Dynamics of Agricultural Biotechnology

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1322 VINCENT, KA; BEJOY, M; HARIHARAN, M; MATHEW, MK. 1991. **Plantlet regeneration from callus cultures of *Kaempferia galanga L.* - a medicinal plant**. *Ind. Journal of Plant Physiology*, 34: 4, 396-400.

GUM AND RESIN PLANTS

1323 ASOKAN, MP; SOBHANA, P; SUSHAMA-KUMARI, S; SETHURAJ, MR. 1988. **Tissue culture propagation of rubber *(Hevea brasiliensis (Willd. ex Adr. de Juss.) Muell. Arg.) clone GT (Gondang Tapen). I.*** *Ind. J. of Nat. Rubber Res.*, 1: 2, 10-12.

An in vitro propagation method for this clone is outlined. The optimal growth regulator range for shoot and root development was 1.5-3.0 mg/litre IAA + 0.5-1.5 mg/litre kinetin. Rooted plantlets were successfully transplanted in the field.

1324 DHAR, AC; KISHOR, PBK; RAO, AM. 1989. **In vitro propagation of guayule (*Parthenium argentatum*) - a rubber yielding shrub**. *Plant Cell Reports*, 8: 8, 489-492; 9 ref.

Nodal explants (0.5 to 0.8 cm long) isolated from 2-year-old plants when cultured on MS medium supplemented with different concentrations of kinetin, BAP [benzyladenine], 2,4-D, 2,4-D + BAP, NAA and NAA + BAP produced callus tissues and shoots simultaneously at different frequencies. Shoots were regenerated at a high frequency (80-88%) from callus on MS medium containing NAA + BAP with or without glutamine. Addition of glutamine to these media improved considerably the number of shoots formed. Shoots could be regenerated from 200-day-old callus cultures at a very high frequency but the organogenetic capacity declined thereafter. Increases in the concentration of sucrose (up to 4%) significantly enhanced the shoot forming ability of callus, but higher concentrations (6%) suppressed it. Rooting was only induced in the dark when IAA, IBA and NAA were used, but 2,4-D could induce root formation in the light and dark.

1325 GUNATILLEKE, ID; SAMARANAYAKE, CHANDRA. 1988. **Shoot tip culture as a method of micropropagation of Hevea**. *Journal of the Rubber Research Institute of Sri Lanka*, 68, 33-44; 26 ref.

Shoot tips of Hevea from aseptically grown seedlings were established in culture on a liquid MS medium with half strength salts, supplemented with 0.5 mg BA + 0.005 mg IBA/litre or on a solid MS medium with full strength salts, both with and without 0.5 mg BA + 0.005 mg IBA/litre. BA was better for axillary bud proliferation and growth than the other cytokinins tested (kinetin and 2iP). Proliferation of buds improved with successive subcultures. A multiplication rate of 30 + 2 shoots per explant was obtained with 3 subcultures in 165 days.

1326 SETIA, RC. 1984. **Traumatic gum duct formation in *Sterculia urens Roxb.* in response to injury**. *Phyton, Austria*, 24: 2, 253-255; 6 ref.

Gum ducts normally occur in the pith and cortex of young stems, but after mechanical injury to both young and old stems gum ducts were formed in the xylem within 30-40 min. These so-called traumatic ducts were formed as a result of breakdown of xylem cells. A traumatic duct shows an irregular lumen without any distinct epithelial cells. Gum produced in these cells was shown histochemically to be similar to that in normal ducts.

1327 SHAH, JJ. 1983. **Gum, resin and gum-resin secretion in plants**. *Acta Bot. Indica*, 11: 2, 91-96.

A brief review of Indian gum and resin plants, discussing familiar distribution, structure of secretory ducts, their development and mode of gum/resin secretion. Experiments showed that ethephon applied to the stem markedly increased gum/resin exudation on injury in mangoes, *Bombax ceiba*, *Sterculia urens*, *Anogeissus latifolia* and *Ailanthus excelsa*.

1328 VENKAIAH, K; SHAH, JJ. 1984. **Distribution, development and structure of gum ducts in *Lannea coromandelica (Houtt.) Merril***. *Annals of Botany*, 54: 2, 175-186; 35 ref.

Gum ducts were present in leaves, stems and fruits and were most abundant in the bark of the stem of *L. coromandelica [grandis]*. They were absent in roots. Ducts developed schizogenously in the primary phloem, pith and xylem rays and lysigenously in the secondary phloem and phelloderm. Ducts were classified according to their position and arrangement as vertical, horizontal (radial and tangential) and irregular ducts. There was an integrated ramifying duct system in the bark of the trunk. Gum was formed in 2 stages. Secretion of gum occurred from the epithelial cells into the duct lumen and subsequently the disintegration of epithelial as well as neighbouring cells followed, i.e. gummosis occurred.

FRUIT CROPS

Apples

1329 BHARDWAJ, SV; KHOSLA, PK; THAKUR, PD; SHARMA, DR. 1994. **Detection of apple mosaic**

virus in apple using indirect ELISA from Himachal Pradesh. *Virology in the Tropics*/edited by N Rishi, KL Ahauja and BP Singh. India: MPH, p. 615-619.

1330 GULERIA, MANJU BALA. 1993. **Micropropagation of some cultivars and rootstocks of apple (*Malus demestica*)**. Dept. of Biotechnology, UHF, Solan. p. 77.

1331 MEHRA, PN; SACHDEVA, S. 1984. **Embryogenesis in apple in vitro**. *Phytomorphology*, 34: 1/4, 26-36; 18 ref.

Root, hypocotyl, stem, leaf, shoot tip, cotyledon, embryo, petal and flower bud explants from the cultivar Golden Delicious were cultured on a supplemented White's medium; resulting callus was transferred to a second medium. The best embryoid formation occurred on Nitsch's medium supplemented with NAA (2 p.p.m.) and BA (2 p.p.m.); some embryoids developed roots, leaves or shoots, and some developed into plantlets. The embryoids were diploid, polyploid or aneuploid; diploids predominated.

1332 MODGIL, M; SHARMA, DR; BHARDWAJ, SV; KHOSLA, PK. 1994. **In vitro propagation of apple (*Malus domestica Borkh*) *Cv. Golden delicious***. *Ind. Jour Hort*,

1333 PRABHA, TN; SALIMATH, PV; PATWARDHAN, MV. 1990. **Primary metabolites and organic acid metabolism in apple *(Malus sylvestris)* fruit callus culture**. *Journal of the Science of Food and Agriculture*, 51: 3, 381-389.

1334 RANJIT, M; UPADHYAY, NS. 1987. **In vitro propagation of apple rootstock (*Malus prunifolia L.*)**. *Journal of the Institute of Agriculture and Animal Science, Nepal*, 8, 53-59; 8 ref.

Actively growing shoot tips of *M. prunifolia* proliferated more than 12 times in 4 weeks on 1 mg BA/litre on modified MS medium in the absence of auxin. Ninety percent of the in vitro grown shoot tips responded to 1 mg IBA/litre in 2 weeks by forming adventitious roots. The average no. of roots per rooted shoot tip was 4.3.

1335 SHARMA, UPASANA DATT. 1993. **Elimination of viruses through meristem culture in apple (*Malus demestica*)**. Dept. of Biotechnology, UHF, Solan. p. 65.

1336 UPADHYAY, RC; SOHI, HS. 1988. **Apple pomace - a good substrate for the cultivation of edible mushrooms**. *Current Science*, 57: 21, 1189-1190; 11 ref.

Good yields of *Pleurotus* fruitbodies were obtained when 6 spp. were tested for growth on dried apple pomace which had been steeped in carbendazim (50 p.p.m.) and formalin sol. (200 p.p.m.) for 18 h and autoclaved in polypropylene bags. *P. membranaceus* performed best with 48% biological efficiency (BE) followed by *P. sapidus* (40%), *P. ostreatus* (39%), *P. flabellatus* (36%), *P. sajor-caju* (32%) and *P. fossulatus* (10%). BE of *Auricularia mesenterica* was 20%

Diseases

1337 BHARDWAJ, SV; KHOSLA, PK; MODGIL, M; SHARMA, DR. 1994. **Standardization of alkaline phosphatase (ALP) and penicillinase (PNC) based indirect ELISA for detection of apple mosaic virus from Himachal Pradesh**. *Ind. Jour. Virol.* 10: 7-12.

1338 GUPTA, SK; GUPTA, GK; GUPTA, P. 1992. **Efficacy of ergosterol biosynthesis inhibitor fungicides in preharvest sprays against sooty blotch and fly speck diseases of apple**. *Indian Journal of Plant Protection*, 20: 2, 237-238.

Insect pests control

1339 AMIN, MM; TRALI, AR. 1987. **Seasonal history and biological control of San Jose scale *Quadraspidiotus perniciosus (Comstock) (Diaspidae: Homoptera)* on apple in Kashmir**. *Journal of Biological Control*, 1: 1, 3-6; 6 ref.

The biology and natural enemies of *Q. perniciosus* were studied on apple in Kashmir, in 1983 and 1984. There were 2 generations annually, and a partially complete 3rd generation overwintered from November. Overwintering nymphs and alate males emerged in mid-March and late April, respectively. Females gave rise to the 1st-generation crawlers in the 3rd week of May. The 2nd-generation crawlers began emerging in the 3rd week of July and development was completed in the 1st week of Sept. Nymphs of the 3rd generation appeared in the last week of September and entered hibernation at the end of November. A series of releases of the parasitoids *Encarsia perniciosi* and *Aphytis proclia* were made in 4 abandoned apple orchards. The pretreatment rate of parasitism of *Q. perniciosus* was 4.97-15.6%. Recovery tests indicated an increase in apparent parasitism of 9.13-40.2%. During the pretreatment survey, the aphelinids *Marietta carnesi* and *Azotus kashmirensis* [*Ablerus kashmirensis*] were also recorded.

1340 KANWAR, SM. 1987. **General principles of pest control**. *Apples: Production Technology and Economics*, New Delhi: Tata McGraw-Hill, p. 433-474.

The main methods (chemical, biological, cultural, physical and legal) of controlling arthropod pests and diseases of apples in India are described. Details of the most important insecticides and fungicides and their availability for use on apples in India are given, and a schedule for the chemical control of the main pests is tabulated.

1341 KANWAR, SM. 1987. **Control of insects.** *Apples: Production Technology and Economics*. New Delhi: Tata McGraw-Hill Publishing, p. 475-515.

The biology of the main insect and mite pests of apples in India is described, together with details of the nature of damage they cause and methods of their control (chemical, biological and cultural).

Peaches

1342 BHANSALI, RR; DRIVER, JA; DURZAN, DJ. 1990. **Rapid multiplication of adventitious somatic embryos in peach and nectarine by secondary embryogenesis**. *Plant Cell Reports*, 9: 5, 280-284; 21 ref.

A 3-stage process with an initial callus phase was established in darkness on a modified MS medium supplemented with 5 mg 2,4-D, 2 mg kinetin, 2 mg benzyladenine (BA) and 500 mg casein hydrolysate/litre. This was followed by a growth regulator-free medium with activated charcoal for the adventitious and direct multiplication of somatic embryos under continuous light. Somatic embryos (10-15) originated from the epidermal layer of primary somatic embryos 4 to 6 mm in size. The incidence of morphologically abnormal embryoids was reduced by subculturing every 20 days. Calluses which were isolated and grown on a 2,4-D medium were more embryogenic than those on NAA. These embryoids multiplied continuously for >10 months by a repetitive somatic embryogenic process. A third stage medium, supplemented with BA (2 mg/litre), was required for axis elongation and root development before transfer to soil.

1343 DHANJI, MS; CHOPRA, HR; JAWANDA, JS; BAJAJ, YPS. 1983. **Micropropagation of peach (*Prunus persica L. Batsch.*)**. *Journal of Tree Sciences*, 2: 1/2, 54-57; 7 ref.

Callus tissue cultures from shoot tips, vegetative buds and excised cotyledons of the early-flowering cv. Flordasun were established on Murashige and Skoog medium supplemented with NAA, 2,4-D, BA or kinetin. Entire plants were regenerated from in vitro cultured embryos.

Litchi chinensis

1344 AMIN, MA; RAZZAQUE, MA. 1993. **Regeneration of plants in vitro from seedling explants of lychee**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: Dec 19-21).

1345 AMIN, MN; RAZZAQUE, MA. 1993. **In vitro repetitive embryogenetis in the cultures of zygotic embryos of lychee**. *International symposium on Application of Plant in vitro Technology*. UPM, Serdang, Malayasia:

1346 AMIN, MN; RAZZAQUE, MA. 1994. **Induction of somatic embryogenesis in the cultures of zygotic embryos of lychee**. *Bangladesh Journal of Botany*, 23: 2.

1347 THAKUR, S; SHARMA, RK; BRAHMACHARI, VS; CHATTERJEE, D; KUMAR, R. 1989. **Effect of different growth regulators on flowering characters of litchi (*Litchi chinensis Sonn.*)**. *Orissa Journal of Horticulture*, 17: 1-2, 27-31; 6 ref.

Litchi (cultivars Deshi and Purabi) trees were sprayed with GA3 (50 and 100 p.p.m.), NAA (25 and 50 p.p.m.), 2,4,5-T (25 and 50 p.p.m.), MH (200 and 300 p.p.m.), CCC [chlormequat] (1000 and 2000 p.p.m.), ethephon (50 and 100 p.p.m.) or water (control) on 5 occasions between Sep. and Jan. in 1983 and 1984. The greater panicle length and breadth were obtained with the 50 p.p.m. GA3 treatment (20.92 X 11.82 cm for Purabi and 22.85 X 11.27 cm for Deshi). The 2000 p.p.m. CCC treatment produced the highest number of hermaphrodite flowers/panicle and lowest sex ratio (male:hermaphrodite) in both cultivars (respectively, 422.9 and 2.70 for Purabi, and 524.05 and 2.04 for Deshi).

Citrus

1348 AGARWAL, PK. 1989. **Cytogenetical investigations in *Rutaceae*. V. Cytomorphology of three intergeneric hybrids of Citrus and *Poncirus***. *Cytologia*, 54: 4, 705-708; 3 ref.

Cytomorphological studies were conducted in the hybrids *C. jambhiri* X *P. trifoliata*, *C. reshni* X *P. trifoliata* and (*C. paradisi* X *C. reticulata*) X *P. trifoliata*. Hybrids were morphologically intermediate but

trifoliate leaves were predominant. Meiotic studies showed the formation of 9 bivalents and equal distribution of chromosomes at anaphase I and II in the majority of PMCs, indicating close homology of genomes of the 2 genera. Low pollen fertility was observed in *C. jambhiri* X *P. trifoliata* whereas the reciprocal cross had high pollen fertility, indicating cytoplasmic inheritance.

1349 AGARWAL, PK. 1984. **Meiosis in an interspecific mandarin hybrid 'Kinnow' (*Citrus nobilis Lour.* X *Citrus deliciosa Ten.*)**. *Current Science*, 53: 10, 547-548; 8 ref.

Nine bivalents were observed in all the PMCs studied, with 0-6 ring bivalents per PMC. Chiasma frequency was 9-15 per PMC, with a mean of 12.31 per PMC; 3-7 secondary associations per PMC were observed among the bivalents. Early separation of bivalents was seen and, in 2% of PMCs, unequal distribution of chromosomes at anaphase I. Pollen fertility was 98%. It is concluded that there is a close homology between the genomes of the two species. Observations of secondary associations suggested a polyploid origin for the genus and supported earlier observations of a basic chromosome number of n = 3 for Citrus.

1350 AHAD, A; ISLAM, R; JOARDER, OI. 1993. **Micropropagation of *Citrallus vulgaris Schrad* by shoot proliferation**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

1351 BAJAJ, YPS. 1984. **Induction of growth in frozen embryos of coconut and ovules of citrus**. *Current Science, India*, 53: 22, 1215-1216; 7 ref.

Immature embryos of *Cocos nucifera cv. West Coast Tall* and ovules from unripe fruits of Citrus species were partially dehydrated, halved or left whole, treated with cryoprotectant and frozen in liquid nitrogen for 5 minutes, then thawed and cultured on supplemented Murashige & Skoog medium. After a lag of up to 4 months some coconut embryos elongated and proliferated from the cut end. Survival of whole embryos was 17.6%, and of transverse halves 25.0%. Entire young ovules, and the micropylar half of the split citrus ovules showed a survival of 28.8 and 24.3%, respectively, proliferating to form psuedobulbils.

1352 BHAT, SR; CHITRALEKHA, P; CHANDEL, KPS. 1992. **Regeneration of plants from long-term root culture of lime, *Citrus aurantifolia (Christm.) Swing***. *Plant Cell, Tissue and Organ Culture*, 29: 1, 19-25; 15 ref.

An excised root culture of lime, (cv. Kagzi), was established in MS medium containing 3% sucrose. De novo shoot bud initiation was recorded in basal medium at a low frequency during 3 years of continuous culture. The effects of BA alone or in combination with IAA, were investigated. Inclusion of up to 4.4 μM BA in the culture medium enhanced both root growth and shoot elongation: the frequency of shoot regeneration was only slightly improved. Shoot bud differentiation occurred at the proximal region of the root at or just distal to the cut end. Histology of shoot regeneration revealed the endogenous origin of the shoot buds from the pericycle tissue of the root. The regenerated plants had a normal diploid chromosome number (2n = 18) and were established in soil.

1353 CHATURVEDI, HC; SHARMA, AK. 1985. **Production of androgenic plants of *Citrus aurantifolia***. *J. of Plant Physiology*, 119: 5, 473-477; 20 ref.

Anthers having uninucleate pollen grains at the tetrad stage were induced to differentiate embryoids when they were floated on modified Murashige & Skoog medium supplemented with 0.5 mg BA/litre + 1 mg IAA/litre for 20-30 days followed by subculture on semisolid Schenk & Hildebrandt medium, having the same growth hormones, for 30 days. Embryoids originated from within the anther lobes. Embryoid proliferation occurred from the hypocotyl and cotyledons of the first formed embryoids. Plantlets were obtained either by subculturing embryoids in basal medium without auxin or by rooting shoots which were repeatedly clipped from basal stems that had been subcultured on basal medium + BA. The plantlets had 2n = 18 chromosomes and grew normally in soil.

1354 PADMANABHAN, D; RADHAKRISHNAN, R. 1985. **Arrangement of cotyledons in Citrus medica Linn**. *Current Science*, 54: 10, 473-474; 2 ref.

C. medica produces a large zygotic embryo and 4-6 small embryos of nucellar origin. Examination of batches of 40-day-old seedlings revealed that the zygotic embryo developed 2 oppositely placed cotyledons while the nonzygotic embryos showed the following variations: one or 2 cotyledons, opposite and subopposite cotyledons, and an intercotyledonary internode; variations in the phyllotaxy of the seedling leaves were also observed in seedlings from nonzygotic embryos.

1355 PRASAD, MBNV; RAO, NNR. 1983. **Reaction of some citrus rootstock hybrids for tolerance to *Phytophthora* root rot**. *Indian Phytopathology*, 36: 4, 726-728; 4 ref.

Hybrids of *Cleopatra mandarin* X *Trifoliate orange* [*Poncirus trifoliata*] showed potentiality as superior rootstocks because of their high tolerance of *P. nicotianae var. parasitica*.

1356 SHARMA, KK; JAWANDA, JS. 1985. **Identification of nucellar and zygotic seedlings in Citrus rootstock species through isozyme analysis.** *Journal of Research, Punjab Agricultural University*, 22: 2, 277-284; 8 ref.

Peroxidase isoenzyme analysis of extracts of young leaves from nucellar and zygotic seedlings of 5 Citrus species and 2 *Poncirus trifoliata* X *C. sinensis* hybrids, using horizontal potato starch gel electrophoresis, revealed characteristic anodal (A1-A8) and cathodal (C1-C9) bands, the number and intensity of which were variable and which readily distinguished between nucellar seedlings of the different taxa and c. 75% of zygotic from nucellar seedlings within a taxon. The use of peroxidase isoenzyme analysis is advocated as a tool in both taxonomic and breeding work.

1357 VILLECHANOUX, S; GARNIER, M; RENAUDIN, J; BOVE, M. 1992. **Detection of several strains of the bacterium-like organism of citrus greening disease by DNA probes**. *Current Microbiology*, 24: 2, 89-95; 19 ref.

DNA was purified from phloem tissue of periwinkle (*Catharanthus roseus*) plants infected by an Indian strain of the greening bacterium-like organism (BLO) restricted with HindIII endonuclease, and cloned in the replicative form of bacteriophage M13mp18. By differential hybridizations involving DNA from healthy and infected plants, recombinant phages containing BLO DNA were selected. The BLO DNA inserts (In-2.6, In-1.9 and In-0.6) were purified from the viral replicative forms and used as probes. Southern and dot hybridizations showed that In-2.6 and In-1.9 recognized all Asian strains tested (strains from India, Thailand, Philippines, Indonesia, China and Taiwan), but not a South African strain. In-0.6 reacted only with the Indian BLO strain.

Citrus grandis

1358 AKHTAR, S; AMIN, MN; RAZZAQUE, MA. 1992. **Tissue Culture Propagation of *Citrus grandis* - A Common fruit tree of Bangladesh**. *7th Ann. Bangladesh Sci. Conf.* IPSA, Gazipur, Bangladesh: p. 57-58.

1359 AMIN, MN; AKHTER, S. 1993. **Regeneration of plants in vitro from seedling explants of pummelo (*Citrus grandis [L] Osb*)**. *Pl. Tissue Cult.*, 23: 2, 71-79.

Propagation

1360 RAMAN, H; GOSAL, SS; BRAR, DS. 1987. **Plant regeneration from callus cultures of *Citrus limon* and *C. jambhiri*: abstract**. *Symposium on Crop Improvement*. (1st: Ludhiana: 1987: Feb 23-27)/edited by KS Gill, AS Khehra, MM Verma, KS Bains. Crop Improvement Society of India, Ludhiana, p. 158-159.

Stem and root segments from in vitro grown seedlings of *C. limon cv. Baramasi* and *C. jambhiri cv. Jatti Khatti* were cultured on MS [Murashige & Skoog] medium with 10 mg NAA and 0.2 mg kinetin/litre. Stem-derived cultures were superior to root-derived cultures in callus induction, and only the stem cultures produced plantlets, shoots being produced on transfer to half- strength MS medium with BAP [benzyladenine] and GA3 and rooting on half-strength MS medium with NAA and sucrose.

1361 SINGH, S; RAY, DK; BHATTACHARYYA, S; DEKA, PC. 1994. **In vitro propagation of *Citrus reticulata Blanco* and *Citrus liman Barm f.*** *Hortscince*, 29: 3, 214-216.

Multiple shoots were obtained from shoot tips (2 to 3mm) derived from mature plants (5 to 6 years old) of Citurs reticulata Blanco cv. Khasi mandarin and *C. limon* Burm. f. cv. Assam lemon when cultured on Murashige and Skoog (MD) medium supplemented with (mg. liter) 1.0 BAP, 0.5 kinetin, and 0.5 NAA. Root induction was observed when 7-week-old single shoots (=2 cm long) of both Citrus species were cultured on MS medium supplmented with (mg. liter) 0.25 BAP, 0.5 NAA, and 0.5 IBA. These plantlets were successfully established in the soil. Chemical names used: naphthalene acetic acid (NAA), indole 3 butic acid (IBA), and benzylamino purine (BAP).

Insect pests control

1362 KRISHNAMOORTHY, A; SINGH, SP. 1987. **Biological control of citrus mealybug, *Planococcus citri* with an introduced parasite, *Leptomastix dactylopii* in India**. *Entomophaga*, 32: 2, 143-148; 16 ref.

Inoculative releases of the encyrtid *Leptomastix dactylopii* were made in an orange orchard in 1984 and a lime orchard in 1985 in Karnataka, India, for the control of *Planococcus citri*. Prior to release, infestation by the pest ranged from 38 to 65%, but establishment of the parasitoid resulted in complete control within 3 to 4 months. No insecticide treatments were required for the control of the pseudococcid in the following seasons.

1363 KRISHNAMOORTHY, A; SINGH, SP. 1986. **Record of the egg parasite, *Trichogramma chilonis* on *Papilio spp.* in citrus**. *Curr. Science*, 55: 9, 461; 4 ref.

The natural enemies of *Papilio demoleus* and *P. polytes* infesting citrus were surveyed in Karnataka, India, in 1984. Two species of parasites were collected from eggs and identified as *Trichogramma chilonis* and the scelionid *Telenomus sp*. This is the first record of *Trichogramma chilonis* parasitizing eggs of these papilionids in India, and natural rates of parasitism were found to reach as high as 75.9%. In laboratory studies, *T. chilonis* readily parasitized 1-2-day-old eggs of *Papilio spp.*, and development was completed in 8.3 days at 28°C. Adults survived for 6.9 days when fed with 40% honey solution. Each parasitized egg of *Papilio spp.* yielded 8-27 adults of both sexes. The male:female ratio was 1:7.06. It is suggested that *T. chilonis* could be mass-reared on eggs of the pyralid *Corcyra cephalonica* and released to suppress populations of *P. demoleus* and *P. polytes*.

1364 MANI, A. 1988. **Studies on the bacterial parasite *Pasteuria penetrans*: I. Spore viability after storage. II. Culture on citrus nematode *Tylenchulus semipenetrans***. *International Nematology Network Newsletter*, 5: 2, 24-25; 7 ref.

Observations revealed that *P. penetrans* spores were viable for a period of more than one year at 10-30°C and at room temperature (18.5-36°C). The bacterium multiplied readily on *T. semipenetrans* in pot experiments and this is thought to be the first report of a successful culture on this nematode. *P. penetrans* is a potential biocontrol agent for *T. semipenetrans*.

Oranges

1365 KOKAYA, TSD. 1985. **Origin of new forms of citrus following distant hybridization with species of Yuzu orange**. *Subtropicheskie Kul'tury*, No. 4: 127-133.

In work during 1968-83, hybridization of species of the Yuko/Yuzu orange type, such as *Citrus junos* and *C. yuko*, with lemon, orange, mandarin and other citrus crops gave some hybrids reminiscent of existing wild or cultivated citrus species. Open pollination of *C. yuko* gave one seedling (80) similar to *Microcitrus inodora*. Seedling 692, from *C. yuko* X the lemon Sipibai, was similar to a sweet-fruited botanical variety of tropical lemon of the lime type. Other examples are cited in support of Tanaka's view that cultivated species arose as "chance seedlings" among cultivated and wild plants. These chance seedlings are seen as the result of segregation following interspecific hybridization, especially following introduction of the hybrids into different climatic conditions, when they could diverge markedly from their parents. A possible origin of true lemon, with its distinctive aroma not present in the tropical lime and occurring among the other Citrus species only in *C. megaloxicarpa*, is considered to be lemon-like forms of the Meyer type in their passage from India to the Mediterranean; in north Iran, Meyer types have been found growing alongside lemon-like forms of the Ponderosa type (related to *C. megaloxicarpa*), so that true lemon could have developed from their hybridization.

1366 PRASAD, MBNV; RAVISHANKAR, H. 1983. **Studies on polyembryony and seed morphology in some trifoliate orange hybrids**. *South Indian Horticulture*, 31: 2/3, 101-103; 1 ref.

Ten hybrids were examined. Polyembryony was 100% in Rustic citrange and Trifosta trifoliate, 93.3% in Swingle Citrumelo and 86.7% in Troyer citrange. Rustic citrange had 3.3 embryos/seed, Troyer citrange 2.9, Trifosta trifoliate 2.8, and Swingle Citrumelo and Citrangequat 2.6. Data are presented on ten seed morphological characters.

1367 RADHAMANI, J; CHANDEL, KPS. 1992. **Cryopreservation of embryonic axes of trifoliate orange (*Poncirus trifoliata (L.) RA.F*)**. *Plant Cell Reports*, 11: 7, 372-374; 17 ref.

Seeds with testa intact and excised embryonic axes were desiccated to moisture contents ranging from 36.3 to 20.0 and 38.2 to 11.0%, respectively. Intact seeds were sensitive to desiccation, and did not withstand reduction in moisture level below 20%, whereas the excised embryonic axes were easily desiccated to moisture levels as low as 14% without much loss in viability. Axes were successfully cryopreserved in liquid nitrogen (-196°C) for 8 months. The viable embryonic axes exhibited good growth on modified MS medium supplemented with 0.2 mg NAA and BAP [benzyladenine]/-litre. Growth of cryopreserved axes was promoted in the presence of charcoal in the medium. Cryopreservation of axes at 14% moisture content resulted in the best recovery (68% viability).

Guavas

1368 AMIN, MN. 1991. **Callus culture and plant regeneration from an economically important tropical tree**. *Jackfruit Internat. Conference*. Genetic Engineering and Biotechnology, Kathmandu, Nepal. p. 50.

1369 AMIN, MN; JAISWAL, VS. 1989. **Effects of phloriglucinol, sucrose, pH and temperature on the vitro rooting of guava microcuttings**. *Bangladesh Journal Botany*, 18: 129-139.

1370 AMIN, MN. 1991. **Histology of in vitro organogenesis in guava cultures established from shoot explants of mature trees**. *Pl. Tissue Cult.*, 1: 1, 13-18.

1371 AMIN, MN. 1992. **In vitro production of shoots and rooting of microcuttings from sequential reculturing of guava explants**. *7th Ann. Bangladesh Sci. Conf.* IPSA, Gazipur, Bangladesh: p. 66.

1372 AMIN, MN. 1989. **In vitro propagation of guava**. *Bangladesh Journal Botany*, 18: 1-8.

1373 AMIN, MN; JAIWSAL, VS. 1989. **In vitro propagation of guava (*Psidium guajava*) : effect of sucrose, agar, and pH on growth and proliferation of shoots**. *Bangladesh J. Bot.* 18: 1, 1-8.

1374 AMIN, MN; JAISWAL, VS. 1988. **Micropropagation as an aid to rapid cloning of a guava cultivar**. *Scientia Horticulture*, 36: 89-95.

1375 AMIN, MN. 1986. **Micropropagation of a tropical fruit tree *Psidium guajava L.*** *J. Indian Bot. Soc.* 65(suppl): 43-44.

1376 AMIN, MN; JAISWAL, VS. 1987. **Rapid colnal propagation of guava through in vitro shoot proliferation on nodal explanst of mature trees**. *Plant Cell Tisue Organ Culture*, 9: 235-245.

1377 AMIN, MN. 1991. **Selection of inorganic salt combination for in vitro shoot proliferation of guava**. *International Botanical Conference (Biotech. and Tissue Culture. Sec.)*. Dhaka University, Bangladesh.

1378 ARA, KA; SHARIFUZZAMAN, SM; MIAH, MAA; KHAN, MA; HOSSAIN, AE. 1992. **In vitro clonal propagation of Guava (*Psidium guajava L.*)**. *Bangladesh Hort*, 20: 2, 125-131.

1379 JAISWAL, VS; AMIN, MN. 1988. **Genetic Manipulation of Woody *Plants*.** *Micropropagation* as an aid to clonal propagation of guava cultivars. Dept. of Botany, Banaras Hindu Univ., Varanasi, India. p. 427.

1380 JAISWAL, VS; AMIN, MN. 1987. **In vitro progagation of guava from shoot culture of mature trees.** *J. Plant Physiol*, 130: 7-12.

1381 JAISWAL, VS; AMIN, MN. 1986. **In vitro shoot proliferation and plantlet formation from somatic tissues of guava**. *VI International Cong. on Plant Tissue Culture*. University of Minnesota, Minneapolis: p. 279.

1382 JAISWAL, VS; AMIN, MN. 1988. **Micropropagation as an aid to clonal propagation of guava cultivars**. *Genetic Manipulation of Woody Plants*/edited by JH Honover and DE Keathly. New York : Plenum press, p. 427.

1383 KAUNDAL, GS; DEOL, IS. 1990. **Budding techniques in clonal propagation of guava**. *Horticultural Journal*. 3: 1-2, 37-42; 11 ref.

A new method, designated modified ring budding (MRB), was developed to overcome the problem of using different size rootstock shoots. This was compared with the conventional patch budding over 2 years using Lucknow-49 (Sardar guava) as rootstock and Allahabad Safeda as the scion. Budding was carried out on the 15th day of the month from Apr. to Sep. In the case of MRB, a ring of bark 2.0-2.5 X 0.8-1.0 with 2 buds was removed from the freshly cut budsticks. Fitting the modified ring bud onto different size rootstock shoots is illustrated. The mean success with MRB was 71.89--75.85% compared with 63.39-64.22% with patch budding. The highest success with MRB (88.52--89.74%) was obtained in May and the lowest in Sep. (52.45-60.36%). However, sprouting of buds following MRB was delayed until one of the 2 buds was removed.

1384 KHATTAK, MS; MALIK, MN; KHAN, MA. 1990. **Effect of surface sterilization agents on in vitro culture of guava (*Psidium guajava L.*) *cv. Sufeda* tissue**. *Sarhad Journal of Agriculture*, 6: 2, 151-154; 7 ref.

In studies carried out during 1986-87, seedlings (4-5 cm in height) and shoots (3-4 cm in length) taken from plastic-wrapped or unwrapped branches of 10-year-old guava trees were surface sterilized with HgCl2, Ca(OC1)2, NaOCl or ethanol at various concentrations for different durations. Shoot tips (1-2 cm in length) were excised from these seedlings and shoots, placed in tubes on a medium comprising MS salts supplemented with 0.7% agar, 3% sucrose and 0.1 g BA/litre and cultured for 8 weeks. The effects of different sterilization agents on the percentage contamination and bud sprouting of guava explants are tabulated. The best results were obtained with treatment of seedling explants with 70% ethanol for 1 min + 5% NaOC1 for 5 min (70% infection-free tubes and 70% bud sprouting) and

treatment of shoots from plastic wrapped branches with 0.05% HgCl2 for 5 min (90% infection-free tubes and 80% bud sprouting).

Mangoes

1385 NOYES, JS. 1988. ***Gyranusoidea tebygi sp. n.* (*Hymenoptera: Encyrtidae*), a parasitoid of *Rastrococcus (Hemiptera: Pseudococcidae)* on mango in India.** *Bull. of Entomological Research*, 78: 2, 313-316; 2 ref.

Gyranusoidea tebygi sp. nov., an encyrtid parasitoid of *Rastrococcus* on mango in India, is described and compared with related species. The parasitoid is to be introduced into West Africa in an attempt to control the mealybug, which is a serious pest of mango and citrus in some West African countries.

1386 SINGH, NP; CHADHA, KL; SHRIVASTAVA, RP. 1983. **Nucellar seedling from polyembryonic mango stones.** *Current Science*, 52: 16, 782-784; 4 ref.

Seeds from south and north India were studied for germination, number of embryos/seed, and the number of seedlings/seed. The data are tabulated. The number of embryos ranged from 2 to 10, seedlings from 1 to 7 and germination from 40.6 to 87.5%. Polyembryonic seeds produced nucellar seedlings under field conditions, and it is suggested that they can be used as rootstocks.

Averrhoa carambola

1387 AMIN, MN; RAZZAQUE, MA; AKHTER, S. 1992. **Axillary shoot proliferation and adventitious rooting in vitro of carambola (*Averrhoa carambola L.*).** *Plant Tissue Culture*, 2: 1, 7-13.

Proliferating cultures of axillary shoots were established on MS and modified MS media from shoot explants in vitro raised seedlings of *A. carambola* with different concentrations of BA and kinetin. Seedlings grown on medium containing BA 0.5 mg/l developed into bushy shoots with reduced hypocotyl and roots. Nodal segments from these seedlings were found to be the best explants for axillary shoot formation on agar gelled MS medium with t/2 major salts and 0.5-1.0 mg/1 of BA. On this medium axillary buds showed sprouting within one week of incubation. By sequential reculturing and subculturing 20-30 usable shoots (> 1 cm length) could be produced from 2-node shoot segments after 10- 12 weeks of culture. Microcuttings taken from in vitro proliferated shoots were rooted on 1/2 strength MS medium having 0.1-0.5 mg/1 of IBA and/or NAA. Maximum rooting (90%) with 2-4 roots per cutting was achieved at 0.2 mg/1 of IBA on the same medium.

1388 AMIN, MN; RAZZAQUE, MA. 1993. **Regeneration of *Averrhoa carambola* Plants in vitro from callus cultures of seedling explants.** *Journal of Horticulture Science*, 68: 4, 551-556.

1389 JOARDER, OI; KHALEQUE, MA; HOSSAIN, MM; ISLAM, R. 1993. **Somatic embryogenesis on immature cotyledon of *Averrhoa carambola L.*** *Proc. Intl. Conf. on Biotech. and Forestry*. (IARI, New Delhi), p.34.

1390 KHALEQUZZAMAN, M; ISLAM, R; HOSSAIN, M; JOARDER, OI. 1993. **Propagation of *Averrhoa carambola L.* by tissue culture.** *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

1391 RAZZAQUE, MA; AKHTAR, S; AMIN, MN. 1992. **In vitro plant regeneration from seedling root and shoot explants of *Averrhoa carambola L.*** *7th Ann. Bangladesh Sci. Conf.* IPSA, Gazipur: p. 57.

1392 SHAH, MAR; AMIN, MA; MONDAL, A. 1993. **Rooting in vitro of *Averrhoa carambola L.* microcuttings as affected by auzins, sucrose.** *Agar. J. Bio. Sc.* 1: 77-79.

Stone fruits

1393 AHMAD, Z; ZAIDI, N; SHAH, FH. 1989. **Callus formation from the mesocarp tissue of *Pistacia vera L.*** *Pakistan Journal of Scientific and Industrial Research*, 32: 8, 549-550; 8 ref.

Mesocarp tissue cultured in MS medium at 26 ± 1°C with subculture every 9-10 days formed many nodular, compact, greyish white calluses in the presence of 2 mg NAA + 4 mg 2,4-D + 2 mg kinetin/litre. Supplementation with 3 mg 2,4-D + 2 mg kinetin/litre also resulted in nodular, compact, greyish white callus. Callus initiation took about 70-80 days.

1394 THAKUR, PD; BHARDWAJ, SV; GARG, ID; KHOSLA, PK; SHARMA, DR. 1994. **Plum pox virus from stone fruits in India, a new record.** *Plant Disease Research*, 9: 100-102.

Almonds

1395 MUNSHI, SK; SUKHIJA, PS. 1984. **Compositional changes and biosynthesis of lipids in the**

developing kernels of almond (*Prunus amygdalus* Batsch). *Journal of the Science of Food and Agriculture*, 35: 6, 689-697; 30 ref.

1396 UPPAL, DK; DHILLON, DS; DHALIWAL, GS; CHANANA, YR. 1984. **Selection of self-fruitful hybrids in intervarietal crosses of almonds.** *Indian Journal of Horticulture*, 41: 1/2, 80-82; 5 ref.

In 1972 and 1973, 10 cultivars or hybrids (as female) were crossed with the self fertile, prolifically bearing, natural peach X almond hybrid Sloh. Of 439 hybrids raised from the crosses, only AH258, from Pethick's Wonder X Sloh, was self compatible.

Cashew nuts

1397 HARIHARAN, M. 1992. **Shoot apical organization in cashew (*Anacardium occidentale L.*).** *Cashew Bulletin*, 29: 11-12, 10-11.

1398 PHILIP, VJ. 1984. **In vitro organogenesis and plantlet formation in cashew (*Anacardium occidentale L.*).** *Annals of Botany*, 54: 1, 149-152; 12 ref.

When 5 mm cotyledonary explants were cultured on Lin and Staba medium, each plantlet developed directly from an organized hemispherical mass of meristematic tissue that had arisen from a single epidermal cell. Plantlets had formed on 90% of explants after 5 weeks in culture.

Annona

1399 BEJOY, M; HARIHARAN, M. 1992. **In vitro plantlet differentiation in *Annona muricata*.** *Plant Cell, Tissue and Organ Culture*, 31: 3, 245-247.

1400 NAIR, S; GUPTA, PK; MASCARENHAS, AF. 1983. **Haploid plants from in vitro anther culture of *Annona squamosa Linn*.** *Plant Cell Reports*, 2: 4, 198-200; 15 ref.

Haploid plants were induced from anther-derived callus of *A. squamosa* on a Nitsch basal medium supplemented with BA and NAA. Dissection of the flowers in a suspension of activated charcoal and sucrose was essential, and the anthers required an initial dark period and a high sucrose medium followed by light and low sucrose.

1401 NAIR, S; GUPTA, PK; MASCARENHAS, AF. 1984. **In vitro propagation of annona hybrid (*Annona squamosa L.* X *Annona cherimola L.*).** *Indian Journal of Horticulture*, 41: 3/4, 160-165; 20 ref.

Nodal explants carrying axillary buds were cultured on modified Murashige & Skoog medium to propagate this promising hybrid which does not breed true. Rooted plantlets were successfully transferred to the field where 80% of them survived.

1402 NAIR, S; GUPTA, PK; SHIRGURKAR, MV; MASCARENHAS, AF. 1984. **In vitro organogenesis from leaf explants of *Annona squamosa Linn*.** *Plant Cell, Tissue and Organ Culture*, 3: 1, 29-40; 17 ref.

Multiple shoot formation was induced from leaf explants of seedlings on a Murashige and Skoog basal medium containing BA and kinetin. The maximum number of shoots were obtained using the leaf base with petiole at a temperature of 27°C and a light intensity of 1000 lux. Roots were initiated from individual shoots. Of the plantlets grown in soil in pots, 10% survived.

1403 NAIR, S; SHIRGURKAR, MV; MASCARENHAS, AF. 1986. **Studies on endosperm culture of *Annona squamosa Linn*.** *Plant Cell Reports*, 5: 2, 132-135; 17 ref.

Endosperm tissue was excised from seeds 2-4 days after radicle emergence and cultured on White's medium supplemented with growth regulators. Callus formed which could be subcultured periodically. Shoot and root regeneration were obtained on modified Nitsch media. Cytological analysis of root and leaf tips of the regenerated plants showed that they were triploid ($2n=3x=21$).

Ziziphus mauritiana

1404 KABIR, A; ISLAM, R; HAQUE, A; KHALEKUZZAMAN, M; JOARDER, OI. 1994. **Micropropagation of *Zizyphus mauritiana* from nodal segments of mature trees.** *Bull. Sericult. Res.* 5.

1405 ISLAM, R; KABIR, A; HAQUE, A; KHALEKUZZAMAN, M; JOARDER, OI. 1994. **Somatic embryogenesis from immature fruits of *Zizyphus mauritiana*, a food plant of tasar silkworm.** *Bull Sericult. Res.* 5.

1406 RATHORE, TS; SINGH, RP; DEORA, NS; SHEKHAWAT, NS. 1992. **Clonal propagation of *Zizyphus* species through tissue culture.** *Scientia Horticulturae*, 51: 1-2, 165-168; 6 ref.

Protocols for clonal propagation of *Ziziphus nummularia* and *Z. mauritiana* by tissue culture were developed. From a nodal explant of *Z. nummularia*, 5-7 shoots

proliferated on MS medium containing 5.0 mg BA + 0.05 mg IAA/litre. For *Z. mauritiana*, 4-5 shoots developed from the nodal region of each explant on MS medium containing 7.5 mg BA + 0.1 mg IAA/litre. Shoots generated in vitro could be further multiplied on fresh medium. The isolated shoots were placed for rooting on a filter paper bridge in White's liquid medium containing 25 mg IBA/litre; after 48h these shoots were transferred to solid White's medium without growth regulators. Regenerated plants were hardened-off and successfully transferred to pots.

1407 KABIR, MA; ISLAM, R; JOARDER, OI; HOSSAIN, M. 1993. **In vitro propagation of *Ziziphus mauritiana L.* from shoot cultures of mature trees**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

Coconuts

1408 ANITHA, K; SHANKAR, SS; SAJINI, KK; SAJI, KV. 1993. **Field collection and in vitro germination of coconut embryos**. *Journal Plantation Crops*, 21 (suppl), 291-294.

1409 ANITHA, K; SAJINI, KK. 1993. **In vitro germination and ex vitro establishment**. *National Symposium on Developments in Plant Molecular Biology and Genetic Engineering*. (Kasaragod, Kerala: 1993: December 29-31). Biotechnology Section, CPCRI, Kasaragod, Kerala.

1410 ANITHA, K; SAJINI, KK. 1994. **Short term storage of coconut zygotic embryos in sterile water**. *Current Science*, 67: 2, 118-120.

1411 DRRYJS, ZL. 1989. **Culture of leaf explants of coconut: Development towards somatic embryogenesis**. CRI, Lunuwila, Sri Lanka: p. 36.

1412 EBERT, AW; RILLO, EP; ORENSE, OD; AREZA, MBB; CUETO, CA. 1991. **Philippine-German project on coconut tissue culture - first results**. *Philippine Journal of Coconut Studies*, 16: 1, 12-15.

The Philippine-German Project on Coconut Tissue Culture is focusing on technology development and transfer of an asexual propagation system for coconut. Based on an Agreement on Technical Cooperation between the governments of the Republic of the Philippines and Federal Republic of Germany, the project is jointly implemented by the Philippine Coconut Authority and the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH and was started in February 1989 at Albay Research Center (ARC), Banao, Guinobatan, Albay [Philippines]. In 1981 GTZ began funding a British team working on the cloning technique for coconuts under the leadership of Dr. J. Blake at Wye College, University of London, U.K. Since 1989, this British team has worked in close cooperation with the tissue culture team at ARC to enhance the development of the cloning technique. In this paper first results obtained by the tissue culture team at ARC are reported. The culture of zygotic embryos is being further improved to facilitate germplasm exchange and disease screening. Embryo rescue of the high-value Makapuno coconut aims at developing a nontraditional coconut industry, especially for small coconut farmers. For clonal propagation immature embryos, leaves, and inflorescences are used.

1413 FERNONDU, WMU. 1994. **Characterization of coconut germplasm using biochemical markers lisozyme markers**. Council for Agricultural Research Policy, World Bank Assissted Project, Sri Lanka.

1414 GUPTA, PK; KENDURKAR, SV; KULKARNI, VM; SHIRGURKAR, MV; MASCARENHAS, AF. 1984. **Somatic embryogenesis and plants from zygotic embryos of coconut (*Cocos nucifera L.*) in vitro**. *Plant Cell Reports*, 3: 6, 222-225; 13 ref.

Complete plants were grown from zygotic embryos of variety West Coast Tall cultured on Y3 basal liquid medium supplemented with coconut milk, BA and NAA. Stem, leaf and rachilla explants of mature trees turned green and swelled on Y3 semisolid medium supplemented with 2,4-D, K, NAA, BA and activated charcoal. Callus initiated from stem subapical explants on Y3 medium supplemented with 2,4-D, formed globular embryo-like structures when subcultured on auxinless medium. Roots were formed on leaf explants on Y3 medium containing citric acid, ascorbic acid and 2,4-D. Globular embryo-like structures were also obtained directly from leaf explants on Y3 medium supplemented with 2,4-D. Callus from rachilla explants formed nodular struct. on medium with 2,4-D. Nodules developed roots and shoots on Y3 basal liquid medium.

1415 IYER, RD; ANITHA, K; SHIVASHANKAR. 1992. **Tissue culture for rapid multiplication of elite genotypes and basic studies in cocounut and oil palm**. (Coconut-World Bank (NARP - II): 1992: September).

1416 KALAMANI, A; RANGASAMY, SR. 1990. **In vitro culturing of coconut embryo**. *Indian Coconut Journal Cochin*, 20: 11, 9-10; 7 ref.

Embryos from mature nuts of the *Cocos nucifera* hybrid Tall X Gangabondam were cultured on 4 media. Y3 mineral medium was the best for embryo growth and development. Leaf initiation was best on Y3 medium supplemented with 1 mg kinetin per litre while rooting was induced by adding 1.5 mg NAA per litre and 0% charcoal to the medium.

1417 KARUNARATNE, S; KURUKULAARACHCHI, C; GAMAGE, C. 1985. **A report on the culture of embryos of dwarf coconut, *Cocos nucifera L.* var. Nana in vitro**. *Cocos*, 3, 1-8; 12 ref.

Embryos of the 3 colour forms pumila [green], regia [red] and eburnea [yellow], were cultured in modified liquid Eeuwens medium [see Physiologia Plantarum (1978) 42, 173-178] containing 0.09 M sucrose and 0.25% w/v activated charcoal. About 62% of embryos developed into seedlings with up to 4 scale leaves and 2 green leaves in 4 months. Charcoal was essential for seedling development. A high concentration of sucrose was necessary for root initiation: when the concentration was increased to 0.18 M, the root system developed within 6-8 weeks, as a result of rapid enlargement of the haustorium. Seedlings were transferred to sterilized soil and kept under humid conditions and low light (6000 lux) for about 8 weeks, after which surviving seedlings were transferred to ordinary atmospheric conditions.

1418 KARUNARATNE, S; PERIYAPPERUMA, K. 1989. **Culture of immature embryos of coconut, *Cocos nucifera L.*: callus proliferation and somatic embryogenesis**. *Plant Science Limerick*, 62: 2, 247-253; 24 ref.

Embryos (6-7 months after anthesis) produced embryogenic callus when cultured in medium containing 12-20 μM 2,4-D. About 50% of the callus cultures produced globular embryoids when transferred to 8 μM 2,4-D. Embryoids in 22% of these cultures germinated and produced shoots, 6 mm long, when benzyladenine and kinetin (10 μM each) were incorporated into the culture medium. The age of the embryo was an important factor determining callus proliferation and subsequent embryogenesis. More than 50% of embryos excised from 6-7-month-old nuts produced embryogenic callus tissues, while 5-6-month-old nuts were not mature enough for embryo excision. Embryos from older nuts (8 months) germinated in culture. Only a small portion of the immature embryo produced embryogenic callus tissues. The future root region proliferated into a brownish callus which in turn produced roots profusely. The cotyledon of the immature embryo expanded and developed into a haustorium without any sign of callus formation. The shoot apex produced a few plumular leaves but no callus formation was observed.

1419 KUMAR, PP; RAJU, CR; CHANDRAMOHAN, M; IYER, R D. 1985. **Induction and maintenance of friable callus from the cellular endosperm of *Cocos nucifera L.*** *Plant Science*, 40: 3, 203-207; 14 ref.

Fast-growing friable callus was initiated (and maintained by subculture), from West Coast Tall, from the part of the endosperm initially in contact with the embryo. Eeuwens' Y3 mineral formulation [see Physiologia Plantarum (1976) 36, 23] with 2 mg kinetin/litre, 50 mg 2,4-D/litre and 1 g activated charcoal/litre was used to initiate callus in the dark. Callus was subcultured on basal medium containing reduced 2,4-D and no charcoal. Success is partly attributed to the use of explants excised in a sterile condition, with the embryo in situ, and to the high concentration of auxin in the medium. Preliminary cytological studies indicated a high degree of aneuploidy (41 to >175 chromosomes) in callus cells.

1420 KURUVINASHETTI, MS; IYER, RD. 1982. **An evaluation of tissue culture techniques in coconut and turmeric.** *Genetics, Plant breeding and Horticulture: Proc. of the Symposium on Plantation Crops (Placrosym IV)*. (Mysore: 4th: 1981: Dec 3 - 5)/edited by S Vishveshwara. Central Plantation Crops Res. Inst., Kasaragod-670 124, Kerala, India. p. 101-106; 14 ref.

Of the three methods tried using West Coast Tall coconut, embryo culture was the most successful and seedlings with roots were obtained. In *Curcuma domestica [C. longa]*, a method for the rapid multiplication of promising clones (such as 15B), involving cultures of buds excised from sprouting rhizomes, was developed.

1421 LIYANAGE, DV; WICKRAMARATNE, MRT; JAYASEKERA, C. 1988. **Coconut breeding in Sri Lanka: a review**. *Cocos*, 6, 1-26.

1422 SEETHA, K; SUNIL, S. 1991. **An in vitro assay for drought tolerant coconut germplasm.** *Euphytica*, 53:25-30.

1423 SEETHA, K. 1993. **Current status of embryo and tissue culture in coconut in Srilanka**. *Advances in coconut research and development*. Lunuwila, Srilanka: Oxford and IBH Publishing, p. 169-172.

1424 SEETHA, K; SHYAMA, F. 1992. **Embryo and tissue culture research on coconut in Sri Lanka**. *IBPGR Newsletter for Asia and the Pacific*, 9:11.

1425 SEETHA, KARUNARATNE. 1987. **Tissue culture towards better coconut**. *Coconut Bulletin*, 4: 1, 6-10.

1426 SHYAMA, F. 1993. **Status of coconut tissue culture and biotechnology research in Sri Lanka**. *Documentation Report on the International GTZ Workshop on Plant Biotechnology in technical Cooperation Programme (1993:6-11 October:GTZ, Germany)*. p. 193-195.

1427 SUNIL, KP. 1992. **Coconut root wilt management: focus turns to in vitro culture**. *Indian Coconut Journal Cochin*, 22: 10, 10; 4 ref.

Recent trends in research on this disease are outlined, with particular reference to the production of clonal plantlets by culturing spindle leaf tissues from 1- to 2-yr-old coconut seedlings. Attempts are being made to identify materials resistant to the pathogen or its vector, *Stephanitis typica*, and to culture the mycoplasma-like organism causing the disease.

1428 WEERAKOON, K; VIDHANAARACHCHI, VRM. 1986. **Application of embryo culture technology to select drought tolerant coconut germplasm**. CRI, Lunuwila, Sri Lanka

1429 WEERAKOON, K; FERNANDO, SC; DIDHANAARACHCHI, VRM. 1984. **In vitro culture of embryos of coconut**. CRI, Lunuwila, Sri Lanka

Date palms

1430 DASS, HC; KAUL, RK; JOSHI, SP; BHANSALI, RR. 1989. **In vitro regeneration of date palm plantlets**. *Current Science*, 58: 1, 22-24; 8 ref.

Callus cultures were induced from shoot tips (explants) of date palm (*Phoenix dactylifera* cv. Muscat) on nutrient medium contained MS (Murashige and Skoog) basal salts supplemented with various growth regulators and PVP (polyvinylpyrrolidone) in the dark at 28°C. Two media were used for this stage: MMS-I which contained (as mg/litre) NAA (1.0), 2,4-D (2.5), BAP ([benzyladenine] 0.1) and PVP (2000); and MMS-II which contained naphthoxyacetic acid (NOA, 3.0), NAA (5.0), IAA (1.0), kinetin (0.1), BAP (5.0), 2,4-D (0.1) and PVP (2000). Cellular embryos further differentiated from the callogenic explant into well developed, nodular-shaped embryos on transfer to a third medium (MMS-III) supplemented with (as mg/litre) NaH_2PO_4 (170) and KH_2PO_4 (200) which were both omitted from the basal medium, and with kinetin (2.0), BAP (5.0), charcoal (3000) and NAA (0, 0.1, 1.0, 10.0 or 100.0). These embryos further differentiated into complete plantlets; differentiation was best at 0.1 mg/litre NAA.

1431 KACKAR, NL; SOLANKI, KR; JOSHI, SP. 1989. **Micropropagation of date palm (*Phoenix dactylifera L.*) cv. Khadrawy using tissue culture technique**. *Annals of Arid Zone*, 28: 1-2, 137-141.

Culturing small segments (1 cm) from the tip of 1- to 2-year-old offshoots of dates cv. Khadrawy on modified Murashige and Skoog (MS) medium containing 2,4-D, BA and activated charcoal reduced the time required for callus formation by 2 weeks. Transferring 3-week-old callus to growth-regulator-free modified MS medium, incubating it under a light intensity of 3000 lux for 16 h/day produced somatic embryos within 2 weeks. Plantlets were then transferred to a modified MS medium containing 2 mg NAA + 2 mg 2-naphthoxyacetic acid + 2 mg BA/litre for hardening and then transferred to pots. Potted plants were ready for transplanting in the field within 2 months.

1432 REHMAN, A; RASHID, H; QURESHI, A; JOHN, I. 1988. **Effect of GA3 on shoot proliferation in different date palm varieties**. *Pakistan Journal of Botany*, 20: 2, 221-225; 9 ref.

Shoot tips excised from apical and axillary buds of the *Phoenix dactylifera* varieties Dhakki, Khudrawi and Zahidi showed shoot proliferation on MS medium supplemented with gibberellin. Complete plants were obtained only from cv. Dhakki.

1433 SHARMA, DR; CHOWDHURY, JB. 1983. **Clonal propagation of female date palm through tissue culture**. *National Symposium*. (1983: November 26-30). Advanc. Frontiers Pl. Sc., University, Jodhpur.

1434 SHARMA, DR; CHOWDHURY, JB. 1986. **Date palm (*Phoenix dactylifera L.*) tissue culture**. *Future Propagation and Research Needs In Plantation Crops, Opportunities and Constraints: vol. II*. New Delhi: Oxford IBH, p. 207-213.

1435 SHARMA, DR; CHOWDHURY, JB. 1983. **Date palm tissue culture**. *Second National Workshop on Arid Zone Fruit Research*. (Sukhadia University, Udaipur: 1983: July 8-10).

1436 SHARMA, DR; KUMARI, RITA; CHOWDHURY, JB. 1980. **In vitro culture of female date palm (*Phoenix dactylifera L.*) tissues**. *Euphytica*, 29: 169-174.

1437 SHARMA, DR; CHOWDHURY, JB; NEELAN, RY; CHOWDHURY VK. 1990. **In vitro multiplication of female date palm (*Phoenix dactylifera L.*).** *Bull. Soc. Bot. Fr.* 137, *Actual Bot*, 3/4: 15-23.

1438 SHARMA, DR; DEEPAK, S; CHOWDHURY, JB. 1987. **Propagation of female date palm through tissue culture - A case for in vitro multiplication.** *Crop Productivity*. New Delhi: Oxford IBH, p. 239-247.

1439 SHARMA, DR; DEEPAK SUNITA; CHOWDHURY, JB. 1986. **Regeneration of plantlets from somatic tissues of date palm (*Phoenix dactylifera Linn.*).** *Ind. Jour. Expt Biol.* 24: 763-766.

1440 SHARMA, DR; DAWRA, S; CHOWDHURY, JB. 1984. **Somatic embryogenesis and plant regeneration in date palm (*Phoenix dactylifera Linn.*) cv. 'Khadravi' through tissue culture.** *Indian Journal of Experimental Biology*, 22: 11, 596-598; 20 ref.

Callus cultures were established from axillary buds and shoot tips of 4-6-year-old plants. The best results were obtained when these explants were cultured on modified Murashige & Skoog medium containing activated charcoal (0.3%), NaH_2PO_4 (170 mg/litre), KH_2PO_4 (200 mg/litre), 2,4-D (100 mg/litre), BA (5 mg/litre) and thiamine (1 mg/litre). Somatic embryoids were induced on this medium without growth regulators, and viable plants regenerated from them.

1441 SHARMA, DR; CHOWDHURY, JB; RITA, K; KHANNA, U. 1978. **Studies on In vitro culture of date palm (*Phoenix dactylifera*) tissues.** *Second All India Conference*. M.S. University Baroda. p. 64.

Papayas

1442 HOSSAIN, M; RAHMAN, SM; ISLAM, R; JOARDER, OI. 1993. **High efficiency plant regeneration from petiole explants of *Carica papaya L.* through organogenesis.** *Plant Cell Reports*, 13: 99-102.

1443 ISLAM, R; RAHMAN, SM; HOSSAIN, M; JOARDER, OI. 1993. **In vitro. clonal progagation of papaya (*Carica papaya L.*).** *Pakistan Journal of Botany* 25: 2, 189-192.

1444 ISLAM, R; RAHMAN, SM; HOSSAIN, M; JOARDER, OI. 1993. **In vitro clonal propagation of papaya through culture of lateral buds from mature field-grown plants [short communication].** *Plant Tissue Culture*, 3: 1, 47-50.

1445 KUMAR, S; SINGH, S; SINGH, HP; SINGH, AK; SINGH, A. 1992. **Growth regulator studies in tissue cultures of three species of papaya.** *Biologisches Zentralblatt*, 111: 1, 21-26.

1446 PANDEY, RM; KISHORE, DK; ARULMOZHI, K. 1986. **Effect of seasons, plant type and some pre-excision treatments on in vitro behaviour of explants of *Carica papaya L.*** *Indian Journal of Horticulture*, 43: 3-4, 174-179; 8 ref.

Explants from decapitated plants showed a 60% survival percentage vs. 40% for non-decapitated controls, indicating the importance of apical dominance. For Pusa Dwarf and Pusa Delicious, explants taken during December-February failed to establish and highest survival percentages were recorded for June- September, with shoot tip explants performing better than lateral buds. Explants from lateral buds of staminate Pusa Dwarf and Co1 and hemaphrodite Pusa Delicious plants survived slightly better than those from their respective pistillate plants.

1447 RAHMAN, SM; HOSSAIN, M; JOARDER, OI; ISLAM, R. 1992. **Rapid clonal propagation of papaya through culture of shoot apices.** *Indian J. Hort*, 49: 23-26.

Propagation

1448 MONDAL, M; GUPTA, S; MUKHERJEE, BB. 1990. **In vitro propagation of shoot buds of *Carica papaya L. (Caricaceae) var. Honey Dew*.** *Plant Cell Reports*, 8: 10, 609-612; 14 ref.

About 43% of explants from fruit-bearing plants and 69% of those from saplings of cv. Honey Dew remained free of contamination and retained regeneration capacity after initial treatment with gentamicin followed by culture in MS medium containing 500 mg gentamicin/litre. For the establishment of the explants, a medium containing 1 mg gibberellic acid and 2 mg kinetin/litre was necessary. When established buds were transferred to a medium containing 1 mg NAA and 3 mg kinetin/litre, calluses were initiated at cut ends of shoot buds; multiplication started on transfer to a medium containing 0.1 mg NAA and 0.5 mg benzyladenine/litre. Cultures were successfully maintained for 20 months without any loss in their multiplication rate. Rooting was induced in a medium with reduced salt concentration containing 2 mg IBA/litre. Shoot elongation was induced after prolonged culture in the same rooting medium.

1449 PANDEY, RM; SINGH, SP. 1988. **Field performance of in vitro raised papaya plants.** *Indian Journal of Horticulture*, 45: 1-2, 1-7; 7 ref.

In vitro-raised plants of the pawpaw cv. Pusa Delicious were compared with seedling-plants for numerous plant characteristics and fruit chemical composition. The data are tabulated. The in vitro-raised plants outperformed the seedling-plants in almost all respects, yielding 1.5 times more, showing totipotency with regard to sex expression (pistillate plants yielded only pistillate plants) and producing a uniform stand in the field.

1450 PANDEY, RM; RAJEEVAN, MS. 1987. **Transplantation of papaya (*Carica papaya L.*) plants produced through tissue culture**. *Indian Journal of Horticulture*, 44: 1/2, 14-17; 10 ref.

Pawpaw plantlets produced through tissue culture were successfully transferred to soil. Eighty percent of the plantlets survived when they were planted 30 days after root initiation (which took 7 weeks in vitro) in a 1:1:1 mixture of sand, soil and FYM. Subjecting the plantlets to a light intensity above 6000 lx before transplanting was detrimental to establishment in the soil. Rooting under non-sterile conditions using elongated shoots is considered promising for reducing costs in producing plants via tissue culture.

1451 PURNIMA; SANDHYA-BISHT; BISHT, S. 1988. **Genotypic differences of in vitro lateral bud establishment and shoot proliferation in papaya**. *Current Science*, 57: 8, 440-442; 6 ref.

Axillary buds were excised from 3- to 4-month-old plants of the *Carica papaya* genotypes Co6, Co3, Co2 and Delicious, trimmed to 2-3 mm with <1 mm base, and cultured, successively, on MS establishment and proliferation media. Delicious showed the best establishment (80.3%).. Co6 showed the best proliferation (72.3%), compared with 46.5% for Delicious and 42.4% for Co3 and Co2.

1452 RAJEEVAN, MS; PANDEY, RM. 1983. **Propagation of papaya through tissue culture**. *Acta Horticulturae*, No. 131: 131-139; 7 ref.

Tissue culture, using shoot tips from seedlings and lateral buds from female plants, was tried with the cv. Coorg Honey Dew. Shoot tips and lateral buds could be established in MS medium containing NAA at 0.5-10 mum and kinetin at 25-50 mum. BA at 2 mum was optimal for multiplication of shoots. IAA at 10 mum induced profuse rooting and normal plantlet formation. Good survival of plantlets was obtained in a mixture of sand, soil and FYM (1:1:1 v/v).

1453 SINGH, SP; PANDEY, RM. 1988. **Note on a new device for harden-off of in vitro multiplied papaya plants**. *Indian Journal of Horticulture*, 45: 3-4, 271-273; 4 ref.

A transparent plastic chamber (9 X 9 X 3 inches) is described and illustrated. In vitro plantlets of different heights and with different numbers of leaves and leaf sizes were hardened in liquid MS nutrient medium in these chambers for 10 days before transfer to potting compost. They were compared with non-hardened 4.5-cm-tall controls for mean survival %. Plantlet survival after hardening decreased with plantlet height (5.5-9.5 cm) and was best (85%) with 6.5-cm-high plantlets. The control survival was only 50%

Growth regulators

1454 RAHMAN, SM; HOSSAIN, M; JOARDER, OI. 1992. **In vitro culture of *Carica papaya L.* iv. effect of growth regulators on induction, growth and long term maintenance of callus culture**. *Plant Tissue Culture*, 2: 1, 21-25.

In vitro callus culture was induced by culturing petiole segments of papaya (*Carica papaya L.*) on MS medium supplemented with various combinations and concentrations of NAA, 2 4-D, BA + NAA and BA + 2, 4-D with or without coconut water (CW). Coconut water markedly increased callus growth when used with any of the two auxins. Optimum callus growth was observed on the medium supplemented with 0.5 mg/l 2, 4-D + 15% CW. The same medium formulation was found to be the best for long term maintenance of callus tissue. Callus culture was maintained over 20 subcultures without showing any loss of vigour.

1455 RAJEEVAN, MS; PANDEY, RM. 1986. **Lateral bud culture of papaya (*Carica papaya L.*) for clonal propagation**. *Plant Cell, Tissue and Organ Culture*, 6: 2, 181-188; 12 ref.

Lateral buds collected from field grown female plants (cv. Pusa Dwarf) were cultured on Murashige and Skoog media containing various growth regulators. Kinetin at 50 muM and NAA at 10 muM gave the highest bud survival (60%) and bud growth (40%) rates after 3 weeks of culture. Bud cultures were compact with shortened internodes and reduced leaf lamina. Using a basic proliferation medium containing 2.5 muM BA and 0.5 muM NAA an average multiplication rate of 10 was achieved with subculturing at 20 day intervals. Different levels of cytokinins, with NAA at 0.5muM, were assessed for their effect on shoot growth and proliferation. Shoot proliferation was highest with

2 muM BA, but shoot and leaf lengths were reduced. Zeatin at 4 muM and 2iP at 8 muM gave lower proliferation rates but produced longer shoots and larger leaves. Rooting was obtained only with IBA (60% at 20 muM), and not with IAA, NAA, naphthoxyacetic acid or 2,4-D, but shoots failed to elongate, indicating that the lateral buds were possibly under strong apical dominance originally.

Jackfruits

1456 AMIN, MN. 1992. **In vitro enhanced proliferation of shoots and regeneration of plants from explants of jackfruit trees**. *Plant Tissue Culture*, 2: 1, 27-30.

Apical buds containing primordial inflorescences collected from the footstalks of adult trees produced tiny immature inflorescences (7-15 mm long) within 6 weeks of culture on MS medium supplemented with 1 mg/l BA. Upon isolation, sectioning and subculturing on similar medium containing 0.5-1 mg/l BA alone or with 0.1 mg/l NAA, each section of tiny inflorescences produced uniformly growing shoot buds along their full length within 4 weeks of incubation. The buds developed into rootable shoots (5- 15/culture) 4 weeks after additional subculture. Shoots could be multiplied (3-8-fold at every 4 weeks) through the enhanced growth of axillary buds on nodal segments removed from the newly developed in vitro shoots on medium having 1 mg/l BA only. The microcuttings were rooted with 90% success using 2 mg/l IBA in half strength MS medium and by incubating them at 30 C under complete darkness for initial 7-10 days. Employing the present technique an estimated 500 plants could be regenerated from a single explant within 24 weeks.

1457 AMIN, MN; JAISWAL, VS. 1993. **In vitro response of apical bud explants from mature trees of jackfruit (*Artocarpus heterophyllus*)**. *Plant Cell, Tissue and Organ Culture*, 33: 1, 59-65.

1458 AMIN, MN. 1992. **In vitro rooting of jackfruit (*Artocarpus heterophyllus*) microcuttings derived from mature trees**. *Plant Tissue Culture*, 2: 2, 129-133.

1459 AMIN, MN. 1989. **Propagation in vitro of a tropical fruit tree-Jackfruit**. *6th National Botanical Conference*. Chittagong University, Chittagong. p. 74.

1460 ISLAM, MS; SEN, J; ALAM, N; ROY, SK. 1993. **Propagation of jackfruit (*Artocarpus heterophyllus*) through zygotic embryo culture in vitro [short communication - in Bangladesh]**. *Plant Tissue Culture*, 3: 1, 51-55.

1461 JAISWAL, VS; AMIN, MN. 1992. **Guava and jackfruit biotechnology**. *International Biotechnology of Perennial Fruit Crops*/edited by RE Litz and FA Hammerschlag. London: CAB, p. 421-431.

1462 KHANAM, D; ANZU-MAN-ARA, K; KHAN, A; CONSTANTINE, DR; HOSSAIN, AKMA. 1993. **Studies on micropropagation of Jackfruit (*Artocarpus heterophyllus*), Kakrol (*Momordica dioica*) and Tuberose (*Polianthes tuberosa*)**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

1463 RAJMOHAN, K; MOHANAKUMARAN, N. 1988. **Effect of plant growth substances on the in vitro propagation of jack (*Artocarpus heterophyllus Lam.*)**. *Agricultural Research Journal of Kerala*, 26: 1, 29-38; 15 ref.

A multiplication rate of 4.5 was obtained with shoot apices cultured for 5 weeks on MS medium containing 5 mg BA and 0.2 mg NAA/litre. Addition of GA3 had little effect on shoot proliferation rate or growth. Adenine sulphate (20 mg/litre) increased the multiplication rate by 27.3%. Shoot elongation occurred on MS medium supplemented with 2 mg BA and 0.2 mg NAA/litre, and in vitro rooting occurred when shoots were cultured on half-strength MS medium containing 2 mg IBA, 2 mg NAA, 30 g sucrose and 6 g agar/litre for 6 days followed by transfer to a growth regulator-free medium. The chromosome number of the plantlets remained stable. Plantlets were hardened by exposure to high light intensity for 1 week, then transferred to vermiculite medium under 90-100% RH and treated with half-strength MS salts. The survival rate was 55.6% after 8 weeks.

1464 RAJMOHAN, K; MOHANAKUMARAN, N. 1988. **Influence of explant source on the in vitro propagation of jack (*Artocarpus heterophyllus Lam.*)**. *Agricultural Research Journal of Kerala*, 26: 2, 169-174; 8 ref.

Shoot apices, about 1 cm long, from 2-month-old seedlings or 6-month-old grafted plants, and fresh stem shoots of 5-, 10- and 30-year-old trees were used as explants, cultured on an establishment medium (MS + 1 mg GA3/litre + 1% activated charcoal) in darkness for 4 weeks with repeated subculturing. The cultures were then exposed to light for 2 weeks before being inoculated on a proliferation medium (MS + 0.2 mg

NAA + 30 g sucrose + 8 g agar + 500 mg insoluble PVP/litre) containing BA at 5.0, 7.5, 10.0, 12.5, 20.0 or 40.0 mg/litre. Shoots from this medium were transferred after 5 weeks to an elongation medium (MS + 2.0 mg BA + 0.2 mg NAA + 500 mg insoluble PVP/litre), then cultured for 2 weeks on MS medium containing 1% activated charcoal. In vitro rooting on half-strength MS medium was investigated with various auxins (IBA, NAA, IAA and 2,4-D) either alone or in combination. The results are tabulated. The physiological age of the explants significantly influenced shoot growth and rooting. Seedling apices showed a 17.4-fold multiplication rate in 5 weeks, with 100% rooting and an average of 6 roots/explant formed in 20.75 days. For stem shoot apices from 5-, 10- and 30-year-old trees, the multiplication rate was 4.50-, 2.80- and 2.09-fold, respectively, in 5 weeks. Corresponding rooting percentages were 70 (with 5.43 roots/explant in 13.43 days), 40 (2.50 roots in 24 days) and 15 (1.0 root in 46.7 days) after 2-3 subcultures. Explants from 6-month-old grafts failed to produce multiple shoots but showed 50% rooting with an average of 2.0 roots/explant in 20.5 days. Shoot proliferation was maximum with 10 mg BA/litre for seedling explants and 5 mg for explants from trees. Higher rates of BA had adverse effects. For seedling explants, rooting was best with IBA at 0.2 or 0.8 ppm alone, with 0.4 ppm NAA +0.4 ppm IBA and with 0.5 ppm NAA + 2.0 ppm IBA for seedling explants. For tree explants, rooting only occurred with 0.4 ppm NAA + 1.6 ppm IBA and with 2.0 ppm NAA + 2 ppm IBA. The graft explants only rooted with the latter combination.

1465 ROY, SK; RAHMAN, SL; MAJUMDAR, RITA. 1990. **In vitro propagation of jackfruit (*Artocarpus heterophyllus Lam.*)**. *Journal of Horticultural Science*, 65: 3, 355-358; 10 ref.

Nodal explants were cultured on MS (Murashige and Skoog) medium and induced to form multiple shoots when supplemented with 1.0 mg BA [benzyladenine] and 0.5 mg kinetin/litre. Shoots formed in vitro were also subcultured in similar fresh medium, and 5-7 new shoots developed. Rooting was induced on in vitro proliferated shoots by culturing in half-strength MS salts supplemented with 1.0 mg/litre each of NAA and IBA. The regenerants were successfully transferred to pots in a greenhouse and later to the field.

Micropropagation

1466 AMIN, MN. 1990. **Factors affecting rooting in vitro of jackfruit microcuttings**. *International Symposium New Spheres of Botanical researches and Society*. Banaras Hindu University, Varanasi, India. p. 10.

1467 AMIN, MN. 1992. **Rooting in vitro of jackfruit microcuttings originated from mature trees**. *Plant Tissue Culture*, 2: 2, 129-133.

1468 MISTRY, GC; ISLAM, R; JOARDER, OI; HOSSAIN, M. 1993. **Micropropagation of *Artocarpus heterophyllus L.* from shoot cultures of mature trees.** *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

Aegle marmelos (Bael)

1469 HOSSAIN, M; KARIM, MR; ISLAM, R; JOARDER, OI. 1993. **Adventitious shoot formation on nucellus, embryonic tissues and seedling of *Aegle mermelos Corr.*** *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

1470 HOSSAIN, M; KARIM, MR; ISLAM, R; JOARDER, OI. 1993. **plant regeneration from nucellar tissues of *Aegle marmelos* through organogenesis.** *Plant Cell Tissue organ Culture*, 34: 199-203.

1471 HOSSAIN, M; ISLAM, R; KARIM, MR; RAHMAN, SM; JOARDER, OI. 1994. **Production of plantlets from *Aegle marmelos* nucellar callus**. *Plant Cell Reports*, 13: 570-573.

1472 HOSSAIN, M; ISLAM, R; KARIM, MR; BISWAS, BK; JOARDER, OI. 1994. **Regeneration of plantlets from in vitro cultured cotyledons of *Aegle marmelos Corr.* (Rutaceae).** *Scien. Hortic.* 57: 315-321.

1473 ISLAM, R; HOSSAIN, M; JOARDER, OI; KARIM, MR. 1993. **Adventitious shoot formation on excised leaf explants of in vitro grown seedlings of *Aegle marmelos Corr.*** *Journal of Horticultural Science*, 68: 495-498.

1474 ISLAM, R; KARIM, MR; HAQUE, A; HOSSAIN, M; JOARDER, OI. 1993. **High frequency plant regeneration from cotyledon cultures of *Aegle marmelos Corr.*** *Plant Tissue Culture*, 3: 2, 107-110.

1475 ISLAM, R; KARIM, MR; HOSSAIN, M; JOARDER, OI. 1992. **Plant regeneration from leaf derived callus in *Aegle marmelos Corr.*** *Plant Tissue Culture*, 2: 55-59.

1476 ISLAM, R; KARIM, MR; RAHMAN, SM; HOSSAIN, M; JOARDER, OI. 1994. **Plant regeneration from excised cotyledon of *Aegle marmelos Coor.*** *Pakistan J. Bot.* 26: 2.

Blackberries

1477 NARUHASHI, N. 1990. ***Rubus* X semi-nepalensis, a new natural hybrid from Nepal Himalaya**. *Journal of Japanese Botany*, 65: 6, 186-191; 10 ref.

A Latin diagnosis and photographs are given for this natural hybrid discovered in Nepal during a botanical expedition in 1988. Several morphological characters were intermediate between its putative parents, *R. nepalensis* and *R. treutleri*.

1478 NYBOM, H. 1986. **Chromosome numbers and reproduction in *Rubus subgen. Malachobatus*.** *Plant Systematics and Evolution*, 152: 3/4, 211-218; 40 ref.

A review of current knowledge of chromosome numbers and modes of reproduction in *Rubus* is presented. Chromosome numbers from some Indian and Indonesian species of subgenus *Malachobatus* are reported for the first time. Of a number of crosses attempted, only *R. fairholmianus* X *R. rugosus* and its reciprocal set seeds. The resulting plants were intermediate between the parents and had 2n = 77 chromosomes.

Cherries

1479 SHARMA, DR; CHAUHAN, PS; KAUR, R; SRIVASTAVA, DK. 1992. **Micropropagation of colt - a semidwarf rootstock of cherry**. *Ind. Jour. Hort.* 49: 209-212.

Strawberries

1480 SARWAR, M. 1984. **The effect of different media and culture techniques on plating efficiency of strawberry mesophyll cells in culture**. *Physiologia Plantarum*, 60: 1, 57-60; 16 ref.

Strawberry (cv. Redgauntlet) mesophyll cells were isolated mechanically by a hand homogenizer. One gram of fully-expanded healthy leaves yielded 107 cells. Cell division was higher on a complete Lang and Kohlenbach medium than on media consisting only of organic salts or organic salts + microorganic additives (mostly vitamins). Of 3 culture techniques tested (multiple drop, cell culture in thin stationary liquid layers and agar plating) only agar plating gave results from which quantitative data could be obtained.

1481 SARWAR, M. 1989. **The role of medium composition and light intensity on in vitro root formation of strawberry**. *Pakistan Journal of Botany*, 21: 1, 24-30; 21 ref.

Rooting of in vitro propagated strawberry shoots was studied in the presence of different benzyladenine (BA) concentrations, types of media, incubation temperatures and light intensities. Root formation started within 10 days of culture under high light intensities (13.5 W/m2). In vitro rooting of shoot tips occurred readily on MS medium. The extent of root formation was directly related to sucrose and light intensity. No root formation occurred in the dark, under low light and in sucrose free medium. BA at up to 1 μM did not inhibit root formation. Addition of nicotinic acid, pyridoxine-HCl and thiamine-HCl to the media reduced root formation but the effect was masked by a combination of ascorbic acid, biotin, caD-pantothenate, folic acid and riboflavin.

1482 WICKREMASINGHE, AI; FERNANDO, K. 1988. **In vitro propagation of strawberry plants (*Fragaria vesca* cv. Kendall)**. *Tropical Agriculturist*, 144, 53-59; 4 ref.

Experiments were carried out to improve the technique for mass propagation of strawberry plants in vitro and to investigate the possible use of coconut water (CW) as a substitute for BA in the proliferation stage. In an initial experiment, MS medium supplemented with 2 mg BA/litre gave the highest shoot proliferation of all the BA concentrations tested (0-8 mg/litre). In a second experiment, 0.5 g of in vitro-derived shoots of cultivars Kendall and Senga Sengana were cultured in 25 ml of MS basal medium supplemented with 5, 10, 15 or 20% CW, or 2 g BA/litre, at 25 $\pm 2°C$, in 16-h days at 1000 lux for 3 weeks. CW at 10 or 20% resulted in a greater FW increase compared with the control (2 mg BA/litre), 10% CW giving the best result. Multiple shoots were separated and rooted in MS medium supplemented with 0.5 mg IBA/litre. The plantlets were transferred to a soil-based medium with 90% survival.

Banana diseases, bibliography

1483 SURESH, S; REGUPATHY, A. 1987. **Banana bunchy top disease and its aphid vector: an annotated bibliography**. Coimbatore, India: Keerthi Publishing House. 60 p.

This bibliography includes references to 396 papers published during 1912- 86. Lists of host plants and biocontrol agents, and distribution maps of the disease and its vector, the banana aphid *Pentalonia nigronervosa*, are also provided.

Bananas

1484 GANAPATHI, TR; SUPRASANNA, P; BAPAT, VA; RAO, PS. 1992. **Propagation of banana through encapsulated shoot tips.** *Plant Cell Reports*, 11: 11, 571-575; 11 ref.

Shoot tips isolated from multiple shoot cultures of cv. Basrai were encapsulated in 3% sodium alginate containing different gel matrices. The encapsulated shoot tips regenerated in vitro on different media and substrates. White's medium gave the highest percentage (100%) of plantlet development from encapsulated shoot tips. Plantlets were successfully established in soil.

1485 KRISHNAKUMAR, MP; VALSALAKUMARI, PK; ARAVINDAKSHAN, M. 1990. **Cross compatibility and seed set in banana cultivars.** *Agricultural Research Journal of Kerala*, 28: 1-2, 17-21.

1486 LAXMIKANTH, DM; NATARAJA, K. 1989. **Micropropagation of banana through shoot tip culture.** *Current Science*, 58: 3, 140-141; 5 ref.

1487 RAUT, RS; LOKHANDE, VE. 1989. **Propagation of plantain through meristem culture.** *Annals of Plant Physiology*, 3: 2, 256-260; 5 ref.

Shoot tips of *Musa paradisiaca* cv. Basrai formed multiple shoots when cultured on MS medium supplemented with 7 or 10 mg BAP [benzyladenine] per litre. Single shoots were obtained by culturing the explants on MS medium containing 5 mg BAP per litre. Rooting was induced on MS medium with 2 mg IBA per litre and the whole plantlets were successfully transferred to pots for further evaluation.

1488 SIDDIQUI, SH; KHAN, AKIA; NIZAMANI, GS. 1990. **Improvement of banana *(Musa spp.)* through in vitro culture and induced mutations.** *In vitro mutation breeding of bananas and plantains I. Report*. Joint FAO/IAEA Div. of Nuclear Techniques in Food and Agriculture, Vienna (Austria) p. 97-99.

Micropropagation

1489 BALAKRISHNAMURTHY, G; SREE-RANGASAMY, SR. 1988. **Regeneration of banana plantlets from in vitro culture of floral apices.** *Current Science*, 57: 5, 270-272; 9 ref.

After surface sterilization, floral apices dissected from the terminal male flower buds of the varieties Robusta and Montnan were cultured in MS medium with 30 g sucrose/litre and 0.8% bactoagar. The medium was supplemented with 0, 2.5 or 5 mg benzyladenine (BAP)/litre. Irrespective of BAP concentration all floral apices survived. Proliferation of buds was seen only in culture medium containing BAP concentrations of 2.5 and 5 mg/litre, for both varieties. After 35 days apices were divided using a scalpel and subcultured on the same medium (with BAP at 5 mg/litre). Between 4 and 12 shoots were formed which, when transferred to medium containing NAA (1 mg/litre), rooted within 7-10 days. This method is useful for the production of disease free plantlets for use in breeding programmes.

1490 SWAMY, RD; SAHIJRAM, L. 1989. **Micropropagation of banana from male floral apices cultured in vitro.** *Scientia Horticulturae*, 40: 3, 181-188; 13 ref.

Excised floral apices of cultivars Chandrabale, Rasthali (syn. Silk) and Robusta were cultured on MS medium supplemented with cytokinins and auxins. These cultures reverted to the vegetative stage and produced a mass of green leafy shoots which were kept in a state of active growth by systematic subculturing. Male flower clusters at different stages of development, located on the peduncle subtending and distal to the meristematic zone, reverted to the vegetative state when cultured in vitro.

Diseases

1491 SIVAMANI, E; GNANAMANICKAM, SS. 1988. **Biological control of *Fusarium oxysporum* f.sp. cubense in banana by inoculation with *Pseudomonas fluorescens*.** *Plant and Soil*, 107: 1, 3-9; 31 ref.

Isolates of *P. fluorescens* from Tamil Nadu and Kerala, India exhibited in vitro antibiosis towards isolates of races 1 and 4 of *F. oxysporum* f.sp. cubense, the causal agent of Panama wilt disease. Seedlings of Musa balbisiana treated with *P. fluorescens* showed less severe wilting and internal discoloration due to *F. oxysporum* f.sp. cubense infection in greenhouse experiments. In addition to suppression of wilt, bacterized seedlings also showed better root growth and enhanced plant height.

1492 SIVAMANI, E; ANURATHA, CS; GNANAMANICKAM, SS. 1987. **Toxicity of *Pseudomonas fluorescens* towards bacterial plant pathogens of banana (*Pseudomonas solanacearum*) and rice (*Xanthomonas campestris pv. oryzae*).** *Current Science*, 56: 11, 547-548; 17 ref.

A rice str. of *P. fluorescens* caused max. inhibition of *X. campestris pv. oryzae* in plate tests and in another

trial 3 isolates of the latter failed to grow on KB agar containing cell-free siderophore. Results obtained in these preliminary tests suggest that native strs. of *P. fluorescens* could be used as biological control agents against *P. solanacearum* on banana and the rice bacterial leaf blight pathogen.

Vitis vinifera

1493 DALAL, MA; SHARMA, BB; GUPTA, N. 1993. **Seasonal variation in phenol level of shoot tips and its relation with explant survival in grapevine (*Vitis vinifera*) culture initiated in vitro**. *Indian Journal Agricultural Sciences*, 63: 2, 75-79.

1494 GANESHAN, S; ALEXANDER, MP. 1988. **Fertilizing ability of cryopreserved grape (*Vitis vinifera L.*) pollen**. *Genome*, 30: supplement 1, 464.

Grape pollen was successfully cryopreserved for 5 years in liquid nitrogen and used in some intervarietal crosses. Frozen Black Champa and Queen of Vineyards pollen gave normal fruit and seed set when crossed with the respective seed parents. Crosses involving frozen Queen of Vineyards pollen with emasculated Black Champa flowers also produced normal fruit and seed set.

1495 MANI, M. 1988. **Bioecology and management of grapevine mealybug**. *Technical Bulletin, Indian Institute of Horticultural Res.*, No. 5: 32 p.; 4 p. of ref.

Information is presented on the biology, natural enemies, food plants, injuriousness and control of *Maconellicoccus hirsutus*, the most commonly found pseudococcid pest of grapevine in India. The life cycle of the pest is usually completed in a month. A total of 28 plant species have been reported as alternative food plants of *M. hirsutus* in India. Among the indigenous natural enemies, the encyrtid parasitoid *Anagyrus dactylopii* and the coccinellid *Scymnus coccivora* are of considerable importance. Debarking of infested vines, followed by pasting with insecticides, and spraying or dipping fruit bunches in 0.02% dichlorvos in combination with fish oil rosin soap at 25 g/litre, help to control the pest. Biological control with the exotic coccinellid predator *Cryptolaemus montrouzieri* has been very successful in suppressing populations of the pseudococcid. A single predator can consume 900-1500 eggs or 300 nymphs of the prey during its development. The coccinellid can be reared in large numbers on pumpkin fruits infested with the prey. Releases of 1000-1500 adult predators/acre gave effective control within 2 months. Use of *C. montrouzieri* can also be combined with application of 0.20% dichlorvos or 0.05% chlorpyrifos since they are not toxic to the predator. Future control strategies suggested include the introduction of the parasitoid *A. kamali* from Java.

1496 MANI, M; THONTADARYA, TS; SINGH, SP. 1987. **Record of natural enemies on the grape mealybug, *Maconellicoccus hirsutus* (Green)**. *Current Science*, 56: 12, 624-625; 3 ref.

The natural enemies of the pseudococcid *Maconellicoccus hirsutus*, a pest of grapes, were surveyed in Karnataka, India, in 1984-86. A total of 6 parasitoids, the encyrtids *Anagyrus dactylopii*, *Gyranusoidea mirzai* and *Alamella flava*, the platygasterid *Allotropa sp.* near *A. japonica*, the eucoilids *Leptopilina sp.* and *Chartocerus sp.* near *C. walkeri*, and 7 predators, the coccinellids *Scymnus sp.*, *S. coccivora* and *Cryptolaemus montrouzieri*, *Chrysopa sp.*, the lycaenid *Spalgis epius*, the drosophilid *Cacoxenus perspicax* [*Domomyza perspicax*] and the cecidomyiid *Triommata coccidivora*, were recorded. The most dominant parastoid was *Anagyrus dactylopii* with 62.5% parasitism. The remaining parasitoids are reported for the first time in India and are of minor importance. *Scymnus coccivora* was the most common predator and is a new record on *M. hirsutus* on grapes in India. The remaining predators are also new records for *M. hirsutus*. It is suggested that *Cryptolaemus montrouzieri* could be reared for use as a biological control agent of this pest.

1497 SINGH, AK; SHARMA, BB; PANDEY, RM. 1990. **Post in-vitro performance of grape plants**. *Indian Journal of Horticulture*, 47: 2, 159-161; 3 ref.

In studies with 3 cultivars, shoot tip explants taken in Apr. from 1-year- old plants growing in the field were propagated in vitro and later transplanted in the field along with plants obtained from hardwood cuttings. One-month-old in vitro-raised plants of Pusa Seedless and Perlette were weaker compared with plants raised from cuttings, but 5 months later plants of all 3 cultivars raised in vitro were healthier than those obtained from cuttings. Number of nodes, number of leaves, stem diameter and plant height were similar in in vitro-raised plants of Pusa Seedless and Perlette and plants obtained by cuttings, but plants of hybrid W-4-3 propagated in vitro had shorter internodes and were smaller than plants obtained from cuttings. One-month-old in vitro-raised plants had lower rates of respiration and photosynthesis than plants from cuttings, but these differences had disappeared in 5-month-old plants.

1498 SINGH, AK; SHARMA, BB; PANDEY, RM. 1992. **Rapid in vitro multiplication of *Vitis vinifera L.***

through shoot tips and nodal segments. International Society for Horticultural Science (ISHS). Frontier in tropical fruit research. Wageningen (Netherlands). p. 601-605.

1499 SINGH, R; JALIKOP, SH; RANDHAWA, GS. 1984. **Choice of parents in grape hybridization**. *Indian Journal of Horticulture*, 41: 1/2, 25-28; 5 ref.

When 23 cross combinations based on commercial cultivars and promising varieties from a germplasm bank of 1000 accessions were investigated, maximum percentage seed set was achieved by pollinating Bangalore Blue with Black Champa. On the basis of percentage hybrid seed germination, Cheema Sahebi, Anab-e-Shahi and Bangalore Blue were good female parents. Highest percentage hybrid seed germination was achieved from the cross Cheema Sahebi X Anab-e-Shahi. Five crosses were identified as promising for berry and bunch shape and appearance.

1500 SINGH, Z; BRAR, SJS. 1992. **In vivo development of ovule in seedless and seeded cultivars of grapes (*Vitis vinifera L.*) - a particular reference to in ovulo embryo culture**. *Vitis*, 31: 2, 77-82; 17 ref.

Ovule development was examined in the 3 seedless cultivars Perlette, Thompson Seedless and Beauty Seedless and the seeded cv. Anab-e-Shahi, to identify the proper developmental stage of the embryo for in ovulo embryo culture. The number of shrivelled ovules started increasing 20 days after anthesis. At the same time, the number of viable ovules started declining in all the seedless cultivars. Amongst seedless cultivars, the growth of ovules was least in Thompson Seedless and Beauty Seedless. Ovule development was faster in Anab-e-Shahi than in the seedless cultivars. Total number of ovules per berry declined 20 and 30 days post-anthesis in Beauty Seedless and Perlette, respectively. The embryos in seedless grape cultivars may be rescued in vitro prior to 20 days post-anthesis to obtain plantlets from these abortive ovules.

Other Fruit crops

1501 AMIN, MN. 1994. **Tissue culture of fruit plants in Bangladesh: potentials and limitations**. *Workshop on Present Status and Future Direction of Biotechnological Research in Bangladesh*. (BARC, Dhaka: 1994: June 25).

1502 BABBAR, SB; GUPTA, SC. 1986. **Induction of androgenesis and callus formation in in vitro cultured anthers of a myrtaceous fruit tree (*Psidium guajava L.*)**. *Botanical Magaz.*, 99: 1053, 75-83; 16 ref.

Anthers cultured on Murashige & Skoog or Nitsch basal media (BM) or BM + 10-6 M BA produced calluses with restricted growth accompanied by tissue necrosis, possibly as the result of accumulation of polyphenols. To counteract this, polyvinyl pyrrolidone [polyvidone] (PV), which absorbs polyphenols, was added to the media. Although the presence of PV, an increase in the sucrose concentration in the media and cold pretreatment of anthers all decreased the proportion of them turning brown, as well as delaying callus necrosis, it was not possible to maintain calluses for differentiation. Cold pretreatment significantly increased the percentage of callusing anthers and resulted in the early development of callus.

1503 CAPPELLETTI, EM; TREVISAN, R. 1983. **Morphological characterization by SEM of *Psoralea corylifolia* and *Psoralea drupacea* fruits**. *Plantes Medicinales et Phytotherapie*, 17: 4, 202-208; 22 ref.

Fruits of *P. corylifolia* grown in Italy or imported from India and those of *P. drupacea* imported from the USSR were studied. The epicarp surface characters are described for these 2 sources of furocoumarins. In the first species they appeared as sunken areas surrounded by rising cell strips and in the second as dome-shaped outgrowths. Both structures had underlying secretory cavities.

1504 HIRIMBUREGAMA, K; WIJESINGHE, LPJ. 1992. **In vitro growth of *Ananas comosus L. Merr* (pineapple) shoot apices on different media**. *International symposium on transplant production sysems: biological, engineering and socioeconomic aspects*. International Society for Horticultural Science, Wageningen (Netherlands) p. 203-208.

1505 KANCHAN JAIDKA; MEHRA, PN. 1986. **Morphogenesis in *Punica granatum* (pomegranate)**. *Canadian Journal of Botany*, 64: 8, 1644-1653; 29 ref.

Of the various media tested, Murashige and Skoog basal medium supplemented with 4 p.p.m. NAA, 2 p.p.m. kinetin and 15% coconut water was best for callus induction from all explants (roots, hypocotyls, cotyledons, stems, shoot-tips, leaves and embryos of the cv. Kandhari anar). Calluses were heterogeneous in nature consisting mainly of diploid cells, although a few polyploid cells were also observed after 2 and 4 subcultures. Plantlets, isolated roots, leaves, and shoots were differentiated in various callus cultures. The root tips and shoot tips of such plantlets revealed only diploid

cells. Embryo-like structures were formed in callus on transfer to media containing 2 p.p.m. NAA and 2 p.p.m. BA. Embryoid development was traced to a single cell which was invariably isolated from the rest of the callus tissue. This initial divided to form a multicelled structure which later gave rise to a globular, ovoid, or heart-shaped embryoid, or one with irregular form. The embryoids germinated into complete plantlets with roots and shoots. The embryoidal initials were mostly diploid but occasional aneuploids or polyploids were observed. A high frequency of direct regeneration of roots, shoots and whole plants, without callus formation, occurred with cotyledon, leaf and stem explants.

1506 MAHESWAR, DL. 1984. **Pachytene analysis, interspecific hybridization and response to chromosomal doubling in two steroid-bearing *Solanum* species - *Solanum viarum* Dunal. and *Solanum mammosum Linn*.** *Mysore Journal of Agricultural Sciences*, 18: 4, 319. Thesis, University of Agricultural Sciences, Bangalore, India.

Induced autotetraploids of *S. viarum* (x = 12) had higher contents of solasodine (2.16%) in the berries than diploids (1.83%); meiosis was almost normal. Diploid *S. mammosum* (x = 11) was successfully crossed, as female parent, with *S. viarum*; the high pollen sterility of the hybrid (96.5%) was attributed to autosyndetic pairing and meiotic abnormalities. The distribution of flavonoids in the parents and the hybrid differed. Autotetraploids of *S. mammosum* showed poor fruit set and had many meiotic abnormalities.

1507 MEHRA, PN; JAIDKA, KANCHAN. 1985. **Experimental induction of embryogenesis in pear**. *Phytomorphology*, 35: 1/2, 1-10; 20 ref.

Somatic embryogenesis was induced in callus derived from excised cotyledons, embryos, roots, hypocotyls, stems, leaves and shoot tips of *Pyrus communis* seedlings by transferring the calluses to various media supplemented with 2 mg NAA and 2 mg benzyladenine-/litre. The embryoids, which were globular, heart shaped or irregular, arose from single-celled initials (showing variability for chromosome number) which secreted a mucilaginous sheath and became packed with starch grains. They subsequently developed into complete plantlets, although in some instances only roots or leaves were formed.

1508 NEHRA, NS; SINGH, KARTAR. 1982. **Propagation of fruit crops through tissue culture - a review**. *Haryana Journal of Horticultural Sciences*, 11: 1/2, 13-16; 48 ref.

Tissue culture of apples, strawberries, blackberries, citrus, grapevines, pawpaws is reviewed and discussed.

1509 ROY, SK; ISLAM, MS; SEN, J. 1993. **High frequency shoot formation and plant regeneration from mature embryos of *Syzygium cuminii*.** *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21).

1510 SALUNKE, DK; KADAM, SS; DESAI, BB. 1984. **Advances in postharvest biotechnology of fruits and vegetables**. *Journal of Maharashtra Agricultural Universities*, 9: 2, 198-203; 33 ref.

Fruits and vegetables are perishable commodities. Several methods such as control of environmental conditions surrounding the products, ionizing radiation, use of solar energy, canning, preservation by food additives/preservatives and freezing are employed to prevent postharvest losses. Recent developments in these areas of research, feasibility of employing these methods in developing countries like India and further research strategies to overcome these problems are discussed.

1511 SHARMA, JP; DOGRA, GS. 1986. **Studies on the control of the plum scale *Eulecanium sp? tiliae (L.) (Homoptera: Coccidae)* through chemical and natural elements**. *Indian Journal of Entomology*, 48: 3, 258-263; 9 ref.

A species of *Eulecanium* thought to be *E. tiliae* has become a major pest of plum and apple in Himachal Pradesh, India, and also infests peach. During field trials in 1977-78, treatment with Rinki oil, HP spray oil, Him spray oil and an oil manufactured by the Indian Oil Corporation, all at 3%, and diesel oil emulsion at 4% gave good control of the coccid. Post-flowering spray treatment in May with 0.04% monocrotophos, 0.05% methyl-demeton [demeton-S- methyl], 0.03% dimethoate, 0.05% quinalphos, 0.05% fenitrothion or 0.03% diazinon was highly effective against 1st-instar nymphs and was superior to the oil treatments. Second-instar nymphs were parasitized by a species of *Coccophagus* near *C. ishii* and adult females by *Blastothrix sericea*. The rate of parasitism of nymphs and adults was 7.2 and 40.7%, respectively. Up to 13.58% mortality was caused by the fungus *Rhinocladiella* in 2nd-instar nymphs.

1512 YADAV, U; LAL, M; JAISWAL, VS. 1990. **In vitro micropropagation of the tropical fruit tree** *Syzygium cuminii L. Plant Cell, Tissue and Organ Culture*, 21: 1, 87-92; 15 ref.

Multiple shoots were obtained from nodal and shoot tip

segments of 10- to 15-day-old seedlings of *S. cumini* on modified MS medium supplemented with BA (0.23-8.90 μM) singly or in combination with NAA, IAA or IBA. Excised shoots were placed for root induction on MS medium containing NAA and/or IBA and then transferred to MS basal medium to form complete plantlets. The regenerated plantlets were acclimatized and successfully transferred into the soil.

VEGETABLE CROPS

1513 BAJAJ, YPS. 1990. **Cryopreservation of germplasm of vegetatively propagated crops.** *Bulletin de la Societe Botanique de France, Actualites Botaniques*, 137: 3-4, 99-114; 31 ref.

The scope of cryopreservation is discussed in relation to 3 vegetatively propagated crops, potato, cassava (*Manihot esculenta*) and sugarcane. The large-scale application of cryopreservation in gene banks for the long term storage of cell and tissue cultures and pollen is outlined.

1514 BAJAJ, YPS. 1990. **Haploids in crop improvement I.** *Biotechnology in Agriculture and Forestry Volume 12*. Berlin, Germany: Springer-Verlag, 549 p.

The first section (4 chapters) of this book considers the induction of haploids, pollen embryogenesis, ultrastructure and genetic stability. Experience with many species is summarized in tables, and theoretical and practical conclusions are drawn. The remainder of the book details in vitro production of haploids (chiefly through anther culture) with a chapter for each of the following: wheat, barley, maize, rice, rubber, poplar, apple, litchi, *Digitalis*, *Hyoscyamus*, *Arabidopsis*, asparagus, sugarbeet, cabbage and *Brussels sprouts*, *Capsicum*, carrot, strawberry, *Gerbera jamesonii*, sunflower, tomato, lucerne, *Psophocarpus tetragonolobus*, sugarcane, *Solanum carolinense*, *Solanum chacoense* and *Solanum phureja*. Each chapter includes a brief experimental protocol. This thorough treatment will be essential reading for breeders seeking to use haploids.

1515 CHOPRA, VL; KIRTI, PB; NARASIMHULU, SB; PRAKASH, S; ABDURAHIMAN, KK; DOMINIC, B. 1993. **Somatic hybridization for improvement of crop *Brassicas*.** *Biotechnology in agriculture*. (Dordrecht: 1993)/edited by CB You, ZL Chen and Y Ding. Dordrecht: Kluwer Academic Publishers, p. 18-26.

1516 DHALIWAL, HS. 1992. **Unilateral incompatibility.** *Monographs on Theoretical and Applied Genetics*, No. 16: p. 32-46.

1517 ISALM, R; JOARDER, OI. 1994. **Tissue culture research on some tree and vegetable crops of Bangladesh.** *Workshop on Present Status and Future Direction of Biotechnological Research in Bangladesh.* (BARC, Dhaka: 1994: June 25).

1518 JAMBHALE, ND; NERKAR, YS. 1983. **Screening of okra cultivars, related species and interspecific hybrid derivatives for resistance to powdery mildew.** *National seminar on breeding crop plants for resistance to pests and diseases.* (Coimbatore: 1983: May 25-27). Tamil Nadu Agricultural University, Coimbatore, India. p. 44.

Of 44 accessions, including cultivars, mutants, related species, interspecific hybrids, amphidiploids and interspecific derivative lines, screened in the field for resistance to *Erysiphe cichoracearum*, five biotypes drawn from *Abelmoschus [Hibiscus] tetraphyllus*, *A. manihot*, *A. manihot subsp. manihot* and *A. moschatus* [*H. abelmoschus*] were immune from attack. Hybrids and their respective amphidiploids between the *A. esculentus* cultivar Pusa Sawani and *A. manihot*, *A. manihot subsp. manihot* and *A. tetraphyllus* were immune, highly resistant and moderately resistant, respectively. Of nine yellow vein mosaic resistant lines from the cross *A. esculentus* X *A. manihot*, one was highly resistant and two moderately so.

1519 KALLOO, G. 1992. **Utilization of wild species.** *Monographs on Theoretical and Applied Genetics (USA)* No. 16, p. 149-167.

1520 PAL, AMITA. 1983. **Isolated microspore culture of winged bean, *Psophocarpus tetragonolobus (L.) DC.* - growth, development and chromosomal status.** *Indian Journal of Experimental Biology*, 21: 11, 597-599; 9 ref.

Callus was formed by successive vegetative-cell division following culture of pollen on Nitsch & Nitsch medium supplemented with sucrose, amino acids, IAA (0.5 mg/litre) and zeatin (0.5 mg/litre). Cultures were maintained on this medium and on supplemented B5 medium. Profuse, small, leafy shoots regenerated from the callus on B5 medium supplemented with NAA, IAA and kinetin, but plantlet formation did not occur. The haploid chromosome number occurred in about 80% of cells examined from undifferentiated and differentiated callus.

1521 SALUNKHE, DK; DESAI, BB; BHAT, NR. 1987. **Vegetable and flower seed production.** New Delhi: Agricole Publishing Academy, 486 p.