semisolid medium, which developed into calluses. Shoot bud differentiation was observed in the calluses transferred to medium devoid of auxin but containing 0.5-2.0 mg BA/litre. The isolated microshoots were rooted on modified MS medium containing low organic salts and auxins.

1955 KUMAR, ANJANI. 1989. **Silver nitrate promotes proliferation of *Dalbergia sissoo Roxb*. callus in vitro**. *Indian J. of Plant Physiol.*, 32: 4, 387-388; 6 ref.

Callus cultures of *D. sissoo*, about 4 wk old and raised from nodal explants, were grown in Murashige and Skoog culture medium containing NAA (1 mg/litre) and benzylaminopurine [benzyladenine] (2 mg/litre), and with added AgNO3 (0, 0.1, 0.5, 1.0 or 3.0 mg/litre). After 45 days' growth the calli grown in the absence of AgNO3 (controls) turned tan in colour and showed signs of senescence, while those grown in the presence of AgNO3 remained yellowish- white, the colour typical of vigorously proliferating callus. The fresh weight of the calli grown in the presence of AgNO3 was 3.2-7.6X greater, and the dry weight 5.0-7.4X greater, than that of the control callus, with the greatest increase occurring with 0.5 mg/litre AgNO3.

1956 RAI, VR. 1993. **Embryogenesis through cell suspension culture of forest tree: *Dalbergia latifolia Roxb*.** *Plant Tissue Culture*, 3: 1, 23-27.

Embryogenic cell suspension cultures were established from calli derived from hypocotyl segments of in vitro germinated seedlings of *Dalbergia latifolia* by placing them in MS liquid medium containing 1 mg/l NAA and 5 mg/l BAP. Different stages of development from single celled to globular proembryo which subsequently transformed into heart or torpedo shaped embryoid were observed. In order to regenerate plants cell suspensions were planted on to MS agar medium containing growth regulators in Petri dishes. Once the shoot buds differentiated, they were transferred to conical flask for further growth and development.

1957 RAI, VR; CHANDRA, KSJ. 1989. **Micropropagation of Indian rosewood by tissue culture**. *Annals of Botany*, 64: 1, 43-46; 19 ref.

Multiple shoots were induced on excised hypocotyl and shoot tips of in vitro germinated seedlings of *Dalbergia latifolia* on MS medium supplemented with cytokinins and auxins. Roots were induced when individual shoots were treated first with half strength MS medium supplemented with NAA, IAA and IBA (1 mg/litre each) and subsequently transferred to hormone-free half-strength MS medium. The plantlets were then transferred to pots and grown in the greenhouse.

1958 SAXENA, PK. 1985. **Enhancement of protoplast regeneration by cold-conditioning of the donor tissue**. *J. of Plant Physiology*, 119: 5, 385-388; 18 ref.

Enzymatic digestion of cotyledons of *Dalbergia sissoo* using a mixture containing 2% cellulase Onozuka "R-10" and standard isolation conditions produced large numbers of viable protoplasts which were capable of cell-wall synthesis and cell division. Exposure of the cotyledons to 8 ± 1°C for 48 h prior to protoplast isolation had a marked promotory effect on callus formation, >32% of protoplasts forming colonies after treatment vs. >5% with no treatment, >10% after treatment with growth regulators and >30% after treatment with growth regulators + temp. treatment.

1959 SUWAL, B; KARKI, A; RAJBHANDARY, SB. 1988. **The in vitro proliferation of forest trees. 1. *Dalbergia sissoo Roxb. ex Dc*.** *Silvae Genetica*, 37: 1, 26-28; 10 ref.

Multiple shoots were induced on cotyledonary node cultures of *D. sissoo* in the presence of 1 mg/litre benzylaminopurine and 0.1 mg/litre NAA. On a medium containing 0.25 mg/litre benzylaminopurine, these shoots multiplied at a rate of 10-15 shoots per explant after 4 wk culture. The shoots were subcultured for 2 yr at intervals of 8 wk with no loss of multiplication potential. On transfer to non-sterile sand beds >85% developed into rooted plantlets within 10 days, and were subsequently successfully established in the field.

1960 SWAMY, BV, RAGHAVA; HIMABINDU, K; SITA, GL. 1992. **In vitro micropropagation of elite rosewood (*Dalbergia latifolia Roxb.*)**. *Plant Cell Reports*, 11: 3, 126-131; 22 ref.

Induction of single and multiple shoots was obtained from nodal explants of 60-80-year-old elite trees on MS basal medium supplemented with 1 mg 6-benzylaminopurine and 0.05 mg NAA or 0.5 mg IAA/litre. Multiplication of shoots was obtained on MS or Woody Plant Medium supplemented with 1 mg 6-benzylaminopurine and 0.5-1 mg kinetin/l. Excised shoots were rooted on half-strength MS with 2 mg IBA/litre to obtain complete plantlets. The regenerated plantlets were acclimatized and successfully transferred to the soil.

Eucalyptus

1961 AHUJA, A; GREWAL, S. 1983. **Biochemical markers for in vitro initiation of cultures in *Eucalyptus macrorhyncha* and *Eucalyptus youmanii***. *National Academy of Sci., Science Letters*, 6: 6, 185-187; 10 ref.

Activities of peroxidase and IAA-oxidase, and total polyphenol content were measured of explants from 8, 18 and 30 month old plants of *E. macrorhyncha* and *E. youmanni* [*E. youmanii*] together with their % callus induction in culture. Callus induction in both spp. fell with age of explant source and in proportion to a fall in enzyme activity and an increase in total polyphenols. All 3 are therefore possible indicators of the tissue's ability to produce successful cultures.

1962 AHUJA, ASHOK. 1985. **In vitro shoot differentiation in *Eucalyptus citriodora Hook.*: effect of activated charcoal**. *Indian Journal of Forestry*, 8: 4, 340-341; 5 ref.

Activated charcoal at 0.5 or 1.0% was added to stock culture medium with BA and IAA before autoclaving, and effects on bud cultures observed after 30 days. Treatments increased shoot elongation and the size of the leaves but significantly reduced the number of shoots per culture compared with untreated controls.

1963 ARYA, HC; SHEKHAWAT, NS. 1986. **Clonal multiplication of tree species in the Thar desert through tissue culture**. *Forest Ecology and Management*, 16: 1-4, 201-208; 17 ref.

Details are given of techniques for the successful propagation by tissue culture of *Prosopis cinerea* [*P. cineraria*], *Zizyphus* [*Ziziphus*] *Mauritiana*, *Tecomella undulata*, *Aegle marmelos*, *Eucalyptus viridis* and *E. sideroxylon* for reforestation in this region of Rajasthan, India.

1964 COWIE, RH; LOGAN, JWM; WOOD, TG. 1989. **Termite (Isoptera) damage and control in tropical forestry with special reference to Africa and Indo-Malaysia: a review**. *Bulletin of Entomological Research*, 79: 2, 173-184

Termite damage is a major problem in tropical forestry especially where exotic tree species are used. Stressed trees are generally the most susceptible to attack. Dry-wood termites (*Kalotermitidae*) live and feed in dead wood but sometimes attack living parts of mature trees; generally, they are pests only in the humid tropics, causing local but sometimes serious damage. *Coptotermes* (*Rhinotermitidae*) causes more widespread and serious damage to mature trees, especially in Malaysia and Australia. The most serious losses (up to 100%), due predominantly to various Macrotermitinae (Termitidae) such as Macrotermes, Odontotermes and Microtermes, occur in young, exotic trees such as *Eucalyptus* in dry regions in Africa and India. Chemical control of dry-wood termites is not feasible; use of resistant trees is probably the only statisfactory strategy. Control of *Coptotermes* by various methods has been suggested; but only insecticide injection into nests within affected trunks (Australia) and destruction of nests with explosives prior to planting, followed by destruction of queens in subsequently located nests (Papua New Guinea), are effective and economically viable. Attack on seedlings, especially by Macrotermitinae in Africa and India, can be prevented by the increasingly unacceptable persistent cyclodienes used as mound poisons or as a barrier around the roots preventing attack by subterranean species. Controlled-release formulations of otherwise non-persistent insecticides are being developed but are expensive and not widely available. Many non-chemical measures have been suggested, but none has been rigorously evaluated; none will provide the almost complete protection afforded by cyclodienes. Biological control shows little promise. Use of resistant tree species and development of resistant varieties offers the only long-term solution, but until these are available there will be a need to continue using cyclodienes or rapidly to develop alternative control methods.

1965 DAS, T; MITRA, GC. 1990. **Micropropagation of *Eucalyptus tereticornis Smith.*** *Plant Cell, Tissue and Organ Culture*, 22: 2, 95-103; 16 ref.

Axillary shoot bud multiplication was achieved using explants from of 8-10- year-old elite trees growing in the field. Results showed that addition of 0.1 mg NAA and 1.0 mg benzyladenine/litre to modified MS medium induced the highest number of shoot buds. For inducing axial growth in regenerated bud primordia, the growth regulator concentration of the medium was decreased. Addition of charcoal and gibberellic acid to the medium was beneficial. Rooting was best in Knop's medium

containing 1.0 mg IBA/litre. The key factor in root induction was dark incubation for a short period. The percentage of shoots rooting and survival of the rooted shoots was 60-80%. Continuous trials throughout the year showed that July-September was the best season for obtaining the explant source; phenolic exudation was least at this period. When the experiments were repeated using 50 populations from different plantations, response varied genotypically.

1966 ILAHI, IHSAN; JAMAL, SHABANA. 1987. **Mass propagation of *Eucalyptus tereticornis Smith*.** *Pakistan Journal of Botany*, 19: 1, 67-74; 14 ref.

Eucalyptus tereticornis seeds germinated on 5% sucrose agar medium. A massive callus was induced on 6-week-old seedlings when cultured on MS [Murashige and Skoog's medium] containing 0.5 mg/litre each of 2,4-D and BAP [benzyladenine]. Multiple shoots resulted when MS was supplemented with 0.1 mg/litre each of K(6-furfurylaminopurine) and BAP and 5.0 mg/litre of AS (adenine sulfate). Although massive callus was induced on 6-month-old nursery raised seedlings, no organogenesis was detected on MS with 1.0 mg/litre 2,4-D. Addition of various cytokinins and CM (coconut milk) with or without NAA had no effect on organogenesis. NAA at 0.1 or 0.5 mg/litre with 0.5 mg/litre BAP and 500 mg/litre CH (casein hydrolysate) induced a massive callus which gave rise to numerous bud primordia.

1967 KAPOOR, ML; CHAUHAN, JMS. 1992. **In vitro clonal propagation of mature *Eucalyptus* F1 hybrid (*E. torelliana F.V. Muell* X *E. citriodora Hook*).** *Silvae Genetica*, 41: 6, 305-307.

1968 KHUSPE, SS; GUPTA, PK; KULKARNI, DK; URMIL-MEHTA,; MASCARENHAS, AF. 1987. **Increased biomass production by tissue culture of *Eucalyptus*.** *Canadian Journal of Forest Research*, 17: 11, 1361-1363; 12 ref.

Plantlets (25 cm tall) produced by tissue culture from buds of elite trees and seedlings of a similar size raised from seed of *Eucalyptus tereticornis* and *E. torelliana* were planted in July 1983 with spacings of 2X2 or 3X3 m at the National Chemical Laboratory [Poona, India]. Measurements in May 1986 showed that ht., girth and biomass production per 100 m2 were greater in micro-propagated plants than in seedlings at a spacing of 2X2 m. Differences were not as noticeable at the wider spacing.

1969 KOHLI, RK; PARVEEN-CHAUDHRY; ANITA-KUMARI. 1988. **Impact of *Eucalyptus* on Parthenium - a weed.** *Indian Journal of Range Management*, 9, 63-67; 12 ref.

Various extracts were made of *Eucalyptus* leaves collected in the Botanical Garden at Punjab University. Fresh leaves were extracted with distilled water (aqueous leachate). The residue from this extraction was treated with 50% HCl and the resulting precipitate extracted with ethyl alcohol (organic leachate). Shade dried leaves were powdered and extracted with petroleum ether; the ether extract was evaporated and the residue dissolved in a little xylene and Tween- 20 and made up to volume with water (pet. ether fraction). The undissolved material remaining from the ether extraction was extracted with methanol. Half the methanol extract was evaporated and the residue was dissolved in a little methanol and made up to volume with water (methanol fraction); the other half of the extract was evaporated and the residue partitioned between water (water fraction) and chloroform; the chloroform was evaporated and the residue dissolved in methanol and made up to volume with water (chloroform fraction). A *Eucalyptus* oil preparation was also prepared using an oil trap and fractional distillation. The different extracts were tested for their allelopathic activity by spraying a fine mist onto 2-month old seedlings of *Parthenium hysterophorus* for 3 consecutive evenings; a distilled water spray was used as control. After the treatments, measurements were made on the leaves of cell survival, and contents of chlorophyll, soluble proteins, RNA and carbohydrates. All the extracts reduced % cell survival and chlorophyll content; the least effective were the organic leachate and the chloroform fraction. Most extracts also reduced contents of RNA (organic leachate and water fraction least effective), protein (organic leachate and chloroform fraction least effective), acid soluble carbohydrate (organic leachate, and chloroform and water fractions least effective), and water soluble carbohydrate (water fraction least effective).

1970 KUMAR, RR; RAMAN, K. 1989. **Callus induction and recovery of plantlets from seedling explants of *Eucalyptus camaldulensis* Dehn.** *Journal of Plantation Crops*, 16: Supplement, 21-26; 8 ref.

Callus induction from embryo tissue was achieved on MS medium supplemented with 1 g casein hydrolysate and 2 mg 2,4-D/litre after 7 days of culture. Cotyledonary nodes cultured on proliferation/induction medium containing 5 mg BAP [benzyladenine], 160 mg adenine sulfate and 170 mg sodium dihydrogen orthophosphate/litre developed 3-6 shoot buds from each axil and elongated within 20-30 days. Small buds initiated from callus after subculture on media similar to those used

for callus induction elongated upon transfer to shoot induction media consisting of 0.2 BAP, 1.8 mg NAA, 1.0 mg IAA and 0.5 mg IBA/litre after 20-30 days. Rooting of elongated shoots occurred on hormone-free medium.

1971 MURALIDHARAN, EM; GUPTA, PK; MASCARENHAS, AF. 1989. **Plantlet production through high frequency somatic embryogenesis in long term cultures of *Eucalyptus citriodora***. *Plant Cell Reports*, 8: 1, 41-43; 14 ref.

A highly embryogenic culture of *E. citriodora* was obtained by repeated embryogenesis from somatic embryos cultured in the dark on a medium containing 500 mg/litre each of glutamine and casein hydrolysate, 30 g/litre sucrose and 5 mg/litre NAA. Cultures retained morphogenetic ability for up to 36 months when maintained at 27°C by subculture at intervals of 4-5 wk. The subculture period could be extended beyond 9 months if cultures were stored at 10°C. When incubated in light on a hormone-free medium, 50% of the embryos produced plantlets of which 70% survived transfer to a sand and soil mixture.

1972 RAGHAVAN, P. 1986. **Plantlet regeneration from callus cultures [derived from terminal vegetative buds] of *Eucalyptus grandis Hill ex Maiden***. *Current Science*, 55: 15, 741-743; 11 ref.

1973 RAO, KS. 1988. **In vitro meristem cloning of *Eucalyptus tereticornis Sm***. *Plant Cell Reports*, 7: 7, 546-549; 17 ref.

Rapid multiplication of axillary meristems and direct shoot development occurred from nodal explants of mature *E. tereticornis* cultured on a Murashige and Skoog (MS) medium with 5.3 μM NAA, 1.1 μM IAA and 4.4 μM benzyladenine. Repeated subcultures of the second generation shoots on media containing 0.44-0.88 μM benzyladenine + 0.1 μM NAA yielded large numbers of axillary microshoots. Half-strength MS liquid medium with 4.9 μM IBA, 5.5 μM IAA and 5.3 μM NAA for 4 days, half-strength semi-solid hormone-free MS medium with charcoal and MS liquid medium without charcoal or hormones in sequence induced rooting of shoots in the dark. This system is suitable for the mass propagation of this difficult-to-root eucalypt.

1974 RAO, KS; VENKATESWARA, R. 1985. **Tissue culture of forest trees: clonal multiplication of *Eucalyptus grandis L.***. *Plant Science, Irish Republic*, 40: 1, 51-55; 26 ref.

Leucaena

1975 CHANDRASEKHARAN, P; GOVINDASWAMY, M. 1985. **Occurrence of mimosine in the leaves of some species of *Leucaena* and hybrid derivatives of *L. diversifolia* and *L. leucocephala***. *Leucaena Research Reports*, 6, 25-28; 3 ref.

Data from analyses of mimosine concentration in the dried leaves of 11 varieties (from 4 species) showed that the lowest concentration (1.61%) occurred in Fijian accession 643 of *L. leucocephala var. salvadorensis*, while the highest (6.23%) was in Mexican accession 993 of *L. lanceolata*. Results from hybridization between *L. diversifolia* accession FD644 (*Roja Deoxaca*) and *L. leucocephala var. salvadorensis* accessions showed that FD644 transmitted low mimosine content and high biomass to the progeny.

1976 DATTA, K; DATTA, SK. 1985. **Auxin + KNO3 induced regeneration of leguminous tree-*Leucaena leucocephala* through tissue culture**. *Current Science*, 54: 5, 248-250; 15 ref.

Nodal explants of *L. leucocephala cv. K8* produced regenerants with vigorous rooted shoots on MS1 medium (Murashige & Skoog medium with double the usual amount of KNO3) supplemented with 1 mg IAA/litre or 2 mg NAA/litre.

1977 DATTA, SK; DATTA, K. 1984. **Clonal multiplication of 'elite' trees - *Leucaena leucocephala* through tissue culture**. *Leucaena Research Reports*, 5, 22-23; 6 ref.

Nodal explants of cv. Hawaiian Giant (K8) were excised and cultured on Murashige & Skoog basal medium supplemented with 30 g sucrose/litre and 0.9% agar. Healthy leafy shoots were obtained when BA or kinetin was added at 1 mg/litre. Healthy roots were obtained on medium with added IAA.

1978 DHAWAN, V; BHOJWANI, SS. 1985. **In vitro vegetative propagation of *Leucaena leucocephala* (Lam.) de Wit**. *Pl. Cell Reports*, 4: 6, 315-318; 23 ref.

A method for in vitro clonal multiplication of *L. leucocephala cv. K-8* is described. On Murashige and Skoog (MS) medium with 3 X 10-6M BA, shoots from seedlings or adult trees multiplied 6- to 7-fold every 3 weeks. Addition of adenine or glutamine reduced precocious leaf drop. All shoots rooted on MS with 5 X 10-6M IAA. Micropropagated plants were successfully transferred to soil.

1979 DHAWAN, V; BHOJWANI, SS. 1984. **Reduction in cost of tissue culture of *Leucaena leucocephala (Lam.) De Wit* by replacing AR grade sucrose by sugar cubes**. *Curr. Science*, 53: 21, 1159-1161; 5 ref.

Sugar cubes conforming to British Pharmocopoeia and ISI specifications, and a market sample of sugar were compared with AR grade sucrose (BDH) for suitability as an energy source for in vitro shoot multiplication and embryo culture on supplemented Murashige & Skoog media. Commercial sugar produced a poor response in both systems, but the sugar cubes compared well with AR grade sugar for most growth characters.

1980 GUPTA, VK; PATIL, BD. 1984. **A simple technique of hand emasculation in *Leucaena leucocephala***. *Leucaena Research Reports*, 5, 29-30; 2 ref.

Heads ready to flower the following day were trimmed to leave about 20 florets/head. Sepals and petals were removed first, then anthers. Heads were covered with glassine bags and pollinated the next morning, using male flowers whose anthers were dehiscing.

1981 GUPTA, VK; PATIL, BD. 1984. **Performance of the *Leucaena* species and hybrids**. *Leucaena Research Reports*, 5, 27-28.

Mean values of growth and leaf characters are tabulated for 9 species and 2 interspecific hybrids grown in the field in the semiarid conditions of Jhansi, India. Performance was good in *L. leucocephala* (K8 and K28), *L. diversifolia* (K156), *L. lanceolata* (K10), *L. macrophylla* (K156), *L. shannoni* (K405 and 78- 40) and *L. leucocephala* X *L. pulverulenta* (22-/9-5), at temperatures below 40°C. Although flowering occurred within a year of planting in 5 species and both hybrids, only *L. leucocephala* set pods.

1982 HOSSAIN, M; HOSSAIN, T; ROY, SK; HOSSAIN, SN. 1992. **Morphogenic responses in explants of *Leucaena leucocephala (Lam.) de Wit* following**. *Plant Tissue Culture*, 2: 1, 31-34.

Explants from cotyledon, hypocotyl and shoot apex were cultured on MS medium supplemented with BAP (0.2-3.5 mg/l) singly or in combinations with BAP (0.2-3.0 mg/l) and IAA, IBA and NAA (0.1-0.5 mg/l) at 26 + 1 C under 16th light period. Explants from cotyledon, hypocotyl and shoot apex produced multiple shoots on MS medium supplemented with 2.5 mg/l BAP. Callus induction was 60 and 70% at the base of hypocotyl and cotyledon explants in 3.0 mg/l BAP + 0.5 mg/l IAA.

1983 HOSSAIN, T; HOSSAIN, M; ROY, SK; HOSSAIN, SN. 1992. **Effect of BAP - casein hydrolysate on in vitro multiplication of *Leucaena leucocephala* from different explants**. *Plant Tissue Culture*, 2: 2, 97-101.

Different explants, namely, cotyledonary node, stem node and shoot apex of *Leucaena leucocephala* were cultured on MS medium supplemented with 2.5 mg/l BAP and 50-200 mg/l casein hydrolysate. All explants produced multiple shoots. Maximum number of multiple shoot production was obtained from cotyledonary node explants on MS supplemented with 2.5 mg/l BAP and 150 mg/l casein hydrolysate. 0.5 mg/l IBA-supplemented medium proved best for root formation. About 30% plantlets were successfully transferred into soil.

1984 KULKARNI, DK; GUPTA, PK; MASCARENHAS, AF. 1984. **Tissue culture studies on *Leucaena leucocephala***. *Leucaena Research Reports*, 5, 37-39; 3 ref.

Nodal segments from one to 2-year-old plants were sterilized and transferred to a series of Murashige & Skoog media. Maximum number of shoots was obtained when the basal medium was supplemented with 0.2 mg kinetin, 0.3 mg BA, 0.1 mg calcium pantothenate and 0.1 mg biotin per litre. Elongated shoots were excised and treated with half-strength liquid medium containing an auxin mixture for 72 h in the dark. They were then transferred to half- strength semisolid medium containing 0.25% activated charcoal. Rooting occurred in 70% of shoots within 15-20 days.

1985 NATARAJA, K; SUDHADEVI, AM. 1984. **In vitro induction of plants from seedling explants of subabul (*Leucaena leucocephala Lamk.*)**. *Indian Journal of Plant Physiology*, 27: 3, 255-258; 8 ref.

Shoot buds and roots were observed in callus obtained from cotyledonary leaf and epicotyl segments of *L. leucocephala*. Callusing and differentiation of plants were achieved on a modified Murashige and Skoog medium fortified with 2,4-D or IAA individually and also in different combinations with kinetin, coconut water and casein hydrolysate. BA alone induced multiple shoot formation unaccompanied by rooting. Rooting of these shoot buds could be induced by transferring them to rooting medium.

1986 PRATAP SINGH. 1988. ***Heteropsylla cubana Crawford*, a new psyllid pest of *Leucaena* in India**. *Indian Forester*, 114: 4, 200-205; 11 ref.

H. cubana was detected in Feb. 1988 on *Leucaena* in Chengalpettu District, Tamil Nadu, and was afterwards found also in Pudukottai, Trichi and Coimbatore Districts. The biology of the pest, its host plants (10 species

of *Leucaena*, and *Samanea saman*), damage caused, and its distribution and spread are briefly described. Resistance in *Leucaena* species and provenances, and possible biological control methods, are discussed. The threat to the widespread cultivation of *Leucaena* in India is noted and it is suggested that the best approaches to control are biological and genetic, either through the establishment of an all India project (with participation of the Wasteland Development Board and other research organizs.), or by participation in a regional res. plan.

1987 RAVISHANKAR, GA; AMRITA WALI; GREWAL, S. 1983. **Plantlet formation through tissue cultures of *Leucaena leucocephala*.** *Leucaena Research Reports*, 4, 37; 4 ref.

Complete plantlets formed from cultured shoot tips from 4-day-old seedlings of *L. leucocephala var. K8*.

Prosopis

1988 NANDWANI, D; RAMAWAT, KG. 1992. **High frequency plantlets regeneration from seedling explants of *Prosopis tamarugo*.** *Plant Cell, Tissue and Organ Culture*, 29: 3, 173-178; 13 ref.

Callus cultures of *P. tamarugo* (*Leguminosae sub Mimosoideae*) were established from hypocotyls and cotyledons on MS medium supplemented with NAA (2.0 mg/litre) and BA (benzyladenine) (0.2 mg/litre). Regeneration through various juvenile explants was obtained on hormone-free and high cytokinin containing MS media. Multiple shoot bud formation was observed from the embryonic axis on MS medium incorporated with BA (5.0 mg/litre). Elongation of shoot buds was observed on subsequent transfer to MS medium with BA (1.0-2.5 mg/litre) or without BA. Explants containing apical meristems showed greater shoot formation at an early period. De novo shoot bud formation through callus morphogenesis was observed at the base of differentiated shoots on high cytokinin containing medium. All the manipulations of salt strength of MS, nitrogen, carbon, ascorbic acid and polyamines failed to induce organogenesis in isolated callus. In vitro produced shoots were rooted on MS medium supplemented with IBA or NAA singly or in combination.

1989 NANDWANI, D; RAMAWAT, KG. 1992. **In vitro regenerative potential of explants and callus morphogenesis in *Prosopis tamarugo*.** *Gartenbauwissenschaft*, 57: 3, 106-111.

1990 SHEKHAWAT, NS; RATHORE, TS; SINGH, RP; DEORA, NS; RAO, SR. 1993. **Factors affecting in vitro clonal propagation of *Prosopis cineraria*.** *Plant Growth Regulation*, 12: 3, 273-280.

Santalum album (Sandalwood)

1991 BAPAT, VA; FULZELE, DP; HEBLE, MR; RAO, PS. 1990. **Production of sandalwood somatic embryos in bioreactors.** *Current Science*, 59: 15, 746-748; 5 ref.

An outline is given of a procedure for producing somatic embryos of sandalwood (*Santalum album*). Conversion of non-embryogenic cells (derived from an actively growing cell suspension maintained by subculturing every 3 wk in Murashige and Skoog (MS) medium supplemented with 1.0 mg/litre 2,4-D) to embryogenic cells was achieved in a 7-litre bioreactor; the medium used was MS + 0.5 mg/litre IAA + 0.5 mg/litre BAP [benzyladenine]. Pro-embryo cells were grown in a 1-litre bioreactor in MS medium + 1.0 mg/litre IAA + 0.5 mg/litre IBA + 0.5 mg/litre GA [gibberellins]. Mature somatic embryos developed. Viable plantlets were regenerated from mature embryos upon transfer of the embryos from the bioreactor to solid medium.

1992 BAPAT, VA; GILL, R; RAO, PS. 1985. **Regeneration of somatic embryos and plantlets from stem callus protoplasts of sandalwood tree (*Santalum album L.*).** *Current Science*, 54: 19, 978-982; 18 ref.

After isolating protoplasts from leaf mesophyll and from hypocotyl and stem calluses, various treatments were used to encourage division. No division of protoplasts was obtained from leaf mesophyll, but hypocotyl callus gave multicellular colonies by 8 weeks. Best results were obtained from stem callus which grew rapidly into microcalluses in medium containing 1% cellulase, 0.5% macerozyme with 0.5 M sorbitol or mannitol. After transfer to new medium, somatic embryos formed and subsequently developed into plantlets.

1993 BAPAT, VA; RAO, PS. 1984. **Regulatory factors for in vitro multiplication of sandalwood tree (*Santalum album Linn.*). I. Shoot bud regeneration and somatic embryogenesis in hypocotyl cultures.** *Proceedings of the Indian Academy of Sciences, Plant Sciences*, 93: 1, 19-27; 17 ref.

Large numbers of plantlets were obtained from hypocotyl tissue cultures, either through direct differentiation of shoot buds and their subsequent induction into rooted plants or through callus induction and somatic embryogenesis. Bud differentiation was most successful on basic medium plus NAA (1 mg/litre) and rooting of

shoot buds was achieved on a variety of auxin-enriched media. Callus growth was stimulated by BA, while IAA at 0.5 and 1 mg/litre stimulated somatic embryogenesis. Concentrations of NH4NO3 (optimum 1650 mg/litre) and sucrose (optimum 4%) in the medium also affected callus growth and embryogenesis.

1994 GOWDA, ANS; NARAYANA, R. 1986. **In vitro studies of spike disease of sandal (*Santalum album L.*)**. *Current Science*, 55: 5, 253-254; 11 ref.

Segments from healthy plants showed callus initiation in 6-8 wk after culture on Murashige & Skoog's or White's basal media supplemented with 2,4-D and benzyl adenine (BA) or kinetin. Spike diseased segments failed to grow on these media unless they were supplemented with gibberellic acid (GA3) in addition to 2,4-D and BA. This difference in response is attributed to the deficiency in the endogenous contents of the spike tissue of growth regulators, particularly GA3. Preliminary trials showed that application of GA3 to diseased sandal plants resulted some degree of recovery.

1995 RAO, PS. 1985. **Plant protoplasts: a new tool in plant biotechnology**. *Current Science*, 54: 7, p. 335-336.

This brief survey deals with work carried out at the author's institution. The use of protoplasts for plant regeneration and/or somatic hybridization in *Santalum album*, *Tylophora indica*, *Arachis hypogaea* and *Physalis spp.* is mentioned.

1996 RAO, PS; BAPAT, VA; MHATRE, M. 1984. **Regulatory factors for in vitro multiplication of sandalwood tree (*Santalum album Linn.*). II. Plant regeneration in nodal and internodal stem explants and occurrence of somaclonal variations in tissue culture raised plants**. *Proceedings of Indian National Science Academy, Part B: Biological Sciences*, 50: 2, 196-202; 25 ref.

Highly variable plantlets were raised following somatic embryogenesis in callus from cultured internodal stem explants. One grew to 210-240 cm in the first year and flowered within 18 months.

Sesbania

1997 SINHA, RK; MALLICK, R. 1991. **Plantlets from somatic callus tissue of the woody legume *Sesbania bispinosa (Jacq.) W.F. Wight***. *Plant Cell Reports*, 10: 5, 247-250; 22 ref.

Callus was established from both cotyledons and mature leaflets on MS basal medium supplemented with BAP [benzyladenine] and 2,4-D (optimum concentrations for callus growth were 0.5 mg and 2 mg/litre, respectively). Callus mediated shoot bud differentiation was studied under defined nutritional, hormonal and cultural conditions. Various concentrations of BAP (0.2-4.0 mg/litre) or kinetin (Kn) (0.5-4.0 mg/litre) with coconut milk (CM) (15% v/v) in MS media induced different levels of shoot bud differentiation as well as multiplication. Multiple shoot bud differentiation occurred in most of the primary calluses. The highest mean number of shoot buds/unit callus tissue (14.33 ± 3.59) was obtained using 2 mg BAP/litre and 15% CM. More efficient shoot bud organogenesis was recorded with BAP than Kn. Supplementation with CM of MS media accelerated shoot bud organogenesis in differentiating callus tissue. Rooting of differentiated shoots was achieved by a 3 step culture procedure involving: (1) MS solid medium containing 2 mg IBA/litre; (2) growth regulator free half-strength MS medium with 1% charcoal; and (3) half strength MS liquid medium free of vitamins, growth regulators and charcoal. Callus mediated successful plant regeneration and multiplication of *S. bispinosa* has not been previously reported.

FEED AND FODDERS

1998 AKHILA, A. 1986. **Biosynthesis of monoterpenes in *Cymbopogon winterianus***. *Phytochemistry*, 25: 2, 421-424; 10 ref.

The isotope ratios of geraniol, citronellol and citronellal biosynthesized in *C. winterianus* from 3H- and 14C-labelled mevalonate indicate that geraniol is converted into citronellol which in turn is converted into citronellal.

1999 AKHILA, A. 1985. **Biosynthetic relationship of citral-trans- and citral-cis in *Cymbopogon flexuosus* (lemongrass)**. *Phytochemistry*, 24:11, 2585-2587; 9 ref.

The use of [14C,3H]-labelled precursors revealed that leaf blades converted geraniol (3,7-dimethylocta-trans-2,6-diene-1-ol) into citral-trans with the loss of pro(1S)-hydrogen whereas nerol lost the pro-(1R) hydrogen while being converted into citral-cis. The citral-trans was converted into citral-cis and vice versa and there was no separate route for the biosynthesis of either of the two aldehyde isomers.

2000 ARYA, ID; ARYA, SARITA; RAO, DV; SHEKHAWAT, NS. 1990. **Variation amongst protoplast-derived moth bean *Vigna aconitifolia* plants**. *Euphytica*, 47: 1, 33-38; 26 ref.