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CONTENTS

Cinnamomum tamala (cinnamon) were studied. The growth regulators required by gall tissue did not differ fundamentally from those required by healthy tissue. Optimum callusing of explants occurred on medium containing 2,4-D, (10 mg/litre), kinetin (0.1 mg/litre) and beta- mercaptoethanol (1-2 mM). Calluses grew better in medium fortified with 2,4-D (4 mg/litre) and kinetin (0.4 mg/litre). Gall tissue grew faster than healthy tissue. Healthy tissue failed to grow in auxin-free medium, but gall tissue grew poorly after 4-5 passages on medium containing 2,4-D and kinetin. Year-old cultures of both healthy and gall tissues grew on medium devoid of cytokinin for a long time. Addition of caffeic acid and catechol [pyrocatechol] enhanced the growth of both normal and gall tissues, but these phenolics had no effect in the absence of auxin.

1003 KESHAVACHANDRAN, R; KHADER, MA. 1989. **Tissue culture propagation of turmeric**. *South Indian Horticulture*, 37: 2, 101-102; 2 ref.

Bud tissues of the turmeric [*Curcuma longa*] cultivars Co.1 and BSR.1 were cultured on MS medium supplemented with 1 mg kinetin/l, 1 mg BA/l and 40 g sucrose/l. The culturing procedure and explant development are described. After 5 weeks the rooted plantlets were transferred to pots, covered with polyethylene bags and kept under shade. Two weeks later the plants were well established. The average number of shoots produced per bud was 2.11 in BSR.1 and 2.5 in Co. 1.

1004 UNNIKRISHNAN, MC; KUTTAN, R. 1988. **Cytotoxicity of extracts of spices to cultured cells**. *Nutrition and Cancer*, 11: 4, 251-257; 19 ref.

The cytotoxicity of the extracts from 8 different spices used in the Indian diet was determined using Dalton's lymphoma ascites tumour cells and human lymphocytes in vitro and Chinese Hamster Ovary cells and Vero cells in tissue culture. Alcoholic extracts of the spices were more cytotoxic to these cells than their aqueous extracts. Alcoholic extracts of several spices inhibited cell growth at concentrations of 0.2 to 1 mg/ml in vitro and 0.12 to 0.3 mg/ml in tissue culture. Ginger, pippali (dried catkins), pepper and garlic showed the highest activity followed by asafoetida, mustard and horse-gram. These extracts also inhibited thymidine uptake into DNA.

OILSEED PLANTS

Arachis hypogaea

1005 ATREYA, CD; SUBRAHMANYAM, NC. 1989. **Comparative analysis of repetitive DNA in five *Arachis* species**. *Biochemical Systematics and Ecology*, 17: 1, 11-13; 13 ref.

The amount, nature and distribution of repetitive DNA was compared among the 5 species. Repeated DNA varied from 59.0 to 73.5% in the species studied. In the diploid species (*A. regonii* and *A. villosulicarpa*) the amount of highly repetitive DNA was twice as much as in the tetraploid species (*A. hypogaea*, *A. glabrata* and *A. hagenbeckii*). The present comparison suggests that highly repeated DNA elements have been selectively diminished in the tetraploids during speciation in *Arachis*.

1006 ATREYA, CD; RAO, JP; SUBRAHMANYAM, NC. 1984. **In vitro regeneration of peanut (*Arachis hypogaea L.*) plantlets from embryo axes and cotyledon segments**. *Plant Science Letters*, 34: 3, 379-383; 17 ref.

Plantlets were regenerated from embryo axes on Murashige and Skoog (MS), Gamborg B5, potato-extract and Linsmaier and Skoog basal media, MS being best. Plantlets were also regenerated from cotyledon segments on MS supplemented with NAA and/or BA, 1 mg/l NAA inducing the maximum rooting frequency, while 2 mg/l BA induced most shoot formation. Transfer of the shoots to basal MS induced root formation. Combination of 1 mg/l NAA with 0.5-2 mg/l BA in MS resulted in regeneration of whole plants from cotyledon segments, but the regeneration frequency was lower than that with BA alone. Shoot induction was predominantly from the cotyledon segments proximal to the embryo axes.

1007 ATREYA, CD; RAMAKRISHNA, T; PANDIT, MW; SUBRAHMANYAM, NC. 1985. **Molecular approaches to genome analysis in *Arachis* species.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). Central Univ. Hyderabad, Hyderabad, AP 500 134, India. p. 87-92; 17 ref.

DNAs from leaves of *A. hypogaea* (2 cultivars), *A. rigonii*, *A. glabrata* and *A. hagenbeckii* had buoyant densities in caesium chloride which were all within the range 1.6954-1.6962 g/cm3, while the value for *A. villosulicarpa* was distinct (1.6923 g/cm3). Melting temperatures of DNAs were in the range 83.13-85.29°C and their guanine-cytosine contents were 34.1-39.4%, indicating the heterogeneity and relatively high adenine-thymine content of *Arachis* DNA. A comparison of the derived melting curves revealed 4-6 components according to species. Some components were common to all 5 species and others were specific to species or

sections. The differences between observed buoyant densities and those predicted on the basis of melting temperatures indicated the presence of rare or modified bases. The results were in agreement with the classification of Gregory & Gregory (J. of Hered., 1979, 70).

1008 BAJAJ, YPS. 1985. **In vitro induction of genetic variability in groundnut.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). Tissue Culture Lab., Punjab Agric. Univ., Ludhiana 141 004, India. p. 165.

Triploid hybrid plants were raised from *Arachis hypogaea* X *A. villosa* following embryo culture 30-35 days after pollination. Of various seedling explants, hypocotyl segments from 10-14-day-old seedlings gave the highest yield of protoplasts. Mesophyll protoplasts of *A. hypogaea* were fused with callus-derived protoplasts of *A. villosa*. Anther-derived callus and plants regenerated from anther culture of *A. villosa* were mixoploids, with a range from haploidy to octoploidy.

1009 BANDYOPADHYAY, A; MURTHY, TGK; RADHAKRISHNAN, T. **High frequency of samurai embryogenes in groundnut**. *Proc. 5th All India Conf. Cytol. Genet*. National Research Centre for Groundnut, Ivnagar Road, P. Bag No. 5, Junagadh-362 001, India.

1010 BHARATHI, M; MURTY, UR; KIRTI, PB; RAO, NGP. 1983. **Chromosome pairing in the interspecific hybrids: *Arachis hypogaea L.* X *Arachis chacoense nom. nud. Krap et Greg.* and *A. hypogaea L.* X *A. villosa Benth.*** *Cytologia*, 48: 3, 527-538.

Chromosome pairing at meiotic pachytene was studied in the triploid hybrids between *A. hypogaea* (2n = 4x = 40, genomes AB) and the diploid (2n = 2x = 20) A-genome species *A. chacoense* and *A. villosa*. All 10 *A. chacoense* or *A. villosa* chromosomes paired regularly with chromosomes of *A. hypogaea*, though unpaired regions and heteromorphic bivalents were observed occasionally. It is concluded that (1) the 3 species are closely related, (2) *A. hypogaea* has 10 chromosomes in common with *A. chacoense* and *A. villosa*, although the 10 chromosomes of the 2 A-genome species are not necessarily homologous, and (3) there have been extensive structural changes during evolution in the A-genome and in both genomes of *A. hypogaea*, indicating that the classification of the genomes into A and B should be considered only tentative.

1011 BHARATHI, M; MURTY, UR. 1984. **Comparative embryology of wild and cultivated species of *Arachis***. *Phytomorphology*, 34: 1/4, 48-56; 20 ref.

Material from 5 species was studied. Pollen fertility ranged from 75% in *A. hagenbeckii* and *A. glabrata* to 100% in *A. hypogaea*. Fertilization was successful in *A. hypogaea*, *A. chacoense* and *A. villosa*. In *A. hagenbeckii* and *A. glabrata*, fusion of male and female nuclei was slower than in the other species. In *A. hagenbeckii*, the primary endosperm nuclei divided only once and then degenerated, and the embryos did not develop beyond the 8-celled stage. No viable seeds were formed in *A. glabrata*. The failure to set seed in *A. glabrata* and *A. hagenbeckii* (both are tetraploid, 2n = 40) is attributed to hybrid origin.

1012 BHATIA, CR; MURTY, GSS; MOULI, C; KALE, DM. 1986. **Regeneration of M1 plants from 'de-embryonated' cotyledons to modify diplontic selection**. *Nuclear techniques and in vitro culture for plant improvement: Proceedings of a symposium (Vienna, Austria: 1985: 19-23 August)*. International Atomic Energy Agency, Vienna, Austria Food and Agriculture Organization of the United Nations, Rome, Italy. p. 419-427; 5 ref.

Cotyledons of *Arachis hypogaea*, cultured on moist cotton wool after excision of the embryonal axis, turned green and produced callus, roots or adventitious shoots on the basal region from which the embryonal axis had been removed. Application of BA enhanced the frequency of adventitious shoot formation. When transferred to the field, the cotyledons developed into nearly normal looking plants which produced pods and seeds. Such cotyledonary plants raised from unirradiated control seeds and from seeds exposed to 20 kR gamma rays were progeny tested in the M2 generation. No mutations were found in 153 control cotyledonary plant progenies but 16% (13 out of 80) of the cotyledonary plant progenies raised from irradiated seeds segregated for mutations. This figure was lower than the number of seed-raised progenies that segregated for mutations.

1013 BHATIA, CR; MURTY, GSS; MATHEWS, VH. 1985. **Regeneration of plants from "de-embryonated" peanut cotyledons cultured without nutrients and agar**. *Zeitschrift fur Pflanzenzuchtung*, 94: 2, 149-155; 13 ref.

Plantlets have been regenerated from callus produced by culturing the cotyledons that remained when the embryonal axis had been excised from soaked seeds of *Arachis hypogaea*. The cotyledons were cultured in Petri dishes lined with moist filter paper or over cotton wool in beakers or test tubes. Shoot regeneration was enhanced by the presence of 0.05 p.p.m. BA. Plantlets were grown to maturity in the field. When similar cotyledons

were sliced longitudinally into 2 pieces before culture, 48% of such slices regenerated plantlets.

1014 BHUIYAN, M SAFIUL ALAM. 1991. **Induction of callus from explants of *Arachis hypogaea L.*** *Plant Tissue culture Conference*. (BINA, Mymensingh: 1991: Dec 7-8), p. 16.

1015 BHUIYAN, M SAFIUL ALAM. 1992. **Callus induction and plant regeneration from different explants of peanut**. *Biennial Conference of BAPTC*. (Dhaka University, Department of Botany: 1st: 1992: Dec 15). p. 9.

1016 BHUIYAN, M SAFIUL ALAM. 1993. **Somaclonal variation in regenerats from in vitro culture of peanut**. *International Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: December 19-21). p. 34.

1017 BHUIYAN, M SAFIUL ALAM. 1994. **Development of in vitro regeneration system in peanut (*Arachis hypogaea L.*)**. *International Congress of Plant Tissue and Cell culture*. (8th: Firenze, Italy: 1994: Jun 12-17), p. 33.

1018 BHUIYAN, MSA; HAQUE, MM; HOQUE, MI; SARKER, RH; ISLAM, AS. 1992. **Morphogenic responses of peanut leaflet explants cultured in vitro**. *Plant Tissue Culture*, 2: 1, 49-53.

Leaflet explants of peanut were cultured on modified MS medium containing different concentrations and combinations of 2, 4-D, NAA, Kn and BAP for callusing and shoot production. NAA and 2, 4-D gave good callus but no shoots. Shoot buds were obtained when BAP was used either singly (0.5, 1.0, 1.5, 2.0 and 2.5 mg/l). Histological studies of differentiating callus showed the presence of meristemoids that developed into green buds and shoots. Regenerated shoots produced profuse roots when they were cultured in half strength MS medium containing 0.2 mg/l IBA.

1019 DEMSKI, JW; REDDY, DVR; WONGKAEW, S; XU, ZY; KUHN, CW; CASSIDY, BG; SHUKLA, DD; SALEH, N; MIDDLETON, KJ; SREENIVASULU, P; RAO, RDVJP; SENBOKU, T; DOLLET, M; MCDONALD, D. 1993. **Peanut stripe virus**. ICRISAT, Patancheru, A.P. (India) 20 p.

Different isolates of peanut stripe virus (PStV) induce different symptoms in groundnut. In the USA, a striping symptom is common; however, in Southeast Asia the most common symptoms are dark green blotches and ring spots. One good local lesion host is *Chenopodium amaranticolor* and the propagation hosts are *Lupinus albus* and *Nicotiana benthamiana*. Antisera have been produced for several PStV isolates and serological tests to detect the virus in foliage and seed are available. Based on serology and peptide profiling of the coat protein, PStV is related to blackeye cowpea mosaic virus. Studies on the genome organization of PStV at the molecular level indicate that it is closely related to soybean mosaic virus, watermelon mosaic virus, and zucchini yellow mosaic virus with an amino acid sequence homology of about 75. Resistance to PStV has not been identified in commercial cultivars of groundnut. Based on available epidemiological information, disease management strategies are discussed.

1020 DWIVEDI, SL; NIGAM, SN; PANDEY, SK; GIBBONS, RW. 1984. **Inheritance of albinism in certain interspecific and intersubspecific crosses in groundnut (*Arachis hypogaea L.*)**. *Euphytica*, 33: 3, 705-708; 5 ref.

F2 segregation data from 39 crosses indicated that chlorophyll deficiency or albinism is a recessive trait and in these crosses is controlled by 3 genes.

1021 HAZRA, S; SATHAYE, SS; MASCARENHAS, AF. 1989. **Direct somatic embryogenesis in peanut (*Arachis hypogaea*)**. *Bio/Technology*, 7: 9, 949-951; 35 ref.

Plants of the cultivar SB11 were regenerated from immature zygotic embryo axes by direct somatic embryogenesis without a callus stage on modified MS medium. Induction and maturation of the embryoids were achieved on the same medium, with 2,4-D being essential for this response. The size of the initial embryo axis and the 2,4-D concentration were important for direct somatic embryogenesis, with 3-6 mm axes and concentrations of 1, 3 and 6 mg/litre giving embryoid development. Embryoids formed shoots and roots on medium without growth regulators, and plantlets were obtained which survived in a sand/soil mixture.

1022 JAHNAVI, MR; MURTY, UR. 1985. **Interspecific gene transfer in *Arachis hypogaea L.*, in relation to the behaviour of triploid, pentaploid and hexaploid derivatives**. *Cytologia*, 50: 4, 865-878; 40 ref.

Triploid hybrids were obtained by crossing *A. hypogaea* (cultivars TMV2 and Florunner) with *A. chacoense*, *A. correntina* and *A. villosa*; some hybrids set seed, giving

rise to tetraploids, pentaploids and hexaploids. Fertile tetraploids resembling *A. hypogaea* in plant type but having some of the traits of the wild parent were selected in the F4. Detailed information on chromosome pairing and fertility in interspecific hybrid derivatives of different ploidy level is presented.

1023 KALE, DM; MOULI, C. 1984. **Hybridization technique in groundnut**. *Indian Journal of Genetics and Plant Breeding*, 44: 3, 379-384; 12 ref.

An emasculation technique, involving making an incision in the flower bud and removing the anthers, is described. Pollen from freshly collected, intact flowers is applied to stigmas, either directly or with a brush or forceps. In general, pollination carried out at 0600-0900 h was successful. Such hybridization has been carried out since 1974 and was, on average, 65-78% successful. The best time for crossing was 30-35 days after sowing in Spanish and Valencia types and 40-53 days after sowing in Virginia types.

1024 KIRTI, PB; BHARATHI, M; MURTY, UR; RAO, NGP. 1983. **Chromosome morphology in three diploid species of *Arachis* and its bearing on the genomes of groundnut (*Arachis hypogaea L.*)**. *Cytologia*, 48: 1, 139-151; 21 ref.

Chromosome morphology at the pachytene stage of meiosis was studied in *A. chacoense* and *A. villosa* (A genome species) and *A. batizocoi* (B genome species). Chromosomes were identified individually on the basis of total length, arm ratio, nucleolus attachment and proportion and disposition of heterochromatin. Idiograms were constructed for each species. The individual chromosomes of all 3 species were compared to those of *A. hypogaea*. It is suggested that the genomes of the segmental allopolyploid *A. hypogaea* may have been derived from *A. villosa*, or a similar species, and *A. batizocoi*; alternatively, *A. hypogaea* could have evolved from an amphidiploid of two A genome species similar to *A. villosa* and *A. chacoense*.

1025 KRISHNAPPA, DG; JOSEPH, DSM. 1985. **Preliminary cytogenetical studies on wild species of *Arachis* at Bangalore University**. *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). Dep. Bot., Bangalore Univ., Bangalore, Karnataka 560 056, India. p. 135-136; 9 ref.

Diploid interspecific hybrids from the crosses *Arachis sp.* HLK410 X *Arachis sp.* HLK408, *A. duranensis* X *Arachis sp.* 408 and the reciprocal of the latter all had regular meiosis and formed 10 bivalents at metaphase I. Triploid hybrids from the crosses *A. stenosterma* (2n=20) X *A. hypogaea cv. TMV2* (2n = 40), *A. monticola* (2n = 40) X *A. duranensis* (2n = 20) and *A. cardenasii* (2n = 20) X *A. hypogaea cv. Robut 33-1*, had irregular meiosis, 6-14 univalents at metaphase I and 90-95% pollen sterility. While the diploid hybrids were resistant to *Cercosporidium personatum* [*Mycosphaerella berkeleyi*], *Cercospora [Didymosphaeria] arachidicola* and *Puccinia arachidis*, the triploid hybrids were only partially so.

1026 MALLIKARJUNA, N; SASTRI, DC. 1985. **In vitro culture of ovules and embryos from some incompatible interspecific crosses in the genus *Arachis*.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). ICRISAT, Patancheru, India. p. 153-158; 10 ref.

Ovules up to 3 mm in length and embryos from larger ovules, obtained following hormone-assisted incompatible intersectional pollination of *Arachis hypogaea* cultivars, were successfully cultured on Murashige & Skoog medium with or without agar and supplemented with various concentrations of sucrose and growth regulators (kinetin, IAA, BA and NAA). Callus formation was common in cultured ovules, and some cultured embryos and embryos from some cultured ovules developed into plantlets.

1027 MALLIKARJUNA, N; SASTRI, DC. 1985. **Utilization of incompatible species in *Arachis*: sequential hormone applications.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31-Nov 2). ICRISAT, Patancheru PO, AP 502 324, India. p. 147-157; 16 ref.

Application of GA to the bases of flowers following incompatible intersectional pollinations led to peg formation and in some cases to the formation of pods. Of 5 *A. hypogaea* cultivars used as female parents in crosses with 3 members of section Rhizomatosae, MK374 produced most pods, though peg production did not differ among cultivars. Subsequent application of 10-100 p.p.m. IAA 10-25 days after pollination increased pod set, especially on day 20, irrespective of concentration. Application of 1-50 p.p.m. kinetin instead of IAA was variable in effect on pod set. Both these treatments generally increased ovule size.

1028 MEHAN, VK; MCDONALD, D. 1984. **Research on the aflatoxin problem in groundnut at ICRISAT**. *Plant and Soil*, 79: 2, 255-260; 17 ref.

Of 850 cultivars or lines screened for reaction to seed invasion by *Aspergillus flavus* in laboratory and field

tests, 8 proved resistant. Three of these had been reported resistant in the USA but the other 5 were new sources of resistance. No cultivar or line was completely resistant to aflatoxin production following seed invasion but significant intercultivar differences occurred in the amounts of aflatoxin produced by seeds inoculated with a toxigenic strain of *A. flavus*.

1029 MHATRE, M; BAPAT, VA; RAO, PS. 1985. **Micropropagation and protoplast culture of peanut (*Arachis hypogaea L.*)**. *Current Science*, 54: 20, 1052-1056; 17 ref.

By germinating seeds on a cytokinin medium and then isolating and culturing cotyledonary segments from the seedlings on a medium enriched with BA, multiple shoot bud formation was obtained. Five of the 6 varieties gave optimum shoot bud formation when BA was used at 1 mg/litre. Shoot buds were rooted and complete plants were produced. Protoplasts were isolated from 30- day-old shoot cultures, but although division occurred and callus was formed, no regeneration was obtained when different hormonal treatments were used.

1030 MOSS, JP. 1985. **Breeding strategies for utilization of wild species of *Arachis* in groundnut improvement.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31-Nov 2). ICRISAT, Patancheru PO, AP 502 324, India. p. 93-99; 38 ref.

This outline of approaches to the use of intrasectional and intersectional hybrids includes information on the intrasectional breeding programme used at ICRISAT and some of the promising hybrids resulting from it, notably the Virginia Bunch type ICGS50 and the disease resistant ICG FDRS17 and ICG FDRS18; all three are from *A. hypogaea* X *A. cardenasii*.

1031 MURTY, UR; JAHNAVI, MR. 1985. **Breeding potential of interspecific tetraploids in *Arachis* L.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). IARI, Rajendranagar, Hyderabad, AP 500 130, India. p. 125-130; 4 ref.

Triploid hybrids from crosses of 10 *A. hypogaea* cultivars as female with *A. chacoense* PI276235, *A. correntina* PI331194 and *A. villosa* (from Coimbatore, India), produced 5 tetraploids, 1 pentaploid and 28 hexaploids. The tetraploids produced tetraploids only. Progenies from F3 tetraploids from 2 chacoense crosses and one villosa and one correntina cross differed slightly from the cultivated parents in vegetative characters but were generally similar to them in reproductive features. Immunity to rust [*Puccinia arachidis*], absent in the cultivated parents, was present in nearly 50% of the tetraploid derivatives.

1032 MURTY, UR; JAHNAVI, MR. 1986. **The 'A' genome of *Arachis hypogaea L.*** *Cytologia*, 51: 2, 241-250; 13 ref.

Detailed cytological data are presented on 3x, 4x and 6x derivatives from the crosses *A. hypogaea* X *A. correntina* and *A. hypogaea* X *A. chacoense*, from which it is concluded that *A. correntina* (2x) could have been the donor of the A genome of *A. hypogaea* (4x). The 4x derivatives from both crosses resembled *A. hypogaea* morphologically but had the leaf spot [unspecified] and rust [*Puccinia arachidis*] resistances of the wild species.

1033 NARASIMHULU, SB; REDDY, GM. 1985. **Callus induction and morphogenesis in *Arachis hypogaea L.*** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). Dep. Genetics, Univ. Coll. Sci., Osmania Univ., Hyderabad, AP 500 007, India. p. 159-163; 15 ref.

In tests with 4 genotypes, using 6 different seedling explants and 7 different media, shoots were regenerated with frequencies of 11-38% from callus cultures of epicotyl, hypocotyl, leaves and cotyledons on Murashige & Skoog (MS) medium with BA (1 mg/litre) + NAA (0.4 mg/litre) or with kinetin (1 mg/litre). Epicotyl-derived callus gave the highest frequency of regeneration. Rooting was induced following transfer of shoots to a medium containing NAA (1 mg/litre) + kinetin (0.04 mg/litre). Regeneration was successful with genotypes ICG4367 and TMV2 but not with TG19B or US48. In tests with 7 *A. hypogaea* genotypes and *A. duranensis* and *A. monticola*, cotyledons with or without embryo axes produced flower buds and flowers directly on Blaydes medium supplemented with cytokinins.

1034 NARASIMHULU, SB; REDDY, GM. 1984. **In vitro flowering and pod formation from cotyledons of groundnut (*Arachis hypogaea L.*)**. *Theoretical and Applied Genetics*, 69: 1, 87-91; 17 ref.

Tabulated data are presented on the frequency of flower bud formation from embryonated (possessing an embryo axis) and deembryonated cotyledons of 7 genotypes cultured on Blaydes' medium in the presence of cytokinins. The response of cotyledons of TMV2 to different media and growth regulators was investigated in more detail. Embryonated cotyledons cultured on Blaydes' medium with cytokinins produced shoots, in the axils of which 2-7 flower buds could be seen. The frequency of flower bud induction in general increased with increas-

ing concentrations of cytokinins, the optimal levels being 3 mg/litre of kinetin or 4 mg/litre of BA. Deembryonated cotyledons cultured on Blaydes' medium with BA (0.5 mg/litre) produced a cluster of 8-28 flower buds directly without any vegetative growth. Excised embryo axes cultured on the same medium gave plantlets without flower buds. IAA, NAA, GA and ABA failed to induce flower buds in independent treatments. However, lower concentrations (0.1 mg/litre) of IAA and NAA in combination with cytokinins exerted a positive influence on flowering. The flowering of the buds was facilitated on media supplemented with low concentrations of cytokinins. Of the induced flowers, 6% resulted in gynophore development and ultimately formed pods when cultured in the dark in modified Murashige & Skoog medium supplemented with kinetin.

1035 NARASIMHULU, SB; REDDY, GM. 1983. **Plantlet regeneration from different callus cultures of *Arachis hypogaea L.*** *Plant Science Letters*, 31: 2/3, 157-163; 12 ref.

Leaflets, epicotyls, hypocotyls, primary and secondary roots and cotyledons excised from seven-day-old seedlings of four cultivars were cultured on Murashige and Skoog medium supplemented with various concentrations of 2,4-D, IAA and NAA in combination with kinetin. The combination of 2,4-D (2 mg/l) and kinetin (0.5 mg/l) was most effective at inducing callus. Shoots were induced from callus subcultured on medium containing BA and NAA, and also kinetin. Regenerated shoots transferred to a medium containing NAA and kinetin developed roots. In addition to plant regeneration from callus cultures, shoots were also regenerated directly from explants in medium supplemented with IAA and kinetin. ICG4367 had the highest frequency of callus induction, while US48 had the highest frequency of direct shoot formation.

1036 NARAYANASWAMY, P; MAHADEVAN, A. 1983. **Phytoalexin production by groundnut**. *International Journal of Tropical Plant Diseases*, 1: 2, 163-170; 16 ref., 6 tab.

Both detached leaves and immature pods of the cultivars TMV 2, TMV 7 and TMV 11, inoculated with *Curvularia spicata*, produced phytoalexins with max. amounts in drops collected after 18 h and 36 h from pods and leaves, respectively. A spore concn of 1 X 105/ml was most effective on leaves, but on pods 1 X 106 was best. Leaves collected from plants 30-60 d old produced the most phytoalexin when the inducing fungus was *C. spicata*. Immature pods synthesized a large quantity compared with aged pods. Pods incubated over 8-40° for 72 h retained the ability to produce phytoalexins. The diffusates from both control and treated pods kept at 45 and 50° contained only trace amounts. The inducing organism profoundly influenced the synthesis of phytoalexins in pods; *C. spicata* induced 33 μg trans-resveratrol/ml of diffusate whereas *Helminthosporium oryzae* [*Cochliobolus miyabeanus*] induced 667 μg/ml.

1037 PUSHPA, G; NAYAR, KMD; REDDY, BGS; SHAMBYLINGAPPA, KG. 1983. **Studies on the back cross generations of the cross *Arachis hypogaea* X *A. duranensis***. *Cytologia*, 48: 3, 505-509; 4 ref.

When the triploid hybrid between *A. hypogaea cv. Hg8* (2n = 4x = 40) and *A. duranensis* (2n = 2x = 20) was backcrossed to *A. hypogaea*, the small number of plants produced (BC1F1) had 2n = 50 and pollen fertility of ≈36%. These plants were vegetatively propagated by cuttings and seed collected from them was used to produce the BC1F2. In the BC1F2 a few plants were found with erect growth habit, a chromosome number of 2n = 40 and pollen fertility of 92%. An increase in pollen fertility to 98% was observed in the BC1F3. Selected BC1F3 plants showed field resistance to *Cercospora* leaf spot and appeared promising for yield and agronomic characters.

1038 PUSHPA, G; REDDY, BGS. 1983. **Studies on the open pollinated generations of the cross *Arachis hypogaea* X *Arachis duranensis***. *Cytologia*, 48: 3, 565-568; 3 ref.

Open pollination (OP) of the triploid hybrid between *A. hypogaea* and *A. duranensis* produced hexaploid plants with 2n = 60. At meiotic anaphase I in the OP2 generation, 48.3% of PMCs showed chromosomal aberrations (chromosome stickiness, lagging chromosomes and bridges). Pollen fertility was 10.2% in the triploid, 84.94% in the OP1 and 96.2% in the OP2.

1039 RATHNASWAMY, R; SUNDARAM, N; VINDHIYAVARMAN, P; MUTHUSAMY, M; RAMALINGAM, RS; VAMANBHAT, M. 1986. **Groundnut lines resistant to late leaf-spot and rust, developed through hybridization of 'Mutant 1' *Arachis hypogaea Linn* with *A. villosa Benth***. *Indian Journal of Agricultural Sciences*, 56: 7, 537-539; 7 ref.

Of 120 stabilized tetraploid lines derived from the BCF1 of a cross involving *A. hypogaea* Mutant 1 (derived by gamma irradiation) as female parent with *A. villosa*, the lines Cyto 230, Cyto 231 and Cyto 232 had good resistance to *Puccinia arachidis* and *Cercosporidium personatum* [*Mycosphaerella berkeleyi*] on the basis of scores on a 0-9 scale. Cyto 228 was resistant to *P.*

arachidis and moderately so to *C. personatum*, and Cyto 229 showed greater resistance to *P. arachidis* than to *C. personatum*. The lines, like the *A. hypogaea* parent, are of the bunch type.

1040 RUGMAN, EE; COCKING, EC. 1985. **The development of somatic hybridization techniques for groundnut improvement.** *International workshop on cytogenetics of Arachis: Proceedigs*. (Patancheru: 1983: Oct 31 - Nov 2), p. 167-174; 31 ref.

Details are given of procedures found effective for the isolation and culture of mesophyll protoplasts of *Arachis hypogaea*. Fully expanded leaves of seedlings 9-17 days old gave optimum protoplast release. Six wild accessions of section Rhizomatosae responded differently to the various media, *Arachis sp*. PI338265 being the most promising source of protoplasts. Plants were regenerated from cultured immature leaves and cotyledons but not from callus derived from mature leaves or protoplasts.

1041 SAKHUJA, PK; SETHI, CL. 1986. **Multiplication of *Meloidogyne javanica* as affected by *Fusarium solani* and *Rhizoctonia bataticola* on groundnut.** *Indian Journal of Nematology*, 16: 1, 1-3; 11 ref.

In a pot experiment, *M. javanica*, *F. solani* and *R. bataticola* [*Macrophomina phaseolina*] were inoculated on *Arachis hypogaea* in 12 different combinations. Both fungi reduced galling significantly in all treatments except where *F. solani* succeeded the nematode after a week. *M. javanica* multiplication reduction was maximum where one or both fungi were inoculated simultaneously with the nematode. *R. bataticola* exhibited greater antagonistic activity compared with *F. solani*.

1042 SEENI, S; KRISHNAN, M; GNANAM, A. 1983. **Development of photosynthetic structure and function during light-induced greening in photomixotrophic cells of *Arachis hypogaea L.*** *Plant and Cell Physiology*, 24: 5, 823-827; 23 ref.

Chlorophyll synthesis and development of photochemical activity were completed within 70-80 h in greening leaves of groundnut, whereas these processes continued for 8 days with an initial lag of 8 h for pigment synthesis in isolated cells. Photosystem I activity was detected after 24-36 h and photosystem II after 42-54 h illumination in isolated cells. Photosystem II activity coincided with the synthesis of a 46 000 dalton polypeptide of the thylakoid membrane.

1043 SINGH, AK. 1985. **Genetic introgression from compatible wild species into cultivated groundnut.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). ICRISAT, Patancheru PO, AP 502 324, India. p. 107-117; 25 ref.

Tabulated data on the hybridization of *Arachis hypogaea* (4x) with wild 2x species at ICRISAT are presented, showing the results of work on introgression (1) through artificial 6x amphiploids, (2) through triploid hybrids in which the frequencies of bivalents and unreduced gametes are high, (3) using 4x amphiploids (genomes AABB) between wild AA and BB species and (4) using autotetraploids of the wild species. Segregates with resistance to rust [*Puccinia arachidis*] were obtained from procedures (1), (3) and (4), to late leaf spot [*Mycosphaerella berkeleyi*] from procedure (1) and to *Aproaerema modicella*, *Empoasca kerri* and thrips from procedure (2).

1044 SINGH, AK; SUBRAHMANYAM, P; MOSS, JP. 1984. **The dominant nature of resistance to *Puccinia arachidis* in certain wild *Arachis* species.** *Oleagineux*, 39: 11, 535-538; 13 ref.

The material comprised two susceptible cultivars of *A. hypogaea* (tetraploid, 2n = 40), the immune wild species *A. batizocoi* (diploid and autotetraploid), *A. villosa* and *A. duranensis* (both diploid), tetraploid material from the crosses *A. villosa* X *A. batizocoi* and *A. batizocoi* X *A. duranensis*, and triploid and tetraploid F1 hybrids from crosses between the cultivars and the wild material. The cultivars were used as seed parents in all crosses. All the F1 hybrids were highly resistant, both in the field with natural infection and in the laboratory following inoculation, and it is concluded that the gene or genes controlling immunity in the wild species are partially dominant.

1045 SINGH, AK; MOSS, JP. 1984. **Utilisation of wild relatives in the genetic improvement of *Arachis hypogaea L.* 5. Genome analysis in section *Arachis* and its implications in gene transfer**. *Theoretical and Applied Genetics*, 68: 4, 355-364; 26 ref.

Cross compatibility of species in section *Arachis nom. nud.*, and chromosome pairing and pollen fertility in their interspecific F1 hybrids were studied. Except those with *A. batizocoi* nom. nud., hybrids between diploid species had near normal bivalent frequency (9.1-9.8) and moderate to high pollen fertility (60-91%). Hybrids between *A. batizocoi* and other species had low bivalent frequency (5.2-6.9) and very low pollen fertility (3-7%). These results confirm the earlier separation of these species into two groups based on karyomorphology and Mahalanobis D2 values calculated on arm ratios.

Chromosome pairing in triploid hybrids (*A. hypogaea* (4x) X diploid wild species) suggested that *A. batizocoi* is the closest diploid relative of *A. hypogaea*. It is closer to *A. hypogaea subsp. fastigiata* than to *A. hypogaea subsp. hypogaea*. Other diploid species of the section *Arachis* are equidistant from *A. hypogaea*, and have the same genome (A), which has strong homology to one of the genomes of *A. hypogaea* (AABB). It is presumed that *A. batizocoi* has the B genome. Results also revealed that the two tetraploid species, *A. monticola* and *A. hypogaea*, are two forms of the same species. [See also Plant Breeding Abstracts 52, 6920.]

1046 SRINIVASAN, S; RAO, DVS. 1987. **New report of parasites of groundnut leaf webber, *Aproaerema modicella* Deventer (Lepidoptera: *Gelechiidae*).** *Entomon*, 12: 2, 117-119; 9 ref.

Larvae of *Aproaerema modicella* were collected from groundnuts in the field in Andhra Pradesh, India, during kharif and rabi in 1983-1984. They were kept in the laboratory until they reached the adult stage or parasitoids emerged. Percentage parasitism was greatest in September-November and January-March. The parasitoid complex included the braconids *Chelonus blackburni*, *Apanteles sp. and Microbracon sp. [Bracon sp.]*, the eulophid *Tetrastichus*, the eurytomid *Eurytoma* and the pteromalid *Habrocytus sp. [Pteromalus sp.]*. Other natural enemies included *Araneae*, asilids, entomophilic nematodes and the entomogenous fungus *Aspergillus flavus*.

1047 SUKUMAR, S; RANGASAMY, SRS. 1984. **Morphological and growth characteristics of wild and hybrid peanuts (*Arachis sp.*) cultured in vitro.** *Current Science*, 53: 11, 586-588; 6 ref.

Explants of stems, petioles and pinnae of 3 wild diploid species, 4 wild tetraploid species and 2 interspecific hybrids were cultured on a supplemented Murashige & Skoog medium. Pinna segments proliferated the most rapidly to form callus. Root formation was observed only in calluses of the diploid species (2n = 20) *A. villosulicarpa* and *A. duranensis* and the triploid hybrid (2n = 30) *A. hypogaea* X *A. villosa*. Differentiation of shoot buds was observed in *A. villosulicarpa*.

1048 SUNDARAM, N. 1985. **Studies on cytogenetics of *Arachis* at Regional Research Station, Vriddhachalam, Tamil Nadu, India.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31-Nov 2). ICRISAT, India. p. 136-139.

Primary triploids from *A. hypogaea* (2n = 40) X *A. villosa* (2n = 20) were vigorous, with 3.8-11.4% pollen fertility; chromosome associations of 10II + 10I were frequent and bridges and laggards occurred in about 50% of both first and second meiotic divisions. Occasional hexaploids produced were less vigorous, with 30 bivalents in 28% of cells and a mean association of 0.11VI, 1.2IV, 0.18III, 26.55II, 0.961I per cell. In an allotetraploid from *A. hypogaea* X autotetraploid *A. villosa*, one-third of PMCs had 5III + 5II + 15I, with a mean association of 0.16IV, 3.16III, 6.33II, 16.2I and 68.4% pollen fertility. Hexaploid progeny from the primary hexaploids were morphologically variable, with 65% pollen fertility and a mean association of 0.28VI, 3.20IV, 1.04III, 20.28II, 1.28I. Secondary triploids from the primary hexaploids had 3.28III, 6.05II, 8.07I. Hybrids between *A. hypogaea* and autotetraploid *A. villosulicarpa* were vigorous and showed variation in subsequent generations. Hybrids of *A. hypogaea* and *A. chacoense* had 8-11% pollen fertility and a mean association of 0.3III, 9.9II, 9.3I.

1049 TIWARI, SP. 1985. **Utilization of wild species of *Arachis*.** *International workshop on cytogenetics of Arachis: Proceedings*. (Patancheru: 1983: Oct 31 - Nov 2). National Res. Centre for Groundnut, Timbawadi, Junagadh, Gujarat, 362 002, India. p. 131-134; 7 ref.

Derivatives resulting from crosses of *A. hypogaea* with *A. monticola* and *A. villosulicarpa* were similar to cultivars in yield but more tolerant to *Puccinia arachidis* and *Cercosporidium personatum* [*Mycosphaerella berkeleyi*]. *A. hagenbeckii* and *A. glabrata* proved high in leaf protein percentage. A study of cultivated tetraploids, interspecific triploid hybrids and diploid and tetraploid wild species showed the proportion of palisade tissue as a percentage of leaf thickness to be high in drought-resistant forms such as *A. hagenbeckii*, *A. pusilla* and *A. hypogaea* X *A. chacoense* (>70%) and *A. hypogaea* cultivars Krapovickas (64%) and NcAc 17090 (60%).

1050 TYAGI, V; SHARMA, P; SWARNKAR, PL. 1993. **Initiation of callus and differentiation of multiple shoots in *Arachis hypogaea L.*** *Annals of Biology*, 9: 1, 34-37.

1051 VARNAM, P VINDHIYA; RAVEENDRAN, TS; GANAPATHY, T. 1989. **Genome and plasmon effects on rust resistance in groundnut (*Arachis hypogaea L.*).** *Philippine Journal of Crop Science*, 14: 1, 11-13.

A genetic analysis for rust (*Puccinia arachidis Speg.*) resistance was carried out in groundnut (*Arachis hypogaea L.*) involving the F1 progenies of a 4 x 4 diallel

cross with reciprocals and parents. The study revealed the resistance to be due to additive and dominance components but additive variance predominated. Existence of partial dominance and susceptibility being in excess of resistance were also observed. A tendency of the hybrids behaving more like the maternal parent was evident and suggests possible plasmon effects for rust resistance in this crop.

1052 VELAZHAHAN, R; RAMALINGAM, RS; RANGASAMY, SRS. 1991. **Screening of interspecific derivatives of groundnut for resistance to rust**. *Groundnut News*, 3: 1, 3.

Among 25 interspecific crosses involving wild and cultivated species of *Arachis* at the tetraploid level in the F7 generation, 9 entries were resistant to rust [*Puccinia arachidis*] and these were derived from the crosses (*A. batizocoi* X *A. duranensis*) X *A. hypogaea*, *A. batizocoi* X *A. hypogaea*, *A. chacoense* X *A. hypogaea* and *A. hypogaea* X *A. cardenasii*.

Brassica

1053 AGGARWAL, RK; SHARMA, DR; SINGH, RK. 1982. **Isolation and culture of mesophyll protoplasts of a few *Brassica* species**. *Proc. 5th Intl. Cong. Plant Tissue and Cell Culture*. p. 593-594.

1054 ASLAM YOUSUF, M; BECHYNE, M. 1985. **Interspecific hybridization within the genus *Brassica***. *Pak. Jrl. of Agricultural Research*, 6: 1, 60-70; 47 ref.

The following aspects of work reported in the literature during the 1960s and 1970s are reviewed: evolutionary relationships among *Brassica* species; crosses between *B. napus* and its parent species, *B. campestris* and *B. oleracea*; other crosses involving *B. napus*; crosses between other *Brassica* species; and methods of improving interspecific compatibility; improvement of *B. napus* through hybridization with various other species; and attempts at the resynthesis of *B. napus*.

1055 DHAWAN, RS; SHARMA, DR; CHOWDHURY, JB. 1987. **Effect of salinity on germination and yield components in three species of *Brassica***. *Indian Jouranl Agricultural Science*, 57: 107-111.

1056 JAIN, RK; CHOWDHURY, JB; SHARMA, DR; FRIEDT, W. 1988. **Genotypic and media effects on plant regeneration from cotyledon explant cultures of some *Brassica* species**. *Plant Cell Tissue and Organ Culture*, 14: 197-206.

1057 NARASIMHULU, SB; PRAKASH, SHYAM; RISHI, R; CHOPRA, VL. 1988. **Genomic interaction for shoot regeneration in *Brassica***. *Cruciferae Newsletter*, No. 13: 90-91.

Optimum shoot regeneration in vitro of diploid and natural amphidiploid *Brassica* was obtained with 11.4 μM IAA and 17.7 μ benzyladenine in basal MS medium. To test the regeneration response, 5 parental diploids representing genomes A, B and C, 4 synthetic amphidiploids, 2 natural amphidiploids, 5 trigenomic combinations and 1 tetragenomic form were compared. Among parental diploid species *B. campestris* (AA) regenerated at a low frequency, while *B. nigra* (BB) regenerated readily. Among the amphidiploids, serving as female parents for trigenomic combinations, the regeneration frequency was high in synthetic *B. carinata* derived from *B. oleracea* as the female parent, and was least in the natural amphidiploid *B. carinata*. The low regeneration responses of synthetic *B. juncea* and *B. napus* in relation to their superior B and C parents was taken to indicate that the A genome has a negative influence on shoot regeneration, accompanied by a negative interaction of *B. campestris* cytoplasm with the alien genome. Cytoplasmic differences for shoot regeneration were evident with synthetic *B. carinata* because C cytoplasm regenerated at a high frequency compared with its reciprocal. Among the trigenomic combinations, the regeneration response of BBC was significantly greater than the additive effect of the combining genomes, the poorly regenerating natural *B. carinata* and the rapidly regenerating diploid *B. nigra*. The trigenomic combination AAC obtained by crossing synthetic *B. napus* with *B. campestris* showed a response superior to that of its best parent, indicating that interaction between doses of A genome are different from intergenomic interaction between A and C genomes, particularly in the context of unequal genome usage. Shoots of the trigenomic combination ABC obtained by crossing either synthetic *B. napus* with *B. nigra* or natural *B. juncea* with *B. oleracea*, showed very low regeneration. This negative interaction was not observed in the tetragenomic combination ABBC obtained by crossing the natural amphidiploids *B. juncea* and *B. carinata*.

1058 PRAKASH, S; CHOPRA, VL. 1992. **75 years of *Brassica* cytogenetics in India**. *GCIRC Bulletin (France)*. No. 8, p. 49-56.

1059 SONG, K; OSBORN, TC; WILLIAMS, PH. 1990. ***Brassica* taxonomy based on nuclear restriction fragment length polymorphisms (RFLPs). 3. Genome relationships in *Brassica* and related genera and the**

origin of *B. oleracea* and *B. rapa (syn. campestris)*. *Theoretical and Applied Genetics*, 79: 4, 497-506; 21 ref.

Thirty-eight accessions, including 10 of *B. campestris*, 9 cultivated types of *B. oleracea*, 13 nine-chromosome wild *Brassica* species related to *B. oleracea* and 6 other species in *Brassica* and allied genera, were examined with more than 30 random genomic DNA probes, which identified RFLPs mapping to 9 different linkage groups of the *B. campestris* genome. Phylogenetic trees were constructed using the PAUP microcomputer programme. Within *B. campestris* accessions of pak choi, narinosa and Chinese cabbage from East Asia constituted a group distinct from turnip and wild European populations, consistent with the hypothesis that *B. campestris* had 2 centres of domestication. A wild accession from India was positioned in the tree between European types and East Asian types, suggesting an evolutionary pathway from Europe to India, then to South China. Cultivated *B. oleracea* morphotypes showed monophyletic origin with wild *B. oleracea* or *B. alboglabra* as possible ancestors. Cauliflower was closely related to broccoli, whereas cabbage was closely related to leafy kales. Great diversity existed among 13 collections of 9-chromosome wild species related to *B. oleracea*, representing various taxonomic states from subspecies to species. Results suggested that 2 basic evolutionary pathways exist for the diploid species examined. One pathway gave rise to *B. fruticulosa*, *B. nigra* and *Sinapis arvensis*, with *B. adpressa* or a close relative as the initial ancestor. Another pathway gave rise to *B. oleracea* and *B. campestris* with *Diplotaxis erucoides* or a close relative as the initial ancestor. *Raphanus sativus* and *Eruca sativa* [*E. vesicaria*] represented intermediate types between the 2 lineages, and might have been derived by introgression or hybridization between species belonging to different lineages.

1060 VIJAYAKUMAR, NK; VASUDEVA, M; SHARMA, DR. 1982. **Cytogenetic effects of food dyes in *Allium cepa* roots**. *H.A.U. Jour. Res.* 12: 61-63.

1061 YADAV, RC; YADAV, NR; KUMAR, PR; SHARMA, DR. 1987. **Factors affecting and rogenesis in different genotypes of *Brassica* species**. *Recent Advances in Plant Cell and Tissue Culture of Economically Important Plants*. Osmania University, Hyderabad. p. 3-108.

1062 YADAV, RC; YADAV, NR; KUMAR, PR; SHARMA, DR. 1986. **Foctors affecting androgenesis in different genotypes in *Brassica* species**. *Recent Advances in Plant Cell Tissue Culture of Economically Important Plants: National Symposium*. (Osmania University, Hyderabad: 1986: July). p. 15.

Brassica campestris

1063 BATRA, V; PRAKASH, S; SHIVANNA, KR. 1990. **Intergeneric hybridization between *Diplotaxis siifolia*, a wild species and crop brassicas**. *Theoretical and Applied Genetics*, 80: 4, 537-541; 14 ref.

Attempts were made to obtain intergeneric hybrids between *D. siifolia* and cultivars of *Brassica campestris*, *B. juncea* and *B. napus*. The crosses showed unilateral incompatibility. When *D. siifolia* was used as the female parent, pollen germination and pollen tube growth were normal, but hybrid seeds aborted due to post-fertilization barriers. Reciprocal crosses showed strong pre-fertilization barriers; although pollen grains showed germination, pollen tubes failed to enter the stigma. Hybrids were successful in 2 of the crosses, *D. siifolia* X *B. juncea* and *D. siifolia* X *B. napus*, through ovary culture. The hybrids were multiplied in vitro by multiplication of axillary shoots or somatic embryogenesis. Detailed studies were carried out on the hybrid *D. siifolia* X *B. juncea*. F1 hybrids had shrivelled anthers and were pollen sterile. Amphiploids of this hybrid showed 60% pollen fertility and produced seeds upon self-pollination as well as backcross pollination with the pollen of *B. juncea*.

1064 DAS, MK; RAHMAN, L; QUDDUS, MA. 1984. **Selection gains with combined score index in the F3 populations of an interspecific *Brassica* cross**. *Indian Journal of Agricultural Sciences*, 54: 7, 541-545; 10 ref.

Fifty-eight F3 family lines were selected from the F2 progeny of *Brassica juncea* X *B. rapa* [*B. campestris] var. glauca*. A 3-step combined score index for 5 yield-related characters was used to select 40 plants/line. These were reduced to 4/line and 1/line using the same index. Regression analysis on the 11 best selections showed that the highest gain was in siliquas/plant, which showed a maximum of 543.52% and an average of 272.66% gain over the mean parental value. The next highest gains were in secondary branches/plant and primary branches/plant.

1065 GUNDIMEDA, HR; PRAKASH, S; SHIVANNA, KR. 1992. **Intergeneric hybrids between *Enarthrocarpus lyratus*, a wild species, and crop brassicas**. *Theoretical and Applied Genetics*, 83: 5, 655-662; 16 ref.

Attempts were made to produce intergeneric hybrids between *E. lyratus*, a wild species, and several species of crop brassicas: *Brassica campestris*, *B. nigra*, *B. oleracea*, *B. juncea*, *B. napus* and *B. carinata*. Hybrids using *E. lyratus* as the female parent were realized by means of embryo rescue in 4 combinations with *B. campestris*, *B. oleracea*, *B. napus* and *B. carinata*. Reciprocal crosses showed strong pre-fertilization barriers and yielded no hybrids except in one combination, *B. juncea* X *E. lyratus*, in which a single hybrid was realized. All of the hybrids were multiplied in vitro through the multiplication of axillary shoots. Morphological and cytological studies confirmed hybridity. All hybrids were completely pollen sterile except for *E. lyratus* X *B. carinata*, wich showed 2% pollen fertility. Attempts to double the chromosome number through the in vitro application of colchicine to axillary meristems of F1 hybrids were successful in only one hybrid, *E. lyratus* X *B. oleracea*. Cytological studies of the hybrids indicated the presence of a partial homology between the genomes of *E. lyratus* and crop brassicas. Backcross progenies were raised from all of the F1 hybrids to develop male-sterile alloplasmic lines.

1066 KATIYAR, RK. 1985. **Influence of varietal and compatibility differences on the heterosis in oleiferous *Brassica***. *Indian Journal of Agricultural Sciences*, 55: 6, 393-398; 14 ref.

Four cultivars of *B. chinensis* (brown sarson) were crossed as female parents with 6 Indian cultivars of *B. napus* (toria and yellow sarson [*B. campestris*]) and 20 of brown sarson. Data are tabulated on heterosis for 9 yield characters. No heterosis over the better parent was observed for oil content. Self-incompatible X self-compatible crosses were better than self-incompatible X self-incompatible crosses.

1067 KATIYAR, RK. 1986. **Spontaneous secondary shoot development from the root cells of *Brassica* (rapeseed-mustard)**. *Current Science*, 55: 1, 38-39.

Among F5 selections from a cross between the oil crops *B. napus* (2n = 38) and *B. campestris* (2n = 20) some plants produced secondary shoots which arose from a tumour-like body occurring on the central tap root. The plants morphologically resembled *B. napus* more than *B. campestris* but were intermediate for flowering and maturity. The secondary shoots were mostly produced during the later stages of plant growth.

1068 KIRTI, PB; DARGAN, SEEMA; CHOPRA, VL. 1988. **Variation for salt tolerance in somatic embryoids in mustard**. *Cruciferae Newsletter*, No. 13: 91.

Somatic embryoids of *Brassica juncea* were subjected to 1 or 1.5% salt stress made up of 0.5% NaCl + 0.5 KCl and 0.75% NaCl + 0.75% KCl, respectively. Some embryoids survived to produce shoots but others turned white and died within a week of culture. Stem explants from resistant plants grown on MS supplemented with 2% sucrose, 0.5 mg 2,4-D, 0.5 mg benzyladenine, 0.5 g NaCl and 0.5 g KCl/litre callused profusely, whereas control plants died. The results are thought to indicate that variation exists for salt tolerance among embryoids developed in somatic cultures.

1069 KUMAR, PBAN; SHIVANNA, KR. 1991. **In vitro multiplication of a sterile interspecific hybrid, *Brassica fruticulosa* X *B. campestris***. *Plant Cell, Tissue and Organ Culture*, 26: 1, 17-22; 24 ref.

In vitro methods for plant multiplication of a sterile interspecific hybrid between *B. fruticulosa*, a wild species with rust and *Alternaria* resistance, and *B. campestris* through either micropropagation or callus regeneration is described. Shoot-tip, single node and leaf explants, obtained from in vitro-grown hybrids, regenerated on media containing NAA and benzyladenine. In vitro application of colchicine induced chromosome doubling in in vitro-regenerated shoots, resulting in the production of fertile amphidiploids. Comparative studies on regeneration potential of the hybrid and its parents were also carried out using callus from leaf explants. The explants of *B. fruticulosa* and the hybrid were capable of shoot and root formation while those of *B. campestris* failed to form shoots but produced profuse roots. The results demonstrated the efficacy of an in vitro method in producing a large number of hybrid plants and fertile amphidiploids from incompatible crosses that yield very few hybrid seeds/seedlings.

1070 KUMAR, PBAN; SHIVANNA, KR; PRAKASH, SHYAM. 1988. **Wide hybridization in *Brassica*. Crossability barriers and studies on the F1 hybrid and synthetic amphidiploid of *B. fruticulosa* X *B. campestris***. *Sexual Plant Reproduction*, 1: 4, 234-239; 14 ref.

Crosses were made to obtain interspecific hybrids between *B. fruticulosa* (wild species, 2n = 16) X *B. campestris* (brown sarson cultivar, 2n = 20). Although many pollen grains germinated and their tubes entered the style, only about 30% of the ovules received pollen tubes. Fertilized ovules aborted at various stages of development. A few hybrid seeds resulted from hand pollinations in the field, and they showed poor germination and seedling establishment. The in vitro culture of ovaries, ovules and seeds increased the frequency with

which hybrid seeds and plants were obtained; the most effective method was ovary culture followed by ovule culture. The hybrid nature of the plants was confirmed through morphological, cytological, and electrophoretic studies. A meiotic analysis of F1 hybrids (2n = 18) showed that they had 0-5 bivalents and were completely pollen sterile. Electrophoretic analysis of leaf esterases and acid phosphatases of F1 hybrids revealed bands derived from each parent. Induced amphidiploids of F1 hybrids contained mostly bivalents, and had about 50% fertile pollen.

1071 LAKSHMIKUMARAN, MALATHI; RANADE, SA. 1990. **Isolation and characterization of a highly repetitive DNA of *Brassica campestris***. *Plant Molecular Biology*, 14: 3, 447-448; 7 ref.

The nucleotide sequence of 8 tandem repeats and their consensus sequence are reported. The repeats accounted for more than 15% of the total genome and consisted of many, mostly identical copies of the monomer units arranged in tandem. Hybridization data indicated that at least 30-mer copies if not more existed in tandem. The monomer had an overall G + C content of 40% with a very low proportion of CpG dinucleotide. The tandem repeat showed homology to that of most *Brassica* species except *B. nigra* and *B. tournefortii*. It also hybridized to those of *Raphanus sativus*, *Sinapis alba*, *Diplotaxis erucoides*, *D. muralis* and *Erucastrum spp*. The tandem repeat sequence also showed homology to those of *B. oleracea* (98%), *R. sativus* (75%) and *S. alba* (65%).

1072 MANGA, VA; SHARMA, R. 1985. **Nutrients-mediated shift in temporal expression of phytochrome controlled beta-amylase synthesis in mustard (*Sinapis alba L.*) cotyledons**. *Plant, Cell and Environment*, 8: 5, 339-344; 16 ref.

1073 REDDY, AS; SRIVASTAVA, V; MUKHERJEE, S GUHA. 1989. **A tandemly repeated DNA sequence from *Brassica juncea***. *Nucleic Acids Research*, 17: 14, 5849; 7 ref.

Nuclear DNA from hypocotyls (H) and proliferating (PC) and differentiating (DC) callus (not showing and showing root or shoot formation, respectively), of the *B. juncea* variety Pusabold was digested with HindIII and electrophoresed on a 1% agarose gel. A prominent band of approximately 180 bp was eluted from the gel and cloned in the HindIII site of pUC9. Several clones were obtained and 3 each from H, PC and DC were sequenced. Hybridization studies revealed tandem arrays of about 120 elements and at least 680 000 copies of this repeated sequence in the genome. Although there is amplification and demethylation of this sequence in callus cells, the homology of the sequence from H, PC and DC was about 99%, indicating that this repeat is not rearranged in in vitro cell cultures. A consensus sequence (174 bp) from these 3 sequences contained 8 direct repeats, 3 inverted repeats and 14 hairpin loops. Although there are 2 short open reading frames (at 65 to 97 and 156 to 173 nucleotides) no RNA transcripts corresponding to these satellite DNAs were found. The satellite repeat units of the diploids *B. oleracea* and *B. campestris* showed high homology with the amphidiploid *B. juncea* (98%), suggesting that the genus *Brassica* has a specific tandem repeat. It exhibited high homology (80-85%) with mustard and radish and 30% homology with *Arabidopsis*.

1074 SINGH, S; GARG, K; CHANDRA, N. 1985. **Growth and differentiation in internode callus of *Brassica campestris* var. yellow sarson**. *Acta Botanica Indica*, 13: 1, 45-50; 9 ref.

Internode callus of *B. campestris* var. yellow sarson [*B. napus var. glauca*] was cultured on MS medium supplemented with different auxins and cytokinins either singly or in combination. The best growth of callus occurred on MS medium + 5 mg IAA + 3 mg BA/l. Shoot buds were induced on 1.5-5 mg K or BA/l with best response on 5 mg BA. Roots were induced with 3.5 mg IAA, IBA or NAA. Max. roots were induced with 5 mg NAA, but they were smaller. 5 mg IBA induced longer and healthier roots. 2, 4-D alone and in combination with K and/or BA suppressed morphogenesis. Plantlets were obtained by transferring the differentiated shoots to an auxin-supplemented medium.

1075 SINGH, S; CHANDRA, N. 1984. **Plant regeneration in callus and suspension cultures of *Brassica campestris cv. Yellow Sarson***. *Plant Cell Reports*, 3: 1, 1-4; 16 ref.

Prolific shoot-bud differentiation was induced in callus and suspension cultures of hypocotyl origin on Murashige & Skoog medium supplemented with K (139-232 μM) or BA (13.3-22.1 μM). Plantlets were obtained by rooting the in vitro differentiated shoots.

1076 YADAVA, JS. 1991. **Research achievements in oilseed crops at Haryana Agricultural University, Hisar, during 1988-90**. *Cruciferae Newsletter*, No. 14-15: 5-6.

Of more than 10 *Brassica juncea* (Indian mustard) varieties developed with high yields, RH8113 is resistant to *Alternaria* and *Albugo candida*, RH781 is frost

resistant and RH819 is drought resistant. The genotypes ISH8805, and ISH8807 from a *B. juncea* X *B. carinata* cross are also resistant to *Alternaria* and *A. candida*. Genotypes of *B. napus* and *B. carinata* were also selected for high yield and resistance to *A. candida*. A new, early maturing, high yielding variety of toria (*B. campestris*), TH68, was released. Groundnut and sesame genotypes have also been developed.

Brassica carinata

1077 BAJAJ, YPS; MOHAPATRA, D. 1987. **In vitro plant regeneration in *Brassica carinata* A. Br. - an oilseed crop**. *Indian Journal of Experimental Biology*, 25: 3, 161-163; 9 ref.

In a study aimed at using in vitro methods for plant improvement, plants were regenerated via callus from hypocotyl, cotyledon and immature ovary explants cultured on Murashige & Skoog medium supplemented with various growth regulators.

1078 NARASIMHULU, SB; KIRTI, PB; PRAKASH, S; CHOPRA, VL. 1992. **Rapid and efficient plant regeneration from hypocotyl protoplasts of *Brassica carinata***. *Plant Cell Reports*, 11: 3, 159-162; 17 ref.

Protoplasts were isolated from 7-d-old seedlings of 3 genotypes (Line 171, Acc 3 and Line 241) after enzymatic digestion in cellulase R-10 (0.5%) and pectolyase Y-23 (0.025%). The protoplasts were stabilized with 0.4 M mannitol used as osmoticum, and were cultured in darkness in Kao's liquid medium containing 0.4 M glucose, 1.0 mg 2,4-D, 0.1 mg NAA and 0.5 mg zeatin riboside/litre. Protoplasts were transferred to 16 h photoperiod conditions after 3 d of dark culture, and the medium was diluted to reduce the osmoticum on the seventh and tenth days of culture. Microcolonies were thus obtained which, upon transfer to MS agarose medium with 0.1 mg 2,4-D, 1.0 mg BAP [benzyladenine]/litre and 0.1 M sucrose, proliferated further to produce callus clumps. The plating efficiency of the 3 genotypes varied from 1 to 2%. Calluses 2-3 mm in diameter were transferred to MS agarose plates with 2 mg zeatin/litre where they produced shoot buds and shoots with frequencies 22.5, 51.2 and 74.2% for Acc 3, Line 241 and Line 171, respectively. The shoots were rooted in medium with 1.0 mg IBA/litre and were then established in soil. The time required for protoplast to plant development was 8 to 10 weeks.

1079 NARASIMHULU, SB; KIRTI, PB; MOHAPATRA, T; PRAKASH, S; CHOPRA, VL. 1992. **Shoot regeneration in stem explants and its amenability to *Agrobacterium tumefaciens* mediated gene transfer in *Brassica carinata***. *Plant Cell Reports*, 11: 7, 359-362; 15 ref.

Immature stem segments of 7 genotypes produced shoots with variable frequencies when cultured in MS medium with 0.2 mg BAP [benzyladenine] and picloram/litre. Line 171, which produced shoots with 100% efficiency from both cut ends of the explant, was selected for testing the amenability of this regeneration protocol for genetic transformation. Non-oncogenic *A. tumefaciens* containing plasmid PCV 730, a binary vector carrying resistance genes for kanamycin (nptII) and hygromycin (hpt) was used. A cocultivation period of 4 d with a bacterial concentration of approximately 2.5 X 108 cells/ml, followed by a recovery period of 2 d, produced transformed shoots that were selected and rooted in the presence of kanamycin at 15 mg/litre. Transformation was confirmed by NPT assay and Southern blot analysis. Seed analysis of transformed plants indicated that kanamycin resistance was inherited in the progeny.

1080 PARKASH, SURYA; SHARMA, DR; CHOWDHURY, JB. 1988. **High frequency in vitro morphogenesis in *Brassica carinata A.Br.***. *Cruciferae Newsletter*, No. 13: 89; 2 ref.

Cotyledons, petioles, stem segments, leaf pieces and regenerated young plants of *B. carinata cv. HC2* were cultured either on Y medium (MS + 0.05 mg NAA/-litre) or Z medium (MS + 0.2 mg NAA + 2.0 mg kinetin/litre). Regeneration frequency was 212.66 and 126.03% on Z and Y medium, respectively, using young plants. When raised from terminal buds and cultured on these media, callus was formed at the cut ends which produced 1-7 multiple shoots. Most of the regenerated plants bore roots. Regenerated plants showed morphological and cytological differences. The culture method was considered a valuable means of inducing genetic variability in *B. carinata* and of producing a large number of regenerants.

1081 YADAV, RC; SAREEN, PK; CHOWDHURY, JB. 1988. **High frequency induction of androgenesis in Ethiopian mustard (*Brassica carinata A. Br.*)**. *Cruciferae Newsletter*, No. 13: 77; 4 ref.

Anthers from unopened flower buds of cv. BCID1 and HC1 were cultured on Keller medium (R1), Keller medium modified with 100 mg serine (R2), KB5 medium modified with organic components of B5 (R3), and N6 medium modified with organic components of B5 (R4). The anthers were cultured in the dark at 25±2°C for 4 weeks for callus initiation. There was no

anther response on R1 and R2 media, but it was very high on R3 and R4 media. Anther response was greater on R4 medium than on R3 medium. The highest anther response (84.70%) was observed in cultivar BCID1 on R4 medium, where anthers burst open and produced embryogenic callus. The frequency of response on the R3 medium was 36.70%. Cultivar HC1 also had a similar anther response on R3 medium, but on R4 medium its response was 42.0% which was lower than in BCID1. MS media with different concentrations of growth regulators were tried, and those supplemented with IAA (0.5 mg/litre) + BA [benzyladenine] (0.5 mg/litre) or NAA (0.2 mg/litre) + Kn [kinetin] (2 mg/litre) were found suitable for regeneration. When the callus was kept at 25±2°C in bright light (6000 lux) with a 16 h photoperiod, it turned green within 15 days and few plants regenerated. Their ploidy level will be confirmed and the information utilized in the interspecific hybridization programme using anther culture to fix the characters in the F1 generation.

Brassica juncea

1082 ABRAHAM, V; GEORGE, L; SRINIVASAN, VT. 1988. **Seed yield and oil content of mustard somaclones (*Brassica juncea (Linn., Czern. and Coss.)*).** *Current Science*, 57: 18, 1019; 6 ref.

A total of 92 first generations (SC1) somaclones were obtained from cultured cotyledon explants of cv. Rai 5. Plants with the highest yields in the SC1 were evaluated to the SC4. Yields from trials conducted during 1984-87, together with oil content data from 1986-87 are tabulated. Yields of somaclones with yellow seed coats were equivalent to those of Rai 5, while yields of black-seeded somaclones were inferior. All somaclones, except yellow-seeded Y2, had lower oil contents, (27.6-32.3%) than Rai 5 (32.2-32.8%). In Y2 it was 33.4%

1083 AGARWAL, PK; BHOJWANI, SS. 1993. **Enhanced pollen grain embryogenesis and plant regeneration in anther cultures of *Brassica juncea cv. PR-45*.** *Euphytica*, 70: 3, 191-196.

1084 AGGARWAL, RK; SHARMA, DR; MEHRA, HO; SINGH, RK. 1982. **Isolation and regeneration in mesophyll protoplasts of *Brassica juncea*.** *International Symposium on Plant Cell Culture in Crop Improvement*. (Calcutta: 1981: December)/edited by SK Sen and KL Giles. New York: Plenum Press, p. 491-495.

1085 AGNIHOTRI, ABHA; GUPTA, VIBHA; LAKSHMIKUMARAN, MS; RANADE, SA; SHIVANNA, KR; PRAKASH, SHYAM; JAGANNATHAN, V. 1988. **Production of *Eruca Brassica* hybrids by embryo rescue and DNA analysis of the hybrids.** *Cruciferae Newsletter*, No. 13: 84-85; 2 ref.

Emasculated flower buds of *E. sativa* [*E. vesicaria*] (n = 11) were pollinated with pollen from *B. campestris subsp. oleifera* (brown sarson; n = 10) and ovaries were cultured on MS medium supplemented with 1.0 p.p.m. kinetin, 0.1 p.p.m. NAA, 1.0 p.p.m. gibberellic acid and 10.0 p.p.m. casein hydrolysate. After 2 weeks, ovaries were dissected and globular ovules cultured on the same medium. The sole embryo (out of 34 subcultured) was transferred to MS based medium for callusing and then back to the supplemented medium. Following 7-8 further subcultures, numerous embryoids were obtained which were eventually transferred to pots containing soil and peat moss and grown to maturity under natural conditions. Acetocarmine staining of hybrids showed a chromosome number of 2n = 42 indicating that they were amphidiploids produced by doubling of chromosomes. The pollen fertility was 86% and the plants were self-fertile. These hybrids were intermediate between *Eruca* and *Brassica* in general morphological characteristics and growth pattern. The leaves were petiolate and small. The inflorescence was characteristic of *Brassica* with flowers at 45°. Petals were yellow like *Brassica* but flowers had a small style completely enclosed by anthers, typical of *Eruca*. Siliquas were intermediate between the two parents in respect of length of the valve and beak, and arrangement of pods on the axis. Hybrids had only one row of seeds as in *Brassica*, but seeds resembled *Eruca* (flat and brownish in colour). DNA analysis revealed that *B. campestris* satellite DNA hybridized to the DNA of *B. campestris* and the hybrids but not to that of *E. sativa*, clearly indicating the presence of the *B. campestris* genome. The 18S ribosomal DNA hybridization pattern showed that *E. sativa* has specific bands at 0.8 kb and 1.8 kb and *B. campestris* has a specific band at 2.6 kb. The hybrids had 0.8, 1.8 and 2.6 kb bands, showing the presence of both parental genomes.

1086 BANGA, SS; LABANA, KS; MEDHI, BN. 1984. ***Alternaria* incidence in some alloplasmic lines of Indian mustard (*Brassica juncea (L.) Coss.*).** *Theoretical and Applied Genetics*, 67: 2/3, 195-196; 9 ref.

The cytoplasmic substitution lines were evaluated for field resistance to *A. brassicae*. The euplasmic *B. juncea* RLM 198 had a mesothetic reaction while alloplasmic *B. juncea* lines with cytoplasms of *B. campestris*, *B. chinensis* and *B. japonica* were highly susceptible. *B. nigra* cytoplasm had no effect on disease reaction of the

B. juncea genome. However, the alloplasmic lines with *B. napus* and *B. carinata* cytoplasm, were more resistant. The results demonstrated the use of cytoplasmic manipulations in modifying phenotypic expression of nuclear genes.

1087 BANGA, SS; BANGA, SK; LABANA, KS. 1984. **Gametic gene transfer in Indian mustard (*Brassica juncea (L.) Coss.*)**. *Heredity*, 53: 2, 293-297.

Pollen of a strain having a homozygous dominant phenotype for 2 genetic markers was irradiated and used to pollinate 2 strains with the homozygous recessive phenotype for the same markers. All matromorphic M1 plants expressing any paternal marker were selfed to produce the M2. The M1 and M2 derived from pollinations with heavily irradiated pollen (25, 35 and 50 krad gamma radiation) showed a greater similarity with the maternal parent for both qualitative and quantitative traits than did the F1 and F2 derived from pollination with untreated pollen. In general, the similarity increased with radiation dosage. It is concluded that the transfer of paternal characters, and their expression in the maternal background, is random.

1088 BANGA, SS. 1985. **Mentor pollen aided hybridization between *Brassica hirta* and *Brassica juncea***. *Plant Cell Incompatibility Newsletter*, No. 17: 8-9.

B. hirta pollen was irradiated with 15-50 krad gamma rays. Emasculated buds of *B. hirta* were then pollinated with (1) a 1 : 1 mixture of irradiated self pollen and fresh pollen from *B. juncea* strain WF1 (homozygous recessive for white flowers) or (2) irradiated self pollen followed by pollination with fresh *B. juncea* pollen after 24 h. GA3 (20 p.p.m.) was applied to pollinated buds to prevent bud fall. In general, (2) gave the better results. The 15 krad treatment resulted in the highest set of normal seeds (4 in (1) and 10 in (2)). Of 23 normal seeds produced, 9 were self seed, 3 were haploid and 2 (from 15 krad treatment) were hybrid, but resulted in sterile plants.

1089 BIJRAL, JS; GUPTA, BB; SINGH, K; SHARMA, TR. 1992. **Interspecific hybridization between *Brassica juncea (L.) Czern and Coss* and *Brassica hirta Moench***. *Indian Journal of Genetics and Plant Breeding*, 51: 4, 476-478.

1090 CHATTERJEE, G; SIKDAR, SR; DAS, S; SEN, SK. 1985. **Regeneration of plantlets from mesophyll protoplasts of *Brassica juncea (L.) Czern.***. *Plant Cell Reports*, 4: 5, 245-247; 22 ref.

In a suitable growth medium containing 2,4-D, NAA, BA and coconut milk, isolated mesophyll protoplasts of *B. juncea cv. RLM 514* regenerated cell walls, underwent cell division and formed cellular colonies. Subsequent induction of embryoid (embryogenesis) and shoot bud (organogenesis) formations in such cell masses resulted in regeneration of 186 and 42 plantlets, resp., with plantlet formation frequencies of 20-25 and 5-10%

1091 CHOPRA, VL. 1990. **In-vitro genetic modification of crop *Brassicas*: a case study of application of biotechnology for crop improvement**. *Technology blending and agrarian prosperity*/edited by JP Verma, A Varma. New Delhi: Malhotra Publishing House, p. 47-59; 15 ref.

Examples are given of the work of the Biotechnology Centre of the Indian Agricultural Research Institute in the use of biotechnological methods in *Brassica* breeding. The areas covered are somaclonal variation, interspecific hybridization (with regard to introgression of seed shedding resistance and cytoplasmic male sterility into cultivated varieties), somatic embryogenesis, protoplast culture and fusion, in vitro selection in *B. juncea* for salt tolerance and resistance to *Alternaria brassicae* toxin, and restriction fragment length polymorphism.

1092 DAS, MK; RAHMAN, L; QUDDUS, MA. 1984. **Correlation and path analyses in parents and F3 of *Brassica juncea* X *B. campestris***. *Bangladesh Journal of Agriculture*, 9: 2, 1-12; 12 ref.

An analysis of data on seed yield/plant and 9 yield-related characters is presented. The strongest direct effects on yield were given by primary branch number in *B. juncea*, siliqua number and seeds/siliqua in *B. campestris* and siliqua number in the F3, suggesting that the influence of *B. campestris* on the hybrid was greater than that of *B. juncea*.

1093 GEORGE, L; SURYAVANSHI, DR; SIPAHIMALANI, AT; SRINIVASAN, VT. 1985. **Oil content and fatty acid composition of mustard seed (*Brassica juncea L.*) obtained through tissue culture**. *Proceedings of the Indian National Science Academy, Part B: Biological Sciences*, 51: 4, 511-514; 8 ref.

Oil content in seeds and fatty acid composition of oil of *B. juncea cv. Rai-5* obtained in vitro on cotyledon explants from non-irradiated and irradiated seeds were determined after growing the plants in the field for 2 generations. Oil content was determined by pulsed NMR technique. An increase in oil content was observed in the yellow variants obtained from cotyledons of non-

irradiated seeds. Fatty acid composition of the oil from various plants was determined by GLC. Although some reduction was noticed in the erucic acid content of some plants, most of them had a fatty acid composition comparable to that of Rai-5.

1094 JAIN, RK; GUPTA, SS; SHARMA, DR; CHOWDHURY, JB. 1987. **A dwarf mutant among in vitro regenerated plants of Indian mustard (*Brassica juncea L.*)**. *Cruciferae Newsletter*, 12: 78-79.

1095 JAIN, RK; CHOWDHURY, JB; SHARMA, DR. 1989. **High frequency regeneration in cotyledonary tissue of *Brassica juncea* under in vitro conditions**. *Euphytica*, 40: 75-81.

1096 JAIN, RK; SHARMA, DR; CHOWDHURY, JB. 1986. **In vitro high frequecny regeneration in *Brassica juncea* var. Prakash**. *Recent Advances in Plant Cell and Tissue Culture of Economically Important Plants: National Symposium*. (Osmania University, Hyderabad: 1986: July 24-26). p. 87.

1097 JAIN, RK; JAIN, S; NAINAWATEE, HS; CHOWDHURY, JB. 1990. **Salt-tolerance in *Brassica juncea L.* I. In vitro selection, agronomic evaluation and genetic stability**. *Euphytica*, 48:2, 141-152; 22 ref.

Of 2620 cotyledons of cv. Prakash screened for salt tolerance by culturing on medium with a high NaCl content, 3 survived and showed sustained growth and regenerated shoots. The selected shoots retained salt tolerance following 3 months of growth and multiplication on NaCl-free medium. Two of the somaclones (SR2 and SR3) flowered and set seed while the third was sterile, grew slowly and had abnormal leaves. SR2 and SR3 were evaluated in field and greenhouse trials and compared with unselected somaclones. SR2 had reduced height, a longer reproductive phase and a higher 1000-seed weight than the other somaclones tested. Most of the regenerated plants bred true for their specific characteristics and showed a high degree of variation for the 6 characters studied. SR2 and SR3 differed in their salt-tolerance during vegetative and reproductive phases.

1098 JAIN, RK; SHARMA, DR; CHOWDHURY, JB. 1987. **Selection of NaCl tolerant plants from cultured cotyledons of *Brassica juncea***. *Cruc. Newslet.*, 11: 97.

1099 KATIYAR, RK; CHOPRA, VL. 1990. **Somaclonally induced earliness in a *Brassica juncea* germplasm accession with field resistance to important diseases**. *Plant Breeding*, 104: 3, 262-264.

During 1985/86, a spontaneous dwarf (≈2 m tall) which was relatively early flowering was found in a population of BEC286. It was free of symptoms of *Albugo candida* and *Peronospora parasitica*, and had a high degree of resistance to *Alternaria brassicae* and *A. brassicicola*. R2 progenies, raised from selfed somaclones via in vitro culture, were screened. One regenerant was vigorous during early growth, had increased branching and early flowering, and completed 50% flowering in 62 days in comparison with 56 days for Varuna and Pusa Bold. It also retained disease resistance and yielded nearly 88 g seed/plant (66 g in Varuna).

1100 KIRTI, PB; PRAKASH, SHYAM; CHOPRA, VL. 1991. **Interspecific hybridization between *Brassica juncea* and *B. spinescens* through protoplast fusion**. *Plant Cell Reports*, 9: 11, 639-642; 19 ref.

Hypocotyl-derived protoplasts of *B. juncea cv. RLM198* were fused with mesophyll protoplasts of *B. spinescens*, a wild species with desirable characteristics such as resistance to *Albugo candida*, salt tolerance and high photosynthetic rate, using polyethylene glycol. Fusion products were microscopically identified by characteristics of the protoplasts of both parents in the hybrid cells; they were colourless and vacuolated like the hypocotyl protoplasts and possessed chloroplasts of the mesophyll protoplasts. The heterokaryotic fusion frequency was around 5%. The frequency of calluses regenerating hybrid shoots was >10% of regenerating calluses. Putative somatic hybrids had morphological features characteristic of both parents. Twelve plants analysed cytologically possessed 52 chromosomes at meiosis, representing the complete genomes of *B. juncea* and *B. spinescens*. For esterase isoenzymes, the hybrids had bands of both the parents. Some hybrids, such as Rsp19, closely resembled *B. juncea* but had the chromosome number and isoenzyme bands of *B. spinescens*. Somatic hybrids had rudimentary, non-dehiscent anthers and completely sterile pollen. However, on backcrossing with *B. juncea*, 10 out of 12 plants produced seeds and about 100 plants were produced.

1101 KIRTI, PB; HADI, S; KUMAR, PA; CHOPRA, VL. 1991. **Production of sodium-chloride-tolerant *Brassica juncea* plants by in vitro selection at the somatic embryo level**. *Theoretical and Applied Genetics*, 83: 2, 233-237.

1102 KIRTI, PB; NARASIMHULU, SB; PRAKASH, S; CHOPRA, VL. 1992. **Production and characterization of intergeneric somatic hybrids of *Trachystoma***

ballii* and *Brassica juncea. *Plant Cell Reports*, 11: 2, 90-92; 13 ref.

Intergeneric somatic hybrids were obtained by fusing mesophyll protoplasts of *T. ballii* and hypocotyl protoplasts of *B. juncea* using PEG. The heterokaryotic fusion frequency was around 23%. Plants were regenerated from 10 out of 2 X 104 calluses of which 4 were hybrids. Hybrids were intermediate between the parents in general morphology although for some characters one of the parents dominated. All the plants were symmetric in their chromosomal constitution as revealed by the formation of 26 bivalents at metaphase I of meiosis. Two trivalents and 2 univalents were also observed in some PMCs. Hybrid nature was also confirmed by Southern hybridization of DNA of one regenerated plant restricted with HindIII and probed with the nick translated plasmid pTA71 carrying a wheat nuclear rDNA sequence. Hybrid plant RT1 showed bands characteristic of both parents. All the plants were absolutely pollen sterile. However, on backcrosses to *B. juncea* seeds were obtained.

1103 KIRTI, PB; CHOPRA, VL. 1990. **Rapid plant regeneration through organogenesis and somatic embryogenesis from cultured protoplasts of *Brassica juncea***. *Plant Cell, Tissue and Organ Culture*, 20: 1, 65-67; 11 ref.

Protoplasts derived from hypocotyls of seedlings grown on half-strength MS medium containing 1% sucrose were cultured at a density of 5 X 104/ml in Kao's medium supplemented with 1.0 mg 2,4-D, 0.1 mg NAA and 0.5 mg zeatin riboside/litre. After 3 days of culture in darkness at 25 $\pm$ 1°C, cultures were transferred to light (70 μEm-2s-1) in a 16/8 h light/dark cycle. Cultures were diluted on the 7th, 10th and 13th day with Kao's medium containing 3.4% sucrose, 0.1 mg 2,4-D and 1.0 mg benzyladenine/litre. On the 15th day, microcalluses were plated on K3 medium gelled with 0.5% agarose. After a further period of 2 weeks, transfers were made to specific media to achieve either organogenesis or somatic embryogenesis. Time taken from plating protoplasts to obtaining plantlets was 8-10 weeks. Using this procedure, several hundred regenerated plants have been hardened in a growth chamber and transferred to soil.

1104 KIRTI, PB; CHOPRA, VL. 1988. **Regeneration through shoot organogenesis and somatic embryogenesis in hypocotyl protoplast culture of mustard *Brassica juncea (L.) Czern and Coss***. *Cruciferae Newsletter*, No. 13: 96.

Hypocotyl protoplasts were cultured on 8p (Kao & Michayluk) medium supplemented with glucose, 2,4-D, NAA and zeatin riboside. The protoplast suspension was then transferred to petri dishes, incubated for 3 days in darkness at 24°C, then at 25° in a 16/8 h photoperiod on day 4 and finally diluted on days 8 and 11 with 8p medium containing sucrose, 2,4-D and BAP (benzylaminopurine [benzyladenine]). Colonies were plated on K3 medium with 2,4-D, BAP and sucrose. Calluses of 3-5 mm diameter were plated on MS medium with sucrose, IAA, zeatin riboside and BAP. Out of 792 calluses plated, 340 produced multiple shoots giving a regeneration frequency of about 44%. Somatic embryogenesis was also observed in primary cultures, occurring at a frequency of up to 0.0002%. The frequency increased when small calluses were plated on MS medium with sucrose, 2,4-D, NAA and BAP-riboside. About 10% of the calluses produced embryoids.

1105 KIRTI, PB; NARASIMHULU, SB; PRAKASH, S; CHOPRA, VL. 1992. **Somatic hybridization between *Brassica juncea* and *Moricandia arvensis* by protoplast fusion**. *Plant Cell Reports*, 11: 5-6, 318-321; 19 ref.

Hypocotyl protoplasts of *B. juncea* (2n=36, AABB) were fused with mesophyll protoplasts of *M. arvensis* (2n = 28, MM) using polyethylene glycol. Fusion frequency, estimated on the basis of differential morphological characteristics of parental protoplasts, was about 5%. Of the 156 calluses obtained, 4 produced shoots intermediate in morphology between the parents. Hybrid nature of the plants was confirmed using a wheat nuclear rDNA probe. Hybridization of total DNA with a mitochondrial DNA probe carrying 5S-18S rRNA genes of maize showed that the mitochondria of the somatic hybrids were derived from the wild species *M. arvensis*. Meiosis in the only hybrid that produced normal flowers revealed the occurrence of 64 chromosomes, the sum of chromosomes of the parental species. In spite of complete pollen sterility, siliquas were produced in this hybrid by backcrossing to *B. juncea*.

1106 MAHAPATRA, D; BAJAJ, YPS. 1984. **In vitro hybridization in an incompatible cross - *Brassica juncea* X *Brassica hirta***. *Current Science*, 53: 9, 489-490; 2 ref.

Flowers of *B. juncea* (2n = 36) and *B. hirta* (2n = 24) were cross pollinated two days after emasculation and 10-15-day-old ovules were excised and cultured on a supplemented Murashige & Skoog medium. Plantlets from the hybrid ovules had 2n = 30.

1107 MATHEWS, VH; BHATIA, CR; MITRA, R; KRISHNA, TG; RAO, PS. 1985. **Regeneration of shoots from *Brassica juncea* (Linn) Czern and Coss cells transformed by *Agrobacterium tumefaciens* and expression of nopaline dehydrogenase genes**. *Plant Science*, 39: 1, 49-54; 28 ref.

Tumours formed on plants inoculated with *A. tumefaciens* strain A208 (containing the nopaline plasmid pTiT37) were cultured in vitro. Cultures free of bacteria were obtained after 3-4 subcultures on Murashige & Skoog (MS) medium containing streptomycin. Axenic cultures of tumour tissue grew on hormone-free MS medium. Spontaneous shoot regeneration was observed in some cultures, but the regenerated shoots did not produce roots, even in the presence of root-promoting hormones. Leaf explants from the regenerated shoots, cultured on hormone-free MS medium, formed callus at the base and at the sites of injury on the lamina. Axenic cultured tumour tissue showed the presence of nopaline and nopaline dehydrogenase activity and the regenerated shoots and leaves were nopaline positive.

1108 PRABHUDESAI, V; BHASKARAN, S. 1993. **A continuous culture system of direct somatic embryogenesis in microspore-derived embryos of *Brassica juncea***. *Plant Cell Reports*, 12: 5, 289-292.

1109 PRAKASH, S; CHOPRA, VL. 1990. **Male sterility caused by cytoplasm of *Brassica oxyrrhina* in *B. campestris* and *B. juncea***. *Theoretical and Applied Genetics*, 79: 2, 285-287; 13 ref.

The synthetic alloploid from *B. oxyrrhina* (a wild species from Morocco) (2n = 18, genomes OO) X *B. campestris* brown sarson (2n = 20, AA) was repeatedly backcrossed with *B. campestris* to transfer the *B. campestris* nucleus into the *B. oxyrrhina* cytoplasm. Alloplasmic plants obtained in the BC5 generation were stably male-sterile but mildly chlorotic during initial development. When the synthetic alloploid was hybridized with *B. juncea* to transfer *B. oxyrrhina* cytoplasm, segregation for green and chlorotic plants was observed in the BC1 and BC2 generations. By selection, however, normal green male-sterile *B. juncea* was obtained in the BC3. Pollen abortion in both *B. campestris* and *B. juncea* is post-meiotic.

1110 PUA, EC. 1990. **Somatic embryogenesis and plant regeneration from hypocotyl protoplasts of *Brassica juncea (L.) Czern & Coss***. *Plant Science Limerick*, 68: 2, 231-238; 38 ref.

Hypocotyl protoplasts of cultivars Leaf Heading and India Mustard divided rapidly and gave rise to proembryoids at frequencies of 3-6% and 15-20%, respectively, after 17 days on MS medium supplemented with 6% glucose and benzyladenine (BA) in combination with 2,4-D each at 1 or 2.5 μM. Abundant plantlets were regenerated from embryogenic cultures of India Mustard grown on hormone-free medium, whereas regeneration of Leaf Heading was low. The presence of 30 μM AgNO3 in conjunction with 10 μM BA and 2.7 μM NAA considerably enhanced plant regeneration of Leaf Heading. After acclimatization all protoplast-derived plants of India Mustard and 91% of those of Leaf Heading were phenotypically normal.

1111 SAXENA, HK; SINGH, LALLAN. 1982. **Effect of IAA and GA on growth and rooting of apical fragments of *Brassica juncea L.* (*Czern & Coss*)**. *Indian Journal of Plant Physiology*, 25: 4, 330-335; 15 ref.

GA increased the elongation of hypocotyls, epicotyls and leaf petioles in the apical fragments of *B. juncea* seedlings. IAA showed significant influence only on epicotyl elongation but the effect was less pronounced than that of GA. There was no synergism between the effects of GA and IAA except on epicotyl elongation. GA was inhibitory for both the formation and elongation of the roots. IAA did not increase the formation of roots and at a higher dose reduced their elongation. IAA at the higher dose showed a slight moderating influence on the effects of 40 p.p.m. GA on root formation.

1112 SEKHON, MS; GUPTA, VP. 1992. **Seed isozyme differences of parents and single cross performance in Indian mustard (*Brassica juncea L.*)**. *Journal of Genetics and Breeding*, 46: 3, 203-208.

Sixteen diverse Indian mustard genotypes and their crosses were analysed for enzyme and morphological diversity patterns. Isozyme based genetic distances between parents were found to have a strong relationship with hybrid performance for several economically important traits. The study indicated that isozymes can complement morphological criteria in the identification of suitable parents for Indian mustard breeding programmes. However, reliability of isozyme predictions when made in light of pedigree backgrounds, depended upon the tester used and character for which predictions were made.

1113 SHARMA, KK; BHOJWANI, SS; THORPE, TA. 1990. **Factors affecting high frequency differentiation of shoots and roots from cotyledon explants of *Brassica juncea (L.) Czern***. *Plant Science Limerick*, 66: 2, 247-253; 18 ref.

Maximum differentiation of adventitious shoot buds occurred when the explants derived from 5-day-old seedlings of cv. RIK81-1 were cultured on MS medium containing 5 μM benzyladenine (BA). On MS alone only roots were formed. Shoot or root formation was restricted to 1-2 mm of tissue at the cut end of the petiole. Organogenesis occurred only if the proximal cut end of the petiole was in contact with the medium. The lamina did not exhibit organogenesis. Cotyledons cultured for up to 3 days on root induction medium (MS), still retained their full potential to form shoots upon transfer to MS medium containing BA. With longer incubation on MS medium the shoot-forming capacity of the explants declined, and after 8 days it was completely lost. When applied through the agar medium, BA (5 μM) was required for at least 7 days for shoot bud induction.

1114 SHARMA, KK; BHOJWANI, SS. 1989. **Histological and histochemical investigations of pollen embryos of *Brassica juncea (L.) Czern*.** *Biologia Plantarum*, 31: 4, 276-279; 19 ref.

Ten pollen embryos of *Brassica juncea cv. RIK-81-1* obtained through anther culture, were examined histologically and histochemically to find an explanation for their inability to germinate normally like a zygotic embryo. Most of the embryos lacked a distinct plumule or both plumule and radicle. Another abnormal feature of these embryos was the degeneration of cells in the hypocotyl and radicle, which occurred either through lysis or cell shrinkage. Reserve food material was mainly in the form of protein bodies and starch grains. Unlike the zygotic embryos, the pollen embryos lacked lipids. It is concluded that the inability of the pollen embryos to germinate normally is due to their structural abnormalities and physiological immaturity.

1115 SHARMA, KK; BHOJWANI, SS. 1985. **Microspore embryogenesis in anther cultures of two Indian cultivars of *Brassica juncea (L.) Czern*.** *Plant Cell, Tissue and Organ Culture*, 4: 3, 235-239; 13 ref.

Preliminary anther culture at 35°C for 1-5 days or 5°C for 3 days prior to maintenance at 25°C stimulated Embryogenesis from microspores. Squashes revealed that approximately 10% of the microspores began dividing but less than 1% gave macroscopic embryoids. All embryoids transferred to an embryo-culture (B5) medium survived, but only 30% of these subsequently gave normal plantlets, all of which were haploid.

1116 SHARMA, KK; BHOJWANI, SS; THORPE, TA. 1991. **The role of cotyledonary tissue in the differentiation of shoots and roots from cotyledon explants of *Brassica juncea (L.) Czern*.** *Plant Cell, Tissue and Organ Culture*, 24: 1, 55-59; 19 ref.

The influence of the cotyledonary lamina on regeneration of shoots and roots from the cut end of the petiole was studied in *B. juncea* cotyledon cultures. Lamina tissue was surgically removed from the cotyledon explants at 0-10 d after culturing on either root-forming (basal medium) or shoot-forming (basal medium containing 5.0 μM N6-benzyladenine) media. Differentiation of roots or shoots from petioles depended on the presence of the lamina for at least 7 d of culture. Quantitative removal of the laminar tissue had a corresponding negative effect on shoot bud differentiation from the petiole. The 'lamina factor' was auxin-like.

1117 SHARMA, TR; SINGH, BM. 1992. **Transfer of resistance to *Alternaria brassicae* in *Brassica juncea* through interspecific hybridization among *Brassicas*.** *Journal of Genetics and Breeding*, 46: 4, 373-378.

1118 SIKDAR, SR; CHATTERJEE, G; DAS, S; SEN, SK. 1990. **'Erussica', the intergeneric fertile somatic hybrid developed through protoplast fusion between *Eruca sativa Lam.* and *Brassica juncea (L.) Czern*.** *Theoretical and Applied Genetics*, 79: 4, 561-567; 16 ref.

Hypocotyl callus-derived protoplasts of the *B. juncea* (2n = 36) cultivars T59 and B85 were fused with normal as well as gamma-irradiated mesophyll protoplasts of *E. sativa* [*E. vesicaria*] (2n = 22). Irradiation of the *Eruca* fusion partner increased the plating efficiency as well as the morphogenic potentiality of the fusion products over normal fusion. Fertile plants were regenerated from such fusion products and analysis of 63 out of 181 plants regenerated showed that 11 somatic hybrids (2n = 58) and 10 partial somatic hybrids (2n = 50 to 56) were obtained. Pollen viability (0-82.9%) and seed set (0-50%) of the hybrids indicated their potential value for future studies.

1119 YADAV, RC; YADAV, NR; KUMAR, PR; SHARMA, DR. 1988. **Differential androgenic response in *Brassica juncea (L.) Czern and Coss*.** *Cruciferae Newsletter*, No. 13: 76; 5 ref.

Haploids were produced from the *B. juncea* cultivars PR15, RLM514, RS64 and RH30 and their hybrids with disease resistance source RC781 and aphid resistance source T6342 by culturing anthers containing uninucleate microspores from 2-3 mm sized buds. Cold pretreatments were given for 1, 3 and 5 days before culturing, followed by incubation at 37°C for 2 days. Of the 3

media tried, Nitsch and Gamborg's media did not produce any callus, but anthers burst open to produce androgenic callus on Keller medium. The response ranged from 0.2 to 20.3% in plants grown at 25°C without any temperature treatment. Cold pretreatment of the flower buds for 5 days along with elevated temperature treatments for 2 days was the most suitable for inducing callus in different genotypes. Disease resistance source RC781 showed the greatest response (27%). The hybrids showed a greater response than the parental genotypes. It was concluded that appreciable differences exist among genotypes within species. The better response of hybrids over parents was thought to indicate a heterotic effect for androgenesis, in line with previous observations.

Brassica napus

1120 AGNIHOTRI, A; SHIVANNA, KR; RAINA, SN; LAKSHMIKUMARAN, M; PRAKASH, S; JAGANNATHAN, V. 1990. **Production of *Brassica napus* X Raphanobrassica hybrids by embryo rescue: an attempt to introduce shattering resistance into *B. napus***. *Plant Breeding*, 105: 4, 292-299; 13 ref.

Raphanus sativus has hard pods at threshing time. In an attempt to transfer shattering resistance to *B. napus* (rape), Raphanobrassica (*R. sativus cv. Sweta* X *B. oleracea (cauliflower) cv. Early Kunwari*) was used as the male parent in crosses with *B. napus*. Plantlets were obtained by embryo rescue and were further multiplied in vitro by micropropagation of nodal segments. Morphology, cytology and DNA analysis confirmed the hybrid nature of these plants. They were backcrossed with *B. napus* and the progeny raised. Plants of BC1 and BC2 generations showed wide variation in morphology, chromosome number and pollen fertility. Some of the plants showed up to 95% pollen fertility and resistance to shattering, indicating the potential for developing *B. napus* with resistance to shattering.

1121 ANURADHA, G; CHOPRA, VL. 1989. **Genotypic differences in regeneration response of in vitro cultured roots of *Brassica juncea* and *Brassica napus***. *Genetic Manipulation in Plants*, 5: 1, 13-18; 8 ref.

Root segments about 2 cm long were taken from 3, 6 and 9-day-old seedlings of the *B. juncea* cultivars Varuna and Pusa Bold and the *B. napus* cultivars B054 and B015 and cultured on MS medium supplemented with NAA, benzylaminopurine [benzyladenine] and 3% sucrose. All segments cultured gave callus, but callus greening and subsequent regeneration depended on original seedling age regardless of species, genotype or concentration of medium supplements. Nine-day-old seedlings gave the best results. Within *B. juncea*, Pusa Bold responded better than Varuna while within *B. napus* B015 was superior to B054. Overall, *B. napus* (genomes AACC) gave a clearly better response than *B. juncea* (AABB).

1122 BAJAJ, YPS; MAHAJAN, SK; LABANA, KS. 1986. **Interspecific hybridization of *Brassica napus* and *B. juncea* through ovary, ovule and embryo culture**. *Euphytica*, 35: 1, 103-109; 10 ref.

Crosses were made between *B. napus* rape (2n = 38) cultivars RLM198 and RLM514 and *B. juncea* (2n = 36) *cv. Tower*. Ovaries, ovules and embryos were excised 2-9, 7-12 and 10-14 days after pollination, respectively, and cultured on supplemented Murashige & Skoog and White media. The cultured ovaries each produced 1-4 seeds, which germinated to produce hybrid plants. Plants were regenerated directly or via callus from ovule and embryo cultures. Hybrid plants had 37 chromosomes in their root tip cells and those derived from ovules and embryos produced seeds in the field. Plants generally resembled their maternal parent, but some morphological variants were observed.

1123 DHILLON, SS; LABANA, KS; BANGA, SK. 1985. **Root tumours in interspecific crosses of *Brassica***. *Cruciferae Newsletter*, No. 10: 27.

No seed was obtained when *Brassica napus* was used as the female in the cross with *B. juncea*, but there was good seed setting when *B. juncea* was used as the female. F1 plants were taller with more branches and pods than either parent, although there was a large variation in characters. Fertility was low and large root tumours were observed. No tumours existed on the roots of parents, and in F2 and F3 tumour formation was variable. Larger tumours were associated with lower seed setting.

1124 PRAKASH, S; CHOPRA, VL. 1990. **Reconstruction of allopolyploid brassicas through non-homologous recombination: introgression of resistance to pod shatter in *Brassica napus***. *Genetical Research*, 56: 1, 1-2; 10 ref.

Genetic resistance to shattering was introgressed into *B. napus* (rape) from *B. juncea* following allosyndetic pairing between chromosomes of the B and C genomes in the F1 of *B. juncea* X rape (2n = 37, AABC). Reconstituted rape showed regular meiosis with 19 bivalents and had pollen and seed fertility of 84 and 23%, respectively. An approach is suggested for achieving introgression from monogenomic diploids to

digenomic allopolyploids that exploits non-homologous recombination.

1125 QUAZI, HANIF M. 1982. **Suspension cultures of protoplasts from *Brassica***. *Nucleus, Pakistan*, 19: 3/4, 47-50; 7 ref.

About 77% of protoplasts obtained from *Brassica napus cv. Zephyr* (swede rape) and cv. Sensation (swede) and the cabbage Yates Prize Red regenerated cell walls within 36 h of culture on B5 medium at 26°C, but only 5% divided normally.

1126 SINGH, P; SINGH, DP; KUMAR, A; CHAUDHARY, BD. 1990. **Effect of interspecific hybridization, geographic origin and distribution on light interception, canopy temperature and seed yield of irrigated oilseed brassica**. *Indian Journal of Plant Physiology*, 33: 2, 101-107.

1127 ZAMAN, MW. 1990. **Introgression in *Brassica napus* for adaptation in Bangladesh.** *Proceedings of the First National Symposium on Plant Breeding in Bangladesh*. Plant Breeding and Genetics Society of Bangladesh, Dhaka, p. 164-173.

Reciprocal crosses with or without one direct backcross to *Brassica napus* have been carried out with the intention to transfer short day adaptability. The aim was to introgress the A genome of carefully selected early representatives of *Brassica campestris* and *B. juncea* with corresponding genome in *B. napus*, and similarly the C genome from *B. oleracea* and *B. carinata* with the analogous genome in *B. napus*, *B. campestris*, *B. juncea* and clearly later *B. oleracea var. alboglabra* and *B. carinata* seem to be almost equally effective for introgressing appropriate earliness for Bangladesh. One backcross slightly delayed segregation of early types. Convergent crosses did not result in transgression of earliness which was unexpected since the inheritance of flowering and maturity indicated polygenic regulation. This result is partly explained by assuming dominant oligogenic control of photoperiodic response. Introgression of earliness with C genome seems not necessarily related with the earliness of donor species. Intergenomic interactions may be important. Practically interesting lines were selected with high yield and probability that Bangladesh have a new oil crop.

Brassica nigra

1128 AGNIHOTRI, A; GUPTA, V; LAKSHMIKUMARAN, MS; SHIVANNA, KR; PRAKASH, S; JAGANNATHAN, V. 1990. **Production of *Eruca-Brassica* hybrids by embryo rescue**. *Plant Breeding*, 104: 4, 281-289; 17 ref.

About 10% (34) of the ovaries of *E. sativa* [*E. vesicaria*] (2n = 22) pollinated with pollen from brown sarson (*B. campestris subsp. oleifera*) (2n = 20) contained enlarged ovules, 3 of which produced embryos after culture. One of these produced embryogenic callus which yielded embryoids for up to 7-8 subcultures. The resulting hybrid plants were allotetraploids (2n = 42) and showed 21 bivalents at metaphase I of meiosis. Hybridization of total DNA of the hybrids with 2 probes, a *B. campestris* tandem repeat DNA and 18s ribosomal DNA of wheat confirmed that it was derived from the genome of both parents. The hybrids were self fertile and showed high fertility even in the A3 generation. Profuse pollen germination and pollen tube growth was noted in hybrid plants selfed or crossed with *B. juncea*, *B. campestris* or *B. nigra*. Small scale field trials indicated that selfed hybrids are comparable in yield (1.8 t/ha) to the high yielding *B. juncea cv. Pusa Bold* (2 t/ha), but with better disease and pest resistance.

1129 GOVIL, S; BABBAR, SB; GUPTA, SC. 1986. **Plant regeneration from in vitro cultured anthers of black mustard (*Brassica nigra Koch*)**. *Plant Breeding*, 97: 1, 64-71; 21 ref.

Anthers were excised from fresh or cold-pretreated buds and cultured on modified B5 medium containing 2-10% sucrose and supplemented with BA and 2,4-D. Embryoids developed on media containing 6% sucrose or more. These produced callus on transfer to Murashige & Skoog (MS) medium with 2% sucrose, and subsequently a few secondary embryoids differentiated. Shoots were produced by subculturing on MS medium as above supplemented with BA. Shoots were rooted on a medium containing NAA. Of 8 regenerated plants, 2 were haploid (n = 8), 5 diploid and one triploid.

1130 GUPTA, V; JAGANNATHAN, V; LAKSHMIKUMARAN, MS. 1990. **A novel AT-rich tandem repeat of *Brassica nigra***. *Plant Science Limerick*, 68: 2, 223-229; 33 ref.

A family of repeated DNA sequences was characterized by cloning and sequencing of a novel tandem repeat, different from any other known plant repetitive DNA sequences. Its monomeric unit was 348 bp and highly AT-rich (74%). The average copy number of the cloned repeat was 1 X 105 per haploid genome and constituted approximately 2.5% of the total *B. nigra* genome. It showed no sequence homology with the 177 bp satellite DNA sequences of other crucifers or with other plant tandem repeated DNA.

1131 GUPTA, V; LAKSHMISITA, G; SHAILA, MS; JAGANNATHAN, V; LAKSHMIKUMARAN, MS. 1992. **Characterization of species-specific repeated DNA sequences from *B. nigra*.** *Theoretical and Applied Genetics*, 84: 3-4, 397-402; 30 ref.

The construction and characterization of two genome-specific recombinant DNA clones from *Brassica nigra* are described. Southern analysis showed that the two clones belong to a dispersed repeat family. They differ from each other in their length, distribution and sequence, though the average GC content is nearly the same (45%). These B genome-specific repeats have been used to analyse the phylogenetic relationships between cultivated and wild species of the family *Brassicaceae [Cruciferae]*.

1132 GUPTA, VIBHA; AGNIHOTRI, ABHA; JAGANNATHAN, V. 1990. **Plant regeneration from callus and protoplasts of *Brassica nigra* (IC 257) through somatic embryogenesis.** *Plant Cell Reports*, 9: 8, 427-430; 19 ref.

Callus was initiated on MS medium containing kinetin and 2,4-D both at 1 p.p.m. Lowering of auxin levels induced embryoid formation. Supplementation with gibberellic acid (GA3) enhanced embryogenic response 10-fold. Culture in liquid medium devoid of growth regulators was essential for continued growth, while secondary embryoids were produced on transfer to solid basal medium. Embryogenic callus retained its morphogenic ability even after 12 subcultures. Both primary and secondary embryoids produced fertile plantlets. Hypocotyl-derived protoplasts were also regenerated to plants following the same protocol. The survival of plants on transfer to soil was about 80%

1133 GUPTA, VIBHA; AGNIHOTRI, ABHA; JAGANNATHAN, V. 1988. **Plantlet regeneration by somatic embryogenesis in *Brassica nigra*.** *Cruciferae Newsletter*, No. 13: 92-93; 5 ref.

Pale yellow globular callus tissue was obtained on MS medium supplemented with 3% sucrose and 1 p.p.m each of kinetin and 2,4-D. Torpedo shaped somatic embryos developed upon transfer to media containing 1 p.p.m. kinetin and 0.05 p.p.m. 2,4-D or 0.1 p.p.m. NAA. Media without auxins failed to induce embryogenesis. NAA gave better results than 2,4-D, and adding 1.0 p.p.m. gibberellic acid markedly enhanced embryoid formation. Embryoids arose after 6-7 subcultures on a medium containing kinetin, NAA and GA. Embryoids produced on this medium after subculturing in solidified MS basal medium without phytohormones gave rise to 6-7 secondary embryoids from the hypocotyl and cotyledonary region. These were similar to the primary embryoids during subsequent growth and development into plantlets. On liquid MS basal medium without hormones both embryoid types readily developed roots and shoots. Upon transfer to solidified MS medium and then to sand and peat moss soil, 90% of the embryoids survived to produce plantlets of which about 90% flowered and set seeds. These germinated normally and produced viable plants.

1134 HARBINDER, S; GUPTA, V; LAKSHMIKUMARAN, M. 1992. **Fluidity of the 350 bp tandemly repeated DNA family of *Brassica nigra*.** *Plant Molecular Biology*, 18: 6, 1213-1216; 15 ref.

It is reported that 2 subfamilies of the 350 bp tandem repeat DNA sequence exist in *B. nigra*. Nucleotide sequences are presented for 6 cloned units of the *B. nigra* tandem repeats, which were grouped into 2 subfamilies, p and q, on the basis of monomeric units having ≥90% similarity. Consensus nucleotide sequences for the p and q subfamilies have been submitted to the EMBL/GenBank/DDBJ databases under the accession numbers X59430 and X59431. The different monomeric units are highly heterogenous in nucleotide sequence. There are 4 regions of 10 bp or more which are conserved in sequence in all 6 clones. It is suggested that the monomeric units may have differentiated by mutation or other mechanisms during evolution and that during periods of active retroposition monomeric units could have been differentially amplified causing the divergence into subfamilies.

1135 NARASIMHULU, SB; KIRTI, PB; PRAKASH, S; CHOPRA, VL. 1993. **Rapid and high frequency shoot regeneration from hypocotyl protoplasts of *Brassica nigra*.** *Plant Cell, Tissue and Organ Culture*, 32: 1, 35-39.

1136 NARASIMHULU, SB; KIRTI, PB; PRAKASH, S; CHOPRA, VL. 1992. **Somatic embryogenesis in *Brassica nigra (Koch)*.** *Journal of Experimental Botany*, 43: 254, 1203-1207; 18 ref.

B. nigra cv. IC 257, BEC 158, BEC 164 and BEC 165 were tested for their ability to produce somatic embryos in vitro. Seedling-derived hypocotyl.

Brassica oleracea

1137 HARBINDER, S; LAKSHMIKUMARAN, M. 1990. **A repetitive sequence from *Diplotaxis erucoides* is highly homologous to that of *Brassica campestris* and *B. oleracea*.** *Pl. Mol. Biol.*, 15:1, 155-156; 10 ref.

Sequences are presented for 3 of the repeats and their consensus sequence from a tandemly repeated DNA family of *D. erucoides*, a wild relative of *Brassica*. Restriction sites are indicated. The repeat had a G+C content of 39% and showed 96 and 94% homology with repeats from *B. campestris* and *B. oleracea* respectively.

1138 HOSSAIN, MM; ASAHIRA, T. 1992. **Development of heat tolerant somatic hybrids by peg-mediated protoplasts fusion between *Brassica oleracea* and *Brassica campestris L.***. *Pl. Tissue Culture*, 2:2, 61-69.

A good number of heat tolerant somatic hybrids have been developed through protoplast fusion by polyethylene glycol (PEG) between cabbage cv. Yoshin (*Brassica oleracea L. var. capitata*) and Chinese cabbage cv. Kenshin (*B. campestris L. var. pekinensis*). The plant morphology of the somatic hybrids was intermediate between the parents. The somatic hybrids formed head and produced seeds under tropical conditions. Thirty per cent (w/v) PEG of higher molecular weight (6000 MW) induced 23.8% protoplasts fusion compared to 16.17% induced by PEG of lower molecular weight (1540 MW) with high pH and high calcium solution. The hybrid nature of the somatic hybrids has been confirmed through both cytological study and isozyme marker.

1139 MUKHOPADHYAY, A; TOEPFER, R; PRADHAN, AK; SODHI, YS; STEINBISS, HH; SCHELL, J; PENTAL, D. 1991. **Efficient regeneration of *Brassica oleracea* hypocotyl protoplasts and high frequency genetic transformation by direct DNA uptake**. *Plant Cell Reports*, 10: 8, 375-379.

1140 PRAKASH, S; RAUT, RN. 1983. **Artificial synthesis of *Brassica napus* and its prospects as an oilseed crop in India**. *Indian Journal of Genetics and Plant Breeding*, 43: 2, 282-290; 13 ref.

In order to produce early types, amphidiploids of *B. napus* (2n = 38, AACC) were synthesized by crossing early indigenous strains of *B. campestris subsp. oleifera var. brown sarson* (2n = 20, AA) with *B. oleracea var. botrytis* (2n = 18, CC). Some selected genotypes in generation A16 outyielded controls and possessed desirable yield-contributing characters such as high number of siliquas/main branch. Maturity ranged from 140 to 154 days, which is similar to the range for *B. juncea* and fits well into the cropping pattern. The selections were highly tolerant of *Lipaphis erysimi*, *Alternaria brassicae* and frost.

1141 SETHI, U; BASU, A; MUKHERJEE, SG. 1990. **Phosphatidylinositol turnover in *Brassica* cultures and its stimulation by amino acids and polyamines**. *Phytochemistry*, 29: 3, 825-828.

1142 SETHI, URMIL; BASU, ATANU; MUKHERJEE, SIPRA GUHA. 1990. **Control of cell proliferation and differentiation by modulators of ethylene biosynthesis and action in *Brassica* hypocotyl explants**. *Plant Science Limerick*, 69: 2, 225-229; 12 ref.

Proliferation in cauliflower cell cultures was induced by ethylene precursors S-adenosylmethionine or 1-aminocyclopropane-1-carboxylic acid with concomitant increase in the ethylene level, while the inhibitors of ethylene biosynthesis aminoethoxyvinylglycine and cobalt chloride, and the ethylene antagonist silver nitrate, induced a higher percentage of shoot differentiation, with reduced ethylene level, compared to the hormone control. Putrescine, spermidine and the amino acids L-methionine or L-threonine, which increased proliferation, enhanced ethylene emanation as compared to the differentiating cultures raised on methylglyoxal-bis-(guanylhydrazone), L-leucine or L-isoleucine.

1143 SHARMA, DR; GUPTA N; BHASKARAN, S. 1974. **Cell wall regeneration and colony formation in protoplast of *Brassica oleracea***. *Proc. Symp. Biological Approach problems in medicine industry and Agriculture*. (BARC, Bombay: 1974: March 12-14). Bhaba Atomic Research Centre, Bombay, India. p. 39-44.

Carthamus

1144 GEORGE, L; RAO, PS. 1982. **In vitro multiplication of safflower (*Carthamus tinctorius L.*) through tissue culture**. *Proceedings of the Indian National Science Academy, Part B: Biological Sciences*, 48: 6, 791-794; 6 ref.

Hypocotyl and cotyledonary explants from three varieties were aseptically cultured on Murashige and Skoog (MS) basal medium supplemented with various growth regulators. Multiple shoot-bud regeneration was induced in NP 9 Black and Th10 Black. Shoot buds were induced to root on MS medium with increased amounts of sucrose and complete plantlets were obtained.

1145 GOYAL, SC; PILLAI, A. 1983. **Formation of negatively-geotropic roots in shoot apex cultures of *Carthamus tinctorius Linn.***. *Current Science*, 52: 22, 1061-1062; 6 ref.

Safflower shoot apex segments were cultured on Murashige and Skoog medium supplemented with kinetin + NAA at (a) 0.04 + 1.5, (b) 0.08 + 1.5, (c) 0.04 + 3

and (d) 0.08 + 3 mg/l. Profuse callus formation occurred in media (a), (b) and (d). Negatively-geotropic roots in large numbers were formed in medium (c). Subculturing on the same medium showed a continued production of the negatively-geotropic roots; some of the longer roots were diageotropic.

1146 PRASAD, BR; KHADEER, MA; SEETA, P; ANWAR, SY. 1991. **In vitro induction of androgenic haploids in safflower (*Carthamus tinctorius L.*)**. *Plant Cell Reports*, 10: 1, 48-51; 11 ref.

Anthers of 10 genotypes were cultured on 5 different basal media. Callus induction, which was best on MS medium, ranged from 18.9% in genotype EC47006 to 48.6% in cv. Mangira. Callus induction was also enhanced by pre-treatment of anthers at 5°C for 3-5 days. Anthers of field-grown plants were more responsive than those of greenhouse-grown plants. Shoot regeneration occurred on MS medium supplemented with 2 mg benzyladenine and 0.5 mg NAA/litre. Root formation occurred on half-strength MS medium supplemented with 0.1 mg NAA/litre and 1% sucrose. Cytological studies showed that most regenerants (64%) were haploids.

1147 TEJOVATHI, G; ANWAR, SY. 1984. **In vitro induction of capitula from cotyledons of *Carthamus tinctorius* (safflower)**. *Plant Science Letters*, 36: 2, 165-168; 5 ref.

In vitro capitulum induction occurred in cultivars Mangira and A1 on supplemented Murashige & Skoog medium from the inner surface of the cotyledons. Florets in a capitulum flowered within 55-90 days of inoculation. The pollen fertility of florets ranged from 90 to 95%. Embryo development was normal and a few seeds were recovered.

Helianthus annuus

1148 BHATTACHARJEE, A; BHATTACHARYYA, RN. 1988. **Invigoration of deteriorating sunflower seeds by chlormequat**: *Environment and Ecology*, 6: 1, 9-15; 32 ref.

The viability of sunflower seeds subjected to accelerated aging at 95% RH and 30 ± 1°C decreased progressively with increase in the duration of the treatment from 0 to 40 days. Seed treatment with 1000 μg chlormequat-/ml slowed down the progressive decrease in germination percentage and seedling vigour (root and shoot length, seedling DM). Chlormequat altered metabolism of the seeds; it significantly slowed down the progressive decrease in DNA and RNA levels and dehydrogenase and catalase activities in the cotyledons subjected to accelerated aging.

1149 BOSE, G; GHOSH, BN; BOSE, PC. 1988. **Changes in the nucleic acid content and the nucleotide composition of rRNA and sRNA of the cotyledon and embryonic axis of germinating sunflower (*Helianthus annuus L.*) seeds**. *Current Science*, 57: 21, 1166-1169; 12 ref.

Nucleic acid content decreased in sunflower cotyledons (cv. Peredovik) during germination with a concomitant decrease in the DNA : RNA ratio. In the embryonic axis nucleic acid content increased together with the DNA : RNA ratio. No appreciable changes in rRNA : sRNA ratios were observed in either tissue during germination. However nucleotide composition of both RNA types altered as germination progressed in the embryonic axis but not the cotyledons. Similar changes occurred in the purine : pyrimidine and (A + U)/(G + C) ratios.

1150 KAMAL, R. 1986. **Histamine forming capacity of *Helianthus annuus L.* suspension cultures**. *Pharmazie*, 41: 6, 443-444; 16 ref.

Cultures obtained from seeds were grown on revised Murashige and Skoog medium supplemented with 0.025, 0.05 or 0.1% L-histidine and were harvested after 2, 4 or 6 weeks. All tissue and medium samples contained histamine, which generally increased with age. Maximum histamine content (1.2%) was found in tissues grown with 0.05% histidine for 6 weeks.

1151 LUTHRA, R; MUNSHI, SK; SUKHIJA, PS. 1990. **Relationship of carbohydrate metabolism with lipid biosynthesis in developing sunflower (*Helianthus annuus L.*) seeds**. *Journal of Plant Physiology*, 137: 3, 312-318.

1152 NATARAJA, K; GANAPATHI, TR. 1989. **In vitro plantlet regeneration from cotyledons of *Helianthus annuus* cv. Morden (sunflower)**. *Indian Journal of Experimental Biology*, 27: 9, 777-779; 15 ref.

Cotyledonary segments without nodes were excised from seeds and placed on MS media containing various combinations and concentrations of plant growth regulators. Shoot bud differentiation was supported by (1) kinetin (KN) in combination with IAA, IBA or NAA or (2) BAP [benzyladenine] with IAA or IBA. The highest frequencies of shoot bud differentiation/culture were achieved using 5 mg KN + 5 mg IBA/litre (17.5 shoots/culture), 2 mg KN + 1 mg IBA/litre (11) and 2 mg BAP + 5 mg IAA/litre (10). Well developed shoot

buds were isolated from 4 week old cultures, transferred to hormone-free MS medium and successfully rooted in 3 weeks.

1153 PUNIA, MS; BOHOROVA, NE. 1992. **Callus development and plant regeneration from different explants of six wild species of sunflower (*Helianthus L.*)**. *Plant Science*, 87: 1, 79-83; 14 ref.

Stem, leaf, bud and cotyledon explants of six wild species, *H. nuttallii*, *H. mollis*, *H. debilis*, *H. divaricatus*, *H. maximiliani* and *H. praecox*, were cultured on MSD4 medium for callus development. Calluses were regenerated on MS medium supplemented with 1.0 mg benzyladenine, 0.1 mg gibberellic acid, 500 mg casamino acids and 40 mg adenine sulfate/litre (R medium). Regenerated plantlets were grown on MSD4 medium to form complete plants. The highest percentage (88.6%) of fully developed plants from callus regenerated plantlets was obtained from stem explants of *H. maximiliani*. Plants were rooted on MS basal hormone free and BGS media.

Linseed

1154 GHOSH, S; SHIVANNA, KR. 1984. **Interspecific incompatibility in *Linum***. *Phytomorphology*, 34: 1/4, 128-135; 12 ref.

Manual self pollination and cross pollination were carried out on 4 homomorphic (homostylous) species (L. africanum, *L. usitatissimum*, *L. angustifolium* and *L. galicanum*) and 3 heteromorphic (heterostylous) species (L. grandiflorum, *L. austriacum* and *L. perenne*). Interspecific pollination among homomorphic species resulted in seed set. Intermorph pollinations in heteromorphic species resulted in pollen germination and pollen tube growth within the ovules. Intramorph pollinations, whether within or between species, generally resulted in inhibition of pollen tube growth shortly after penetration of stigma tissue. Crosses between a homomorphic and a heteromorphic species showed unilateral incompatibility; pollen germination and pollen tube growth were normal when the homomorphic species were used as female parent but not in the reciprocal crosses. It is concluded that the S-allele system functions in both interspecific and intraspecific incompatibility.

1155 SINGH, NK; CHAUHAN, YS; KUMAR, K. 1991. **Detection of epistatic, additive and dominance variation in linseed (*Linum usitatissimum L.*)**. *Indian Journal of Genetics and Plant Breeding*, 51: 2, 264-267.

Machilus

1156 HAZANIKA, RL; BARNA, JN; DEKA, PC; SAMA, SC; KATAKY, JCS. 1994. **Flavonals of the leaves of Machilus bombycine king**. *Indian Journal of Heterocyclic Cleen*, 3: 139.

Methanolic extract of the leaves of *Machilus bombycina*-king has led to the isolation of three new flavonols alongwith quercetin (3) morin (5) and myrcetin (6) already known. The new falvonols are 3',4' - dimethylquercetin (1) 7,2'4' - trimethoxy - 3,5-dihydroxyflavone (2) and 2'4' - dimethylmorin (4) characterised on the basis of physical and spectral evidence.

1157 HUSAIKA, RL; BARUA, JN; DEKA, PC. 1994. **Chemical investigation of the essential oil of *Machilus bombycina***. *Indian Performer*, 38: 33-36.

Chemical composition of the essential oil in the leves of machilus bombycina king a host plant of Muga Silk work (Antheraea assama Westwood) was investigated by GC and GC-Mass Presence of 29 components was revealed out of which 10 components comprising 65.9% of the total oil were identified.

Ricinus communis

1158 ATHMA, P; REDDY, TP. 1983. **Efficiency of callus initiation and direct regeneration from different explants of castor (*Ricinus communis L.*)**. *Current Science*, 52: 6, 256-257; 4 ref.

2,4-D at 2 mg/l was more effective than BA or NAA at 0.5-2 mg/l in inducing callus in the excised shoot and cotyledonary leaf of castor seedlings, while BA was most effective in inducing root callus. The shoot explants treated with BA resulted in the development of whole plants within 10-20 days with a frequency of 25-30%. The root, shoot and leaf explants treated with 0.5 mg NAA/l produced differentiation of roots in addition to callus from the cut ends, while the higher conc. completely inhibited them.

1159 DUA, S; AMMA, MKP; SAREEN, KN. 1985. **Effect of intact embryo and gibberellic acid on the breakdown of water-soluble proteins in germinated castor (*Ricinus communis L.*) seed**. *Indian Journal of Plant Physiology*, 28: 1, 96-98; 10 ref.

The changes associated with protein and hemagglutinin activity in *R. communis* seed germinated for 96 h after soaking in 10-4 M GA or water (control) for 4 to 24 h showed that the breakdown of water-soluble proteins required an intact embryo. The early soaking period

exerted a profound influence on protein utilization by the developing embryo. The embryonic axis did not show direct control over the development of acid phosphatase activity, but GA stimulated this activity during imbibition.

Sesame

1160 BAPAT, VA; GEORGE, L; RAO, PS. 1989. **Isolation, culture and callus formation of sesame (*Sesamum indicum L.* cv. PT) protoplasts**. *Indian Journal of Experimental Biology*, 27: 2, 182-184; 7 ref.

Protoplasts were successfully isolated from callus and cell suspensions of sesame using an enzyme mixture consisting of cellulase, macerozyme and hemicellulase and were cultured on a modified MS medium supplemented with NAA and BA. Regeneration of cell wall occurred 72 h after culture and subsequent divisions resulted in multicellular colonies. Colonies from protoplasts isolated from callus necrosed eventually whereas protoplasts from cell suspension showed continued divisions leading to callus formation.

1161 CHEEMA, JS; GURDIP-SINGH; SINGH, G. 1987. **Biology of sesame leaf webber and capsule borer, *Antigastra catalaunalis (Duponchel) (Pyralidae: Lepidoptera)* in Punjab**. *Journal of Research, Punjab Agricultural University*, 24: 1, 65-74; 11 ref.

The biology of sesame pest *A. catalaunalis* was studied in the field and laboratory in Punjab, in 1979-80. The insect was active throughout the year and there were 12 overlapping generations. The incubation period of the eggs ranged from 2.0 days in May-August to 5.9 in mid-December to February. Egg viability averaged 78% in August-September. Larval development took 9.6 days in July and 30.5 days in December-January. There were 5 larval instars. The average larval survival was 79.9%. The optimum temperature for development and survival of the larvae was about 30°C. The pupal period lasted 4.1 days in August and 14.9 days in November, and mean pupal survival was 88. The oviposition and post-oviposition periods were 3.6 and 0.6 days, respectively, in June-August. The lifespan of the female was slightly longer (5.6-7.8 days) than that of the male. Females laid a mean of 17.8 eggs in mid-December to February and 84.9 in May-August. The female:male ratio was 1.5:1.0 in the laboratory and 1.22:1.0 in the field. Infestation of plants in the field was 28.5%, and flowers suffered greater infestation (27.8%) than pods (9.9%). The infested pods carried 53.1% less seed than healthy ones. Parasitism of larvae by *Trathala flavoorbitalis* reached a max. of 20% in July-August.

1162 GEORGE, L; BAPAT, VA; RAO, PS. 1987. **In vitro multiplication of sesame (*Sesamum indicum*) through tissue culture**. *Annals of Bot.*, 60:1, 17-21.

In a study directed towards developing in vitro selection methods tissue cultures were established from different parts of seedlings of the cultivar PT. Callus tissue derived from hypocotyl segments produced embryo-like structures. Shoot tips with cotyledons excised from 8 to 10-d-old seedlings produced multiple shoot buds on cytokinin-enriched MS [Murashige & Skoog] medium. Presoaking and germination of seeds in BA [benzyladenine] or 2iP (6- gamma,gamma-dimethylallylamino purine) (8 mg/litre) enhanced the development of shoot buds. On isolation and culture, the shoot buds formed rooted plantlets on MS medium enriched with 0.1% activated charcoal and 1 mg NAA/litre.

1163 GEORGE, L; BAPAT, VA; RAO, PS. 1989. **Plant regeneration in vitro in different cultivars of sesame (*Sesamum indicum L.*)**. *Proceedings of the Indian Academy of Sciences, Plant Sciences*, 99: 2, 135-137; 5 ref.

Seedling explants of 7 sesame cultivars were cultured on MS medium with 8 mg benzyladenine (BA)/litre. Multiple shoot buds were observed in shoot tip cultures of all cultivars, especially Hawary. Pretreatment of seeds with BA before germination increased the frequency of multiple shoot induction. BA was more effective than zeatin at inducing multiple shoots. The highest numbers of shoot buds/explant were obtained with BA in Hawary (15-18), PT (12-15) and N128 (12-15).

1164 KALRA, VK. 1985. ***Carcelia sp.* parasitising *Spilosoma obliqua (Walker)***. *Haryana Agricultural University Journal of Research*, 15: 4, 471-472.

The tachinid *Carcelia sp.* was found parasitizing larvae of the arctiid *Spilosoma obliqua* on sesame in field studies in Haryana, India, in 1980-81. The rate of parasitism was 16% in October-December. Generally only one parasite emerged from a larva, but in some cases 2 larvae of *Carcelia sp.* were observed in a single host. First- and 2nd-instar larvae of *S. obliqua* were the preferred stages for oviposition by *Carcelia sp.*, and in later instars of the host the parasite died or could not complete its life cycle. It is suggested that *Carcelia* could be used as a biological control agent for *S. obliqua*.

Other Oilseed plants

1165 CHATURVEDI, HC; SHARMA, M. 1989. **In vitro production of cloned plants of jojoba (*Simmon-***

***dsia chinensis (Link) Schneider*) through shoot proliferation in long-term culture**. *Plant Science Limerick*, 63: 2, 199-207; 21 ref.

A method for producing clones of known sexuality by in vitro proliferation of axillary buds was developed and standardized. An axillary bud of a nodal segment taken from a male or female plant was induced to proliferate in modified Schenk & Hildebrandt medium supplemented with 1 mg each of 6- benzylaminopurine [benzyladenine] (BAP) and IAA. On average, 5-8 shoots formed per single explant explant in the initial cultures, but the number of shoots in subsequent cultures increased to about 15 in medium with a low BAP content (0.5 mg per litre). About 90% of the isolated shoots rooted in medium supplemented with 7 mg IBA, 1 mg NAA and 1 mg caffeic acid per litre. Regenerated plants were hardened after transplantation to soil by gradually exposing them to decreasing humidity. About 80% of clones were successfully transplanted and grew normally and vigourously in soil.

1166 LEELAVATHI, S; REDDY, VS; SEN, SK. 1984. **Somatic cell genetic studies in *Brassica* species. I. High frequency production of haploid plants in *Brassica alba (L.) H. f. & T.*** *Plant Cell Reports*, 3: 3, 102-105; 30 ref.

In vitro culture of *Brassica [Sinapis] alba* anthers on a growth medium containing the inorganic compounds of medium KB5 and the organic compounds, iron, sucrose and hormones of medium B5 resulted in a very high frequency of callus formation (93.75%). After transfer of the callus to a regeneration medium, the number of embryoids and plantlets produced by one anther was 169.8 and 17, respectively. A total of 87% of the regenerated plants were haploid.

1167 PARKASH, SURYA; CHOWDHURY, JB; JAIN, RK. 1989. **Callus initiation and regeneration potential in different genotypes of *Eruca sativa***. *Current Science*, 58: 17, 979-980; 7 ref.

Cotyledonary leaves of the *E. sativa* [*E. vesicaria*] cultivars T27, TMH46 and TMH48 were cultured on MS medium supplemented with NAA, benzyladenine (BA) and kinetin in various combinations and concentrations. Best results were obtained using 2 mg kinetin or BA/litre and a low concentration of NAA. Highest regeneration frequencies were observed in T27 (9.8%).

1168 PETRI, G; KURSINSZKI, L; SZOKE, E. 1990. **Essential oil production in Matricaria tissue cultures influenced by different chemicals.** *Proceedings of the International Congress of Essential Oils, Fragrances and Flavours*. (New Delhi: 11th: 1989: Nov. 12-16)/edited by SC Bhattacharyya, N Sen, KL Sethi. London: Aspect Publishing, p. 35-41.

1169 RAJU, CR; SAJINI, KK; BALACHANDRAN, SM; SAJI, KV; MAHESHAN, KG; RAJASEKHARAN, PE; GEETHA, L; BAVAPPA, KVA. 1989. **Clonal multiplication of oil palm (*Elaeis guineensis Jacq.*)**. *Journal of Plantation Crops*, 16: Supplement, 17-20; 6 ref.

Leaf explants from 3-year-old seedlings grown on R medium supplemented with 20 mg 2,4-D and 0.1 mg benzyladenine/litre produced callus from veins at the cut surface after 2-3 weeks. By progressively replacing 2,4-D with NAA, bipolar and tripolar embryoids were obtained originating as white protuberances from beneath the callus surface. The germination of these somatic embryoids was comparable to that of zygotic embryos. Adventitious root formation was enhanced by addition of 0.01 mg IBA/litre.

1170 SARVESH, A; REDDY, TP; KISHOR, PBK. 1993. **Embryogenesis and organogenesis in cultured anthers of an oil yielding crop niger (*Guizotia abyssinica*. Cass)**. *Plant Cell, Tissue and Organ Culture*, 35: 1, 75-80.

1171 SARVESH, A; REDDY, TP; KISHOR, PBK. 1993. **Plant regeneration from cotyledons of niger**. *Plant Cell, Tissue and Organ Culture*, 32: 2, 131-135.

1172 SIKDAR, SR; SENGUPTA, SOMA; DAS, SRABANI; SEN, SK. 1990. **Plant regeneration from mesophyll protoplasts of *Diplotaxis muralis*, a wild crucifer**. *Plant Cell Reports*, 8: 12, 722-725; 20 ref.

Leaf mesophyll protoplasts from aseptically grown shoot tips (6.2-7.1 X 105 protoplasts/g fresh weight of tissue) were isolated using one-step enzyme digestion. The protoplasts (71% viability) underwent divisions (4.2 + 0.1%) on plating in M8PS2 medium and ultimately formed calluses with 0.45 + 0.03% plating efficiency. Plant regeneration could be achieved both through embryogenesis and organogenesis. The efficiency of plant regeneration through organogenesis was 9 times higher than through embryogenesis; 48 of 52 plants regenerated from 3 independent experiments were normal with respect to fertility and meiotic chromosomal behaviour, exhibiting 21 bivalents.

1173 THOMAS, V; RAO, PS. 1985. **In vitro propagation of oil palm (*Elaeis guineensis Jac. var. tenera*) through somatic embryogenesis in leaf-derived callus**.

Current Science, 54: No. 4, 184-185; 8 ref.

Callus was derived from leaf explants from 6-month-old plants cultured on MS medium supplemented with 2,4-D. After several subcultures on MS medium with sequentially reduced 2,4-D the callus formed nodular callus masses which were maintained on a supplemented half-strength medium as a continuous source for the induction of embryogenesis. Further subculturing on various MS media led to embryogenesis, shoot formation and rooting.

ESSENTIAL OIL PLANTS

1174 GOPALASWAMY, UV; NAIR, CKK. 1992. **DNA binding and mutagenicity of lindane and its metabolites**. *Bulletin of Environmental Contamination and Toxicology*, 49: 2, 300-305.

1175 KUMARI, NEENA; SARADHI, PP. 1992. **Regeneration of plants from callus cultures of *Origanum vulgare L.***. *Pl. Cell Reports*, 11:9, 476-479; 16 ref.

Investigations were undertaken to achieve rapid multiplication and improvement of *O. vulgare* through plant regeneration from callus. Cotyledon hypocotyl and root segment explants excised from 15 d old aseptic seedlings were cultured on B5 medium supplemented with 2,4-D, NAA and BAP individually and in various combinations (0, 10-7, 10-6 and 10-5 M). Highest callus induction (90%) was noted on medium with 10-7 M 2,4-D alone. Cotyledonary explants were the best source for compact and nodulated callus. Sub-cultured cotyledonary calluses showed shoot induction when transferred onto media supplemented with BAP alone or in combination with 10-7 M or 10-6 M NAA. However, 10-5 M NAA completely suppressed the shoot inducing ability of BAP. In general, NAA promoted root induction from all explants. Highest shoot induction (95%) was obtained on medium supplemented with 10-6 M BAP+10-6 M NAA. Both IBA and NAA at 10-6 M proved to be equally effective in induction of roots from the cut ends of 15-20 mm long shoots (excised from callus) in half-strength B5 liquid medium. Rooted shoots were successfully re-established in soil under controlled conditions.

1176 LAVANIA, UC. 1985. **Nuclear DNA and karyomorphological studies in vetiver (*Vetiveria zizanioides L.) Nash***. *Cytologia*, 50: 1, 177-185; 17 ref.

Detailed karyotypic information is presented on 20 Indian genotypes (representing wild populations and cultivated forms). All genotypes had chromosome numbers of 2n = 2x = 20, but they varied with respect to haploid chromatin length and 2C DNA content. It is suggested that these differences may be related to differences in essential oil content and composition.

1177 QI, SY. 1990. **Accumulation of secondary metabolites in cell suspension culture of *Aquilaria sinensis (Lour.) Gilg. (Thymelaeaceae)***. *Proc. of the Int. Congress of Essential Oils, Fragrances and Flavours. (11th: New Delhi: 1989: 12-16 November)* /edited by SC Bhattacharyya, N Sen, KL Sethi. London: Aspect Publishing, p. 1-4.

1178 SETHI, KL; MAHESHWARI, ML; GUPTA, R. 1990. **Genetic diversity and development of high oil yielding palmarosa strains.** *11th International congress of essential oils, fragrances and flavours, vol. 3: Biosciences*. (New Delhi: 1989: Nov 12-16)/edited by SC Bhattacharyya et al. London: Aspect Publ., p. 89-96.

1179 WAKHLU, AK; NAGARI, S; BARNA, KS. 1990. **Somatic embryogenesis and plant regeneration from callus cultures of *Bunium persicum Boiss***. *Plant Cell Reports*, 9: 3, 137-138; 9 ref.

Callus was obtained from mericarps cultured on MS medium supplemented with 2.0 mg 2,4-D and 4.0 mg kinetin/litre. Small white clumps of compactly packed cells developed on the callus on medium containing 1.0 mg 2,4-D/litre and no kinetin and differentiated numerous globular embryos. Embryo maturation and germination was achieved on basal medium as well as on that supplemented with 1 mg kinetin/litre. All of the regenerated plants examined were normal diploids (2n = 14).

Cymbopogon

1180 BARUAH, ANJANA; BORDOLOI, DN. 1989. **High frequency plant regeneration of *Cymbopogon martinii (Roxb.) Wats* by somatic embryogenesis and organogenesis**. *Plant Cell Reports*, 8: 8, 483-485; 11 ref.

Embryogenic callus cultures were obtained by repeated subculture of non-embryogenic callus from nodal segments. MS medium supplemented with 1 mg 2,4-D and 0.5 mg kinetin per litre and Linsmaier & Skoog (LS) medium supplemented with 2 mg 2,4-D and 0.4 mg kinetin/litre were used as maintenance media for non-embryogenic and embryogenic cultures, respectively. Plant regeneration occurred through organogenesis in MS basal media containing 2 mg kinetin, 1 mg 6-benzylaminopurine [benzyladenine], 0.2 mg biotin, 0.2 mg Ca-pantothenate and 0.1 mg NAA per litre. Embryogenesis was induced in LS medium supplemented with 1 mg kinetin, 0.5 mg 6-benzylaminopurine and 0.1