Deepak PENTAL

Date of Birth	February 12, 1951
Designation	Professor of Genetics and Director CGMCP, University of Delhi South Campus
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Education

Qualification	Institution	Year
Ph.D	Department of Botany Rutgers University New Brunswick, U.S.A.	1974-1978
M.Sc. (Hons school)	Department of Botany Panjab University Chandigarh, India	1971-1973
B.Sc. (Hons school)	Department of Botany Panjab University Chandigarh, India	1968-1971

Employment

Organization	Duration	Position
University of Delhi	2005-2010	Vice-Chancellor
University of Delhi South Campus	2000-2005	Director
Centre for Genetic Manipulation of Crop Plants (CGMCP) University of Delhi South Campus	1995- onwards	Director
University of Delhi South Campus	1994-1996	Dean, Faculty of Interdisciplinary and Applied Sciences (FIAS)
Department of Genetics University of Delhi South Campus	1993-onwards	Professor

Tata Energy Research Institute (TERI) New Delhi	1985-1993	Fellow
Plant Genetic Manipulation Group University of Nottingham	1978-1984	Post-doctoral Research Fellow

Other Information

- Elected member of the National Academy of Agricultural Sciences, National Academy of Sciences, Indian Academy of Sciences and the Indian National Science Academy.
- D.Sc (*honoris causa*) by the University of Nottingham, 2012.
- FICCI Award for Innovative R & D in Life Sciences, 2010.
- J. C. Bose National Fellowship of DST, 2009.
- O. P. Bhasin award for research in Agriculture, 2008.
- Jawaharlal Nehru Birth Centenary Visiting Fellowship INSA, 2008.
- Awarded 'Officer Des Palmes Academiques' for contributions to Research and Education by the Government of Republic of France.
- Awarded Jawaharlal Nehru Fellowship in November, 2004.
- Past Member: Governing Body of CSIR, INSA Council, SAC-C.
- Member of various Project Advisory Committees in DST DBT and CSIR from 1986 onwards.
- Past member of RAC of CCMB and NBRI, currently member of RAC of IHBT.
- Awarded a Panjab University medal for first position in Diploma in Gandhian Philosophy.
- Awarded a Biotechnology Career Fellowship in 1986 by the Rockefeller Foundation to work at the Max-Planck Institute in Koln.
- Coordinator of three major National Network Programmes:
    - "Development of Transgenics in Four Major Crops – Cotton, Rice, Mungbean and Tomato for Resistance to Biotic Stresses" funded by Department of Biotechnology (DBT) - Completed.
    - "Functional Genomics in Plants: Development and Use of the Technologies for Gene Discovery and Expression Modulation" funded by the New Millennium Indian Technology Leadership Initiative (NMITLI, CSIR) - Completed.
    - "Novel approaches for production of hybrid seed with characteristics of improved insect resistance & higher yield; (i) Rice Component (ii) Cotton Component" funded by the New Millennium Indian Technology Leadership Initiative (NMITLI, CSIR) - Ongoing.
    - Edited a special issue of Current Science (Vol. 84, 2003) on Transgenic Crops. Besides editing the volume contributed three articles:

- Grover, A., Pental, D. 2003. Breeding objectives and requirements for producing transgenics for major field crops of India. Curr. Sci. 84: 310-320.

- Chandra, A., Pental, D. 2003. Regeneration and genetic transformation of grain legumes: An overview. Curr. Sci. 84:381-387.

- Pental, D. 2003. Transgenics for productive and sustainable agriculture: some considerations for the development of a policy framework. Curr. Sci. 84: 413-424.

- Contributed an article "Transgenic Crops for Indian Agriculture: An Assessment of Their Relevance and Effective Use" in 'Policy and Institutional Issues and Challenges in Indian Agriculture' Ed: Ramesh Chand, Centad, 2005.

- Contributed articles to the Economic Times, the Indian Express and the Hindustan Times on agriculture policy and higher education.

Contribution to Research and Development

Major research on breeding of Indian oilseed mustard (*Brassica juncea*). Developed following products for field application -

- Mustard hybrid DMH-1 based on a novel CMS system. Provides 15-30% yield enhancement. Released by ICAR in Year 2008. In 2010 -11 rabi season grown in around 71,400 hectares of land.

- Mustard hybrid DMH-11 based on transgenic technologies, undergoing biosafety tests.

- High oleic mustard undergoing nutritional and biosafety tests.

- '00' Canola quality mustard under field trials.

Current research work involves use of molecular markers and transgenic approaches to develop disease resistant varieties and hybrids in mustard. Major success has been achieved on white rust. Work is continuing on Alternaria blight and stem rot.

Transgenic technologies developed for hybrid seed production in mustard are being extended to cotton and rice.

Patents

- Regulation of lethal gene expression in plants. **US patent No. US 6833494 (2004**)

- Method for producing insulator construct . **Indian Patent No. : 199542 (2006)**

- An insulator construct for controlling leaky expression of a lethal gene. **Indian Patent No. : 244002 (2010)**

- A method for obtaining improved fertility restorer lines for male sterile crop plants developed using transgenic approaches for hybrid seed production and a DNA construct for use in said method.
  US patent No. : 7741541 B2 (2010)
  EP patent No. : 1644506 (2009)
  Indian patent No. : 238973 (2010)

- A new cytoplasmic male sterility for *Brassica* species and its use for hybrid seed production in Indian oilseed mustard *Brassica juncea* . (Filed in US, Canada, Australia and India)
  Indian patent No. : 246501 (2011)
  Australian patent No.: 2005276075 (2005)

Ongoing Projects

1. Establishment of (a) Centre for Genetic Manipulation of Crop Plants (CGMCP) at the Department of Genetics, Delhi University South Campus and (b) Research facilities at Mangolpuri for genetic engineering of oil seed mustard / rapeseed and selected vegetable crops. 1996 onwards, Rs. 2085 lakh, funded by NDDB.

2. Centre of Excellence on Genome Mapping and Molecular Breeding of Brassicas. 2009 onwards, Rs. 622.34 lakh, funded by DBT (COE).

3. To conduct confined field trials and biosafety studies on genetically engineered Brassica juncea (Male sterility and restorer lines as pollination control mechanism) for heterosis breeding and yield improvement. 2010 onwards, Rs. 800 lakh, funded by DBT (BIPP).

4. J C Bose National Fellowship. 2010 onwards, Rs. 68 lakh, funded by DST.

Publications (In refereed journals)

- Kumar P., Yadava, S.K., Gupta, V., Panjabi-Massand, P., Sodhi, Y.S., Pradhan, A. K. Pental, D. 2013. RNA-seq based SNPs in some agronomically important oleiferous lines of *Brassica rapa* and their use for genome-wide linkage mapping and specific-region fine mapping. BMC Genomics 14: 463

- Yadava, S. K., Arumugam, N., Mukhopadhyay, A., Sodhi, Y. S., Gupta, V., Pental, D., Pradhan, A. K. 2012. QTL mapping of yield associated traits in *Brassica juncea*: Meta-analysis and epistatic interactions using two different crosses between east European and Indian gene pool lines. Theor. Appl. Genet. 125: 1553-1564.

- Jagannath, A., Sodhi, Y. S., Gupta, V., Mukhopadhyay, A., Arumugam, N., Singh, I., Rohtagi, S., Burma, P., Pradhan, A. K. and Pental, D. 2011. Eliminating expression of erucic acid-encoding loci allows the identification of 'hidden' QTL contributing to oil quality fractions and oil content in *Brassica juncea* (Indian mustard). Theor. Appl. Genet. 122: 1091-1103.

- Pradhan, A. K. and Pental, D. 2010. Genetics of *Brassica juncea*. pp 323-346. In: Genetics and Genomics of *Brassicaceae*. Ed R. Smith and Ian Bancroft. Springer.

- Panjabi, P-M., Yadav, S. K., Sharma, P., Kaur, A., Kumar, A., Arumugam, N., Sodhi, Y. S., Mukhopadhyay, A., Gupta, V., Pradhan, A. K. and Pental, D. 2010. Molecular mapping reveals two independent loci conferring resistance to *Albugo candida* in the east European germplasm of oilseed mustard *Brassica juncea*. Theor. Appl. Genet. 121: 137-145.

- Rawat, P., Kumar, S., Pental, D. and Burma P. K. 2009. Inactivation of a transgene due to transposition of insertion sequence (IS136) of *Agrobacterium tumefaciens.* Journal of Biosciences 34: 199-202.

- Bisht, N. C., Gupta, V., Ramchiary, N., Sodhi, Y. S., Mukhopadhyay, A., Arumugam, N., Pental, D. and Pradhan, A. K. 2009. Fine mapping of loci involved with glucosinolate biosynthesis in oilseed mustard (*Brassica juncea*) using genomic information from allied species. Theor. Appl. Genet. 118: 413-421.

- Rawat, P., Ray, K., Pental, D. and Burma, P. K. 2008. Mutant *acetolactate synthase* gene conferring resistance to the herbicide "imazethapyr" is an efficient *in vitro* selection marker for genetic transformation of cotton. Current Science 95: 1454-1458.

- Panjabi, P., Jagannath, A., Bisht, N. C., Padmaja, K. L., Sharma, S., Gupta, V., Pradhan, A. K. and Pental, D. 2008 Comparative mapping of *Brassica juncea* and *Arabidopsis thaliana* using intron polymorphism (IP) markers: homeologous relationships, diversification and evolution of A, B and C Brassica genomes. BMC Genomics 9: 113.

- Ray, K., Bisht, N. K., Pental, D. and Burma, P. K. 2007. Development of *barnase/barstar* transgenics for hybrid seed production in Indian oilseed mustard (*Brassica juncea* L. Czern & Coss) using a mutant acetolactate synthase gene conferring resistance to imidazolinone – based herbicide 'Pursuit'. Current Science 93: 1390-1396.

- Ramchiary, N., Bisht, N. C., Gupta, V., Mukhopadhyay, A., Arumugum, A., Sodhi, Y. S., Pental, D. and Pradhan, A. K. 2007. QTL analysis reveals context-dependent loci for seed GSL trait in the oilseed *Brassica juncea* : Importance of recurrent selection backcross (RSB) scheme for the identification of 'true' QTL. Theor. Appl. Genet 116: 77-85.

- Ramchiary, N., Padmaja, K. L., Sharma, S., Gupta, V., Sodhi, Y. S., Mukhopadhyay, A., Arumugam, N., Pental, D. and Pradhan, A. K. 2007. Mapping of yield influencing QTL in *Brassica juncea*: Implications for breeding of a major oilseed crop of dryland areas. Theor. Appl. Genet. 115: 807-817

- Arumugam, N., Gupta, V., Jagannath, A., Mukhopadhyay, A., Pradhan A. K., Burma, P. K. and Pental, D. 2007. A passage through in vitro culture leads to efficient production of marker-free transgenic plants in *Brassica juncea* using Cre-*lox P* system. Transgenic Res.16: 703-712.

- Bisht N. C., Jagannath, A., Burma, P. K., Pradhan A. K. and Pental, D. 2007. Retransformation of a male sterile *barnase* lines with the *barstar* gene as an efficient alternative method to identify male sterile-restorer combinations for heterosis breeding. Plant Cell Reports 26: 727-733.

- Bhullar, S., Datta, S., Advani, S., Chakravarthy, S., Gautam, T., Pental. D. and Burma, P. K. 2007. Functional analysis of cauliflower mosaic virus 35S promoter: re-evaluation of the role of subdomains B5, B4 and B2 in promoter activity. Plant Biotech. J. 5: 696-708.

- Panjabi, P., Burma, P.K. and Pental, D. 2006. Use of the transposable element *Ac*/*Ds* in conjunction with *Spm*/*dSpm* for gene tagging allows extensive genome coverage with a limited number of starter lines: functional analysis of a four-element system in *Arabidopsis thaliana*. Mol. Gen. Genomics. 276: 533-543.

- Sodhi, Y. S., Chandra, A., Verma, J. K., Arumugam, N., Mukhopadhyay, A., Gupta, V., Pental, D. and Pradhan, A. K. 2006. A new cytoplasmic male sterility system for hybrid seed production in Indian oilseed mustard *Brassica juncea*. Theor. Appl. Genet. 114: 93-99.

- Padmaja, K. L., Arumugam, N., Gupta, V., Mukhopadhyay, A., Sodhi, Y. S., Pental, D. and Pradhan, A. K. 2005. Mapping and tagging of seed coat color and identification of microsatellite markers for marker assisted manipulation of the trait in *Brassica juncea*. Theor. Appl. Genet. 111: 8-14.

- Kumar, S., Birah, A., Chaudhary, B., Burma, P. K., Gupta, G. P. and Pental, D. 2005. Plant codon optimised *cry* genes of *Bacillus thuringiensis* can be expressed as soluble proteins in *E. coli* BL21 codon plus strain as NusA-Cry protein fusions. J. Inver. Pathol. 88: 83-86.

- Bisht, N. C., Jagannath, A., Gupta, V., Burma, P. K. and Pental, D. 2004. A two gene – two promoter system for enhanced expression of a restorer gene (*barstar*) and development of improved fertility restorer lines for hybrid seed production in crop plants. Mol. Breeding 14: 129-144.

- Ray, K., Jagannath, A., Gangwani, S. A., Burma, P. K. and Pental, D. 2004. Mutant *Acetolactate synthase* gene is an efficient *in vitro* selectable marker for the genetic transformation of *Brassica juncea* (oilseed mustard). J. of Plant Physiol. 161: 1079-1083.

- Bisht, N.C., Burma, P. K. and Penal, D. 2004. Development of 2,4-D – resistant transgenics in Indian oilseed mustard (Brassica juncea). Current Science 87: 367-370.

- Sivaraman, I., Arumugam, N., Sodhi, Y. S., Gupta, V., Mukhopadhyay, A., Pradhan, A. K., Burma, P. K. and Pental, D. 2004. Development of high oleic and low linoleic acid transgenics in a zero erucic acid *Brassica juncea* L. (Indian mustard) line by antisense suppression of the *fad2* gene. Mol. Breeding 13: 365-375.

- Gupta, V., Mukhopadhyay, A., Arumugam, N., Sodhi, Y. S., Pental, D. and Pradhan, A.K. 2004. Molecular tagging of erucic acid trait in oilseed mustard (*Brassica juncea*) by QTL mapping and SNPs in FAE 1 gene. Theor. Appl. Genet. 108: 743-749.

- Srivastava, A., Mukhopadhyay, A., Arumugam, N., Gupta, V., Verma, J. K., Pental, D. and Pradhan, A. K. 2004. Resynthesis of *Brassica juncea* through interspecific crosses between *B. rapa* and *B. nigra*. Plant Breeding 123: 204-206.

- Chandra, A., Gupta, V., Burma, P. K. and Pental, D. 2003. Patterns of morphogenesis from cotyledon explants of pigeonpea. In Vitro Cell. Dev. Biol. – Plant. 39: 514-519.

- Bhullar, S., Chakravarthy, S., Advani, S., Datta, S., Pental, D. and Burma, P.K. 2003. Strategies for development of functionally equivalent promoters with minimum sequence homology for transgene expression in plants: cis-elements in a novel DNA context versus domain swapping. Plant Physiol. 132: 988-998.

- Chaudhary, B., Kumar, S., Prasad, K.V.S.K., Oinam, G.S., Burma, P. K. and Pental, D. 2003. Slow dessication leads to high frequency shoot recovery from transformed somatic embryos of cotton (*Gossypium hirsutum* L. cv. Coker 310FR). Plant Cell Reports 21: 955-960.

- Pradhan, A. K., Gupta, V., Mukhopadhyay, A., Arumugam, N., Sodhi, Y. S. and Pental, D. 2003. A high density linkage map in *Brassica juncea* (Indian mustard) using AFLP and RFLP markers. Theor. Appl. Genet. 106: 607-614.

- Sodhi, Y. S., Mukhopadhyay, A., Arumugam, N., Verma, J. K., Gupta, V., Pental, D. and Pradhan A. K. 2002. Genetic analysis of total glucosinolate in crosses involving a high glucosinolate Indian variety and a low glucosinolate line of *Brassica juncea*. Plant Breeding 121: 508-511.

- Arumugam, N., Mukhopadhyay, A., Gupta, V., Sodhi, Y. S., Verma, J. K., Pental, D. and Pradhan, A. K. 2002. Synthesis of somatic hybrids (RCBB) by fusing protoplasts of heat tolerant *Rapharus sativus* (RR) and *Brassica oleracea* (CC) with *B. nigra* (BB). Plant Breeding 121: 168-170.

- Jagannath A., Arumugam, N., Gupta, V., Pradhan, A., Burma, P. K. and Pental, D. 2002. Development of transgenic *barstar* lines and identification of a male sterile (*barnase*) / restorer (*barstar*) combination for heterosis breeding in Indian oilseed mustard (*Brassica juncea*). Current Science 82: 46-52.

- Jagannath, A., Bandyopadhyay, P., Arumugam, N., Gupta, V., Burma, P.K. and Pental, D. 2001. The use of a Spacer DNA fragment insulates the tissue-specific expression of a cytotoxic gene (*barnase*) and allows high-frequency generation of transgenic male sterile lines in *Brassica juncea* L. Mol. Breeding 8: 11-23.

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- Phogat, S.K., Burma, P.K. and Pental, D. 2000. High frequency regeneration of *Brassica napus* varieties and genetic transformation of stocks containing fertility restorer genes for two cytoplasmic male sterility systems. J. Plant Biochem. Biotech. 9: 73-79.

- Mehra, S., Pareek, A., Bandyopadhyay, P., Sharma, P., Burma, P.K. and Pental, D. 2000. Development of transgenics in Indian oilseed mustard (*Brassica juncea*) resistant to herbicide phosphinothricin. Current Sci.ence 78: 1358-1364.

- Arumugum, N., Mukhopadhyay, A., Gupta, V., Sodhi, Y. S., Verma J. K., Pental, D. and Pradhan, A. K. 2000. Somatic cell hybridization of 'oxy' CMS *Brassica juncea* (AABB) with *B. oleracea* (CC) for correction of chlorosis and transfer of novel organelle combinations to allotetraploid brassicas. Theor. Appl. Genet. 100: 1043-1049.

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- Verma, J. K., Sodhi, Y. S., Mukhopadhyay, A., Arumugum, N., Gupta, V., Pental, D. and Pradhan, A. K. 2000. Identification of stable maintainer and fertility restorer lines for 'Polima' CMS in *Brassica campestris* L. Plant Breeding 119: 90-92.

- Kumar, S. and Pental, D. 1998. Regeneration of Indian cotton variety MCU-5 through somatic embryogenesis. Current Science 74: 538-540.

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- Nagpal, R., Raina, S.N., Sodhi, Y.S., Mukhopadhyay, A., Arumugum, N., Pradhan, A.K. and Pental, D. 1996. Transfer of *Brassica tournefortii* (TT) genes to allotetraploid oilseed *Brassica* species (*B. juncea* AABB, *B. napus* AACC, *B. carinata* BBCC) : homoeologous pairing is more pronounced in the three-genome hybrids (TACC, TBAA, TCAA, TCBB) as compared to allodiploids (TA, TB, TC). Theor. Appl. Genet. 92: 566-571.

- Mukhopadhyay, A., Arumugam, N., Pradhan, A.K., Murthy, H.N., Yadav, B.S., Sodhi, Y.S. and Pental, D. 1995. Somatic hybrids with substitution type genomic configuration TCBB for the transfer of nuclear and organelle genes from *Brassica tournefortii* TT to allotetraploid oilseed crop *Brassica carinata* BBCC. Theor. Appl. Genet. 89: 19-25.

- Sodhi, Y.S., Pradhan, A.K., Verma, J.K., Arumugam, N., Mukhopadhyay, A. and Pental, D. 1994. Identification and inheritance of fertility restorer genes for `tour' CMS in rapeseed (*Brassica napus* L.). Plant Breeding 112: 223-227.

- Shiva Prakash, N., Pental, D. and Bhalla-Sarin, N. 1994. Regeneration of pigeonpea (*Cajanus cajan*) through multiple shoot formation. Plant Cell Reports 13: 623-627.

- Pradhan, A., Sodhi, Y.S., Mukhopadyay, A., Pental, D. 1993. Heterosis breeding in Indian mustard (*Brassica juncea* (L. Czern & Coss): Analysis of component characters contributing to heterosis for yield. Euphytica 69: 219-229.

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