CENTRE OF ADVANCED FACULTY TRAINING IN PLANT BIOTECHNOLOGY

NATIONAL INSTITUTE FOR PLANT BIOTECHNOLOGY, LBS CENTRE, PUSA, NEW DELHI-110012,

REPORT, 2020

Introduction

National Institute for Plant Biotechnology (NIPB) is the premiere research institution of the Indian Council of Agricultural research (ICAR), engaged in plant molecular biology and biotechnology research. The Biotechnology Centre, established in 1985, as part of the Indian Agricultural Research Institute (IARI), was upgraded to a National Research Centre on Plant Biotechnology in the year 1993, with a vision to impart the biotechnology advantage to the National Agricultural Research System (NARS). The name of the Institute has been changed to National Institute for Plant Biotechnology (NIPB) in 2019. NIPB has acquired, in the past, an excellent infrastructure in terms of equipment and other physical facilities and also a high degree of scientific competence. Development of transgenic crops for biotic and abiotic stress management, exploitation of heterosis through marker and genomic approaches, marker assisted selection and molecular breeding of major crops for productivity and quality enhancement, search for novel genes and promoters for efficient native and transgene expression are the major activities taken up by the institute. There is now considerable emphasis on structural and functional genomics of crop species such as rice, wheat, chickpea, pigeonpea, and mustard in the institue. In addition to research, the institute is contributing significantly to competent human resource development by way of offering regular M.Sc. and Ph.D. programmes by partnering with PG School, IARI.

Mandate of the institute

• Basic plant molecular biology research for understanding molecular basis of biological processes

• Coordination and capacity building for devising tools and techniques of biotechnology and genetic engineering for crop improvement

Objective of CAFT:

Considering it immense contribution in the field of plant genome sequencing such as rice, wheat, tomato, pigeon pea, mango, jute, tea and wild relatives, ICAR has recognized this institute as one of the centre for, “Centre For Advanced Faculty Training” in the area of plant biotechnology in the financial year of 2016-2017. Thus since 2017, the centre is conducting the training in the area of Next Genaration Sequencing with the following objectives:-

- To develop human resources by imparting training to the teachers and scientists of various SAU's and ICAR institutes at national level on scientific advancement in next generation sequencing technologies
- To promote and strengthen the teaching and research activities by providing the infrastructure facilities and scientific equipments in the area of next generation sequencing related technologies.

Faculty: Name and Designation (as on 30.12.2019):

Sl.	Name of the Faculty	Designation	Specialization
1.	Prof. N.K. Singh	Director	Genome sequencing, functional genomics for biotic, abiotic stress, yield and quality traits in rice, wheat, pigeonpea, mango, jute etc
2.	Dr. Sarvjeet Kaur	Principal Scientist	Metagenomics and biology of Bt toxin.
3.	Dr. Anita Grover	Principal Scientist	Plant-fungus interaction in Brassica.
4.	Dr. RekhaKansal	Principal Scientist	Development of insect tolarent plant using transgenic approach.
5.	Dr. Sanjay Singh	Principal Scientist	Molecular breeding and association mapping of wheat.
6.	Dr. Jasdeep C. Padaria	Principal Scientist	Functinal genomics for wheat adaptable to climate change induced abiotic stresses.
7.	Dr. Pranab Kumar Mandal	Principal Scientist	Molecular and biochemical basis of nitrogen use efficiency in wheat.
8.	Dr. Debasis Pattanayak	Professor	Gene silencing, RNAi biology
9.	Dr. R.C. Bhattacharya	Principal Scientist	Brassica biotechnology for quality trait
10.	Dr. P.K. Jain	Principal Scientist	Epigenetics study using high throughput sequencing for various trait of chick pea
11.	Dr. Sharmistha Barthakur	Principal Scientist	Functional genomisc of wheat for terminal heat tolarence
12.	Dr. Kishor Gaikwad	Principal	Development of genomic resources through bioinformatics tools, genome and transcriptom sequencing of plants

		Scientist	
13.	Dr. Kanika	Principal Scientist	Salinity tolarence of wheat
14.	Dr. Monika Dalal	PrincipalScientist	Functional genomics for drought and salinity stress in wheat
15.	Dr. Tapan Kumar Mondal	Principal Scientist	Salinity stress tolerance in rice and its wild relatives. Genome sequeicng of plant
16.	Dr. Vandana Rai	Principal Scientist	Proetomics and functional genomics of salinity tolarence of rice
17.	Dr. P.K. Dash	PrincipalScientist	Molecular mechanism of low light intensity tolarence of rice
18.	Dr. Rhitu Rai	Principal Scientist	Molecular biology of bacterial diseases of rice.
19.	Dr. Subodh Kumar Sinha	Senior Scientist	Molecular analysis of nitrogen use efficiency of wheat.
20.	Dr. Rohini Srevathsa	Senior Scientist	Development of insect resistant plant throughtransgenic.
21.	Dr. Ashish Kumar	Senior Scientist	Molecular biology of white rust resistance in mustard
22.	Dr. N. C. Gupta	Senior Scientist	Enhence ment of oil yield of mustard through functional genomics
23.	Dr. S.V.A.C.R. Mithra	Senior Scientist	QTL mapping for grain quality and drought tolarent of rice
24.	Dr. Amolkumar U.Solanke	Senior Scientist	Functional genomics of rice blast diseases
25.	Mr. Ramawatar	Scientist	Functional genomics of chick pea
26.	Dr. Dinabandhu Behera	Scientist	Structural, functional and comparative genomics of crop plants
27.	Mr. Mahesh Rao	Scientist	Improvement of Brassica spp. Using , wide hybridization and gene introgression approaches
28.	Ms. Nimmy M.S.	Scientist	Isolation and characterization of abiotic stress responsive gene(s) and promoter(s) from chickpea
29.	Dr.Deepak Singh Bisht	Scientist	Molecular identification of resistance and susceptibility genes in rice-Rhizoctonia solani system
30.	Dr. Anshul Watts	Scientist	Development and maintenance of genetic stocks for heterosis breeding in Brassica juncea

31.	Dr. Sandhya	Scientist	Functional genomics for milling, cooking and protein quality in pigeonpea

Human Resource Development: Particulars of Short Courses / Training program for HRD conducted during XII plan period

S.No.	Title of Training Programme	Duration	No. of participants
1.	Use of different molecular biology techniques in crop improvement program	17-31 January, 2017	14

Library strengthening

Sl.no	Year of purchase (Financial year 1st April to 31st March)	Number of books	Amount of money (INR RS)
1	2016-17	179	47829.75
2	2017-18	63	206197.444
3	2018-19	Nil	Nil

Manual prepared under CAFT training

Sl No	Year	Title	Editors	Publishers
1	2017	Next generation sequencing and its application in crop science (pp275)	Prof . N. K. Singh Tapan Kumar Mondal Deepak Singh Bisht	ICAR-NRCPB
2	2018	Next generation sequencing and its application in plant science (pp273)	Prof . N. K. Singh Tapan Kumar Mondal Kishor Gaikwad Deepak Singh Bisht	ICAR-NIPB
3	2019	Next generation sequencing and its application in plant science (pp276)	Prof . N. K. Singh Tapan Kumar Mondal Kishor Gaikwad Deepak Singh Bisht	ICAR-NIPB

Awards and Honours

- Dr. Jasdeep C. Padaria received Outstanding Scientist Award -2016 of Academic Research Journals (India) at 4thInternational Conference on Recent Advances in Agricultural and Horticultural Sciences, 30-31 December 2016; Jodhpur, Ralasthan, India.
- Dr. N. C. Gupta received "Fellow Award" from Society for Applied Biotechnology, Tamil Nadu, India.
- Dr. Anshul Watts received IARI Merit Medal Award for the year 2016-2017 for the outstanding work carried out during Ph. D. research.
- Dr. Jasdeep C Padaria received Outstanding Woman Scientist Award in Agriculture Sciences (2017) by Pearl Foundation for excellence in Education, Madurai, India
- Dr. Tapan K. Mondal became Fellow of National Academy of Science India, 2017
- Dr. Amolkumar U. Solanke received "Excellence in Research Award" (2017) from 'National Environmental Science Academy (NESA), New Delhi at Gwalior
- Dr. Nimmy MS received 'Young Scientist Award' in International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2017) on 02-04 December, 2017, held at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan, India), organized by Society for Scientific Development in Agriculture and Technology (SSDAT)
- Dr. NK Singh presented invited talk on reference genome sequence of mango variety 'Amrapali' at the XXVI Plant and Animal Genome-2018 (PAG 2018) conference at San Diego, USA on Jan 13-17, 2018.
- Prof. N. K. Singh received 'Bharat Jyoti Award' from India International Friendship Society, and 'Shikshak Shri Award' from Indian Society of International Law in 2018.
- Dr. Pranab K. Mandal joined as Member, Editorial Board of the Journal of Wheat and Barley Research, Karnal, India.
- Dr. Debasis Pattanayak became Fellow of National Academy of Agricultural Sciences in January, 2019.
- Dr Subosh K. Sinha received INEW Scientific Exchange Scheme Fellowship to undertake research at Department of Plant Sciences, University of Cambridge, UK with Prof. Howard Griffiths.
- Dr. Navin C. Gupta received "Young Scientist Award" 2018 from Society of Plant Protection Sciences, ICAR-NCIPM, India; and "AdarshVidya Saraswati Rashtriya Puraskar" National Award of Excellence-2018, from Glacier Journal Research Foundation, Ahmadabad, India.
- Dr. Navin C. Gupta was elected as "Member of Editorial Board" Glacier Journal of Scientific Research, in the year 2018.
- Dr Sandhya received Young Scientist Award in International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future at Meerut.

Publications 2016-17

1. Hussain IS, Pavithra HV, Sreevathsa R, Nataraja KN & Babu N. 2016. Development of transgenic pigeonpea (*Cajanus cajan* L.) overexpressing citrate synthase gene for high phosphorous uptake. *Indian J Exp Biol* **54:** 493-501.

2. Ali S, Chandrashekar N, Rawat S, Nayanakantha NMC, Mir ZA, Manoharan A, Sultana M & Grover A. 2017. Isolation and molecular characterization of pathogenesis related PR2 gene and its promoter from *Brassica juncea. Biol Planta* doi:*10.1007/s10535-017-0726-7*

3. Arora S, Mahato AK, Singh S, Mandal P, Bhutani S, et al. 2017. A high-density intraspecific SNP linkage map of pigeonpea (*Cajanas cajan* L. Millsp.). *PLoS One***12**: e0179747.

4. Banerjee S, Banerjee A, Gill SS, Gupta OP, Dahuja A, Jain PK& Sirohi A. 2017. RNA interference: a novel source of resistance to combat plant parasitic nematodes. *Front Plant Sci* doi: *10.3389/ fpls.2017.00834*.

5. Chidambaranathan P, Jagannadham PTK, Satheesh V, Jain PK& Srinivasan. 2016. Expression analysis of six chromatin and remodeling complex genes (*SWR1*) in chickpea in different tissues and during heat stress. *Indian J Genet Plant Breed* **76**: 47-56.

6. Dash PK & Rai R. 2016. Translating the "Banana Genome" to delineate stress resistance, dwarfing, parthenocarpy and mechanisms of fruit ripening. *Front Plant Sci* **7**: 1543.

7. Dash PK, Gupta P & Rai R. 2016. Hydropenia induces expression of drought responsive genes (DRGs) *erd1*, *hat1*, *pld*, and *zfa* in flax/linseed (*Linumus itatissimum*). *Indian J Exp Biol* (Accepted).

8. Ghritlahre SK, Rao M, Singh V, Singh VK, Loitongbam B, Yadav SK, Zaidi NW, Singh US & Singh PK. 2016. Inheritance of sheath blight disease resistance in submergence rice (*Oryza sativa* L.). *Int J Agril Environ Biotechnol* **9:** 507-512

9. Goswami S, Kumar RR, Dubey K, Singh JP, Tiwari S, Kumar A, Smita S, Mishra DC, Kumar S, Grover M, Padaria JC, Kala YK, Singh GP, Pathak H, Chinnusamy V, Rai A, Praveen S & Rai RD. 2016. SSH analysis of endosperm transcripts and characterization of heat stress regulated expressed sequence tags in bread wheat. *Front Plant Sci* **7**:1230.

10. Goyal E, Amit SK, Singh RK, Mahato AK, ChandS & Kanika K. 2016. Transcriptome profiling of the salt-stress response in *Triticum aestivum* cv. Kharchia Local. *Sci Rep* **6**: 27752.

11. Goyal E, Singh AK, Singh RS, Mahato AK & Kanika 2016. *De novo* transcriptome sequencing and analysis of *Hydrilla verticillata* (Lf) Royle. *Plant Omics J* **9:** 270-280.

12. Jain P, Singh PK, Kapoor R, Solanke AU, Krishnan SG, Singh AK, Sharma V & Sharma TR. 2017. Understanding host-pathogen interactions with expression profiling of NILs carrying rice-blast resistance *Pi9* gene. *Front Plant Sci* **8**: 93.

13. Kaila T, Chaduvula PK, Saxena S, Bahadur K, Gahukar SJ, Chaudhury A, Sharma TR, Singh NK Gaikwad K. 2016. Chloroplast genome sequence of pigeonpea (*Cajanus cajan* (L.) Millspaugh) and *Cajanus scarabaeoides*: genome organization and comparison with other legumes. *Front Plant Sci* **7**: 1847.

14. Karthikeyan C, Patil BL, Borah BK, R e s m i TR, Turco S, Pooggin MM, Hohn T & Veluthambi 2016. Emergence of a latent Indian cassava mosaic virus from cassava which recovered from infection by a non-persistent Sri Lankan cassava mosaic virus. *Viruses* **8**: 264.

15. Karuppaiah V, Padaria JC, Srivastava C, Subramanian S & Ahuja DB. 2016. Nucleotide polymorphism and modulation of carboxyl esterase activity in *Spodoptera litura* (F.) (Noctuidae: Lepidoptera). *Indian J Entomol* **78**: 252-256.

16. Karuppaiah V, Srivastava C, Padaria JC & Subramanian S. 2017. Quantitative changes of the carboxylesterase associated with pyrethroid susceptibility in *Spodoptera litura* (Lepidoptera: Noctuidae). *African Entomol* **25**: 175-182.

17. Katara JL, Kaur S, Kumari GK & Singh NK. 2016. Prevalence of *cry2*-type genes in *Bacillus thuringiensis* isolates recovered from diverse habitats in India and isolation of a novel *cry2Af2* gene toxic to *Helicoverpa armigera* (cotton boll worm). *Canadian J Microbiol* **62**: 1003-1012.

18. Khomdram S & Barthakur S. 2016. Transient GUS assay based quick screening method of genes cloned in a binary vector in tandem for plant transformation. *Ann Agric Res* **37**: 265-274.

19. Khomdram S, Arambam S, Barthakur S & Devi GS. 2017. Biochemical, nutritional profiling and optimization of an efficient nucleic acid isolation protocol from recalcitrant tissue of wild edible fruit *Antidesma bunius* L. Spreng. *Int J Curr Microbiol App Sci* **6**: 253-264.

20. Kiran K, Rawal HC, Dubey H, Jaswal R, Devanna BN, Gupta DK, Bhardwaj SC, Prasad P, Pal D, Chhuneja P, Balasubramanian P, Kumar J, Swami M, Solanke AU, Gaikwad K, Singh NK & Sharma TR. 2016. Draft genome of the wheat rust pathogen (Puccinia triticina) unravels genome-wide structural variations during evolution. *Genome Biol Evol* **8**: 2702-2721.

21. Koramutla M, Bhat D, Negi M, Venkatachalam P, Jain PK & Bhattacharya RC. 2016. Strength, stability and cis-motifs of *in silico* identified phloem-specific promoters in *Brassica juncea* (L.). *Front Plant Sci* **7**: 457.

22. Koramutla MK, Aminedi R & Bhattacharya RC. 2016. Comprehensive evaluation of candidate reference genes for qRT-PCR studies of gene expression in mustard aphid, *Lipaphis erysimi* (Kalt). *Sci Rep* **6**: 25883.

23. Kumar A, Kakrana A, Sirohi A, Subramaniam K, Srinivasan R, Abdin MZ &Jain PK. 2017. Host-delivered RNAi-mediated root-knot nematode resistance in Arabidopsis by targeting *splicing factor* and *integrase* genes. *J Gen Plant Pathol* **83:** 91-97.

24. Kumar M, Kumar V,Kansal R**,** Srivastava PS & Koundal KR. 2016. Isolation and characterization of a novel gene encoding Kunitz-type protease inhibitor from *Pigeonpea (Cajanus cajan* L.). *Eco Env Cons* **22:** S329-S337.

25. Kumar S, Singh P, Tiwari P, Zauva L &Kansal R.2016. Cloning and expression of pigeonpea lectin gene in an expression vector and its characterization. *New Agriculturist* **27**: 357-365.

26. Lianthanzauva, Singh P, Tiwari P, Pawar DV, Kumar S &Kansal R.2016. Use of the *rolC* promoter to direct phloem-specific expression of *Cajanus cajan l*ectin (CCL) gene in transgenic *Brassica juncea* plants. *Res J Agrl Sci* **7**: 597-601.

27. Mishra P, Singh S, Rathinam M, Nandiganti M, Kumar NR, Thangaraj A, Thimmegowda V, Krishnan V, Mishra V, Jain N, Rai V, Pattanayak D & Sreevathsa R. 2017. Comparative proteomic and nutritional composition analysis of independent transgenic pigeonpea seeds

harboring *cry1AcF* and *cry2Aa* genes and their non-transgenic counterparts. *J Agric Food Chem* **65:** 1395-1400.

28. Mishra S, Singh B, Misra P, Rai V & Singh NK. 2016. Haplotype distribution and association of candidate genes with salt tolerance in Indian wild rice germplasm. *Plant Cell Reports* **35**: 2295-2308.

29. Mishra S, Singh B, Panda K, Singh BP, Singh N, Misra P, Rai V & Singh NK. 2016. Association of SNP haplotypes of HKT family genes with salt tolerance in Indian wild rice germplasm. *Rice* **9**: 15.

30. Muthusamy SK, Dalal M, Chinnusamy V & Bansal KC. 2017. Genome-wide identification and analysis of biotic and abiotic stress regulation of small heat shock protein (HSP20) family genes in bread wheat. *J Plant Physiol* **211**: 100-113.

31. Naresh V, Singh SK, Watts A, Kumar P, Kumar V, Rao KRSS & Bhat SR. 2016. Mutations in the mitochondrial *orf108* render *Moricandia arvensis* restorer ineffective in restoring male fertility to *Brassica oxyrrhina*-based cytoplasmic male sterile line of *B. juncea*. *Mol Breeding* **36:** 67.

32. Nimmy MS & Vinod K. 2016. Identification and expression analysis of six salt inducible genes in chickpea which are Arabidopsis orthologs. *Indian J Plant Physiol* **21:** 362-365.

33. Padaria JC, Tarafdar A, Raipuria R, Lone SA, Gahlot P, Shakil NA & Kumar J. 2016. Identification of phenazine-1-carboxylic acid gene (*phc CD*) from *Bacillus pumilus* MTCC7615 and its role in antagonism against *Rhizoctonia solani. J Basic Microbiol* **56**: 999-1008.

34. Padaria JC, Yadav R, Tarafdar A, Lone SA, Kumar K & Sivalingam PN. 2016. Molecular cloning and characterization of drought stress responsive abscisic acid stress ripening (*Asr 1*) gene from wild jujube, *Ziziphus nummularia* (Burm.f.) Wight & Arn. *Mol Biol Rep* **43**: 849-859.

35. Padaria JC, Biswas K, Bhatt D, Prabhu R, Vishwakarma H&Singh GP. *2016.*Transcriptional profiling of heat stress responsive genes in different developmental stages of bread wheat (*Triticum aestivum* L.)*Indian J Biotechnol **15:** 467-476.*

36. Parameswaran CP, Jagannadham PTK, Satheesh V, Kohli D, Basavarajappa SH, Bharadwaj C, Kumar J, Jain PK& Srinivasan R. 2017. Genome-wide analysis identifies chickpea (*Cicer arietinum*) heat stress transcription factors (*Hsfs*) responsive to heat stress at the pod development stage. *J Plant Res* doi: *10.1007/s10265-017-0948-y*.

37. Parida SK, Kalia S, Pandit A, Nayak P, Singh RK, Gaikwad K, Srivastava PS, Singh NK & Mohapatra T. 2016. Single nucleotide polymorphism in sugar pathway and disease resistance genes in sugarcane. *Plant Cell Rep* **35:** 1629-1653.

38. Patil BL, Bagewadi B, Yadav JS &Fauquet CM. 2016. Mapping and identification of cassava mosaic geminivirus genome sequences for efficient siRNA expression and RNAi based virus resistance by transient agro-infiltration studies.

39. Patil VU, Vanishree G, Pattanayak D, Sharma S, Bhardwaj V, Singh BP & Chakrabarti SK. 2017. Complete mitogenome mapping of potato late blight pathogen, *Phytophthora infestans* A_2 mating type. *Mitochondr DNA Part B* **2***: 90-91*.

40. Prajapat RK, Pawar D, Singh P, Tiwari P, Kumar S & Kansal R. 2016. Legume lectins: a promising candidate for confronting a plethora of biotic stresses. *Indian Res J Genet Biotech* **8**: 6-13.

41. Prakash C, Amitha Mithra SV, Singh PK, Mohapatra T & Singh NK. 2016. Unraveling the molecular basis of oxidative stress management in a drought tolerant rice genotype Nagina 22. *BMC Genomics* **17**: 774.

42. Raman KV, Agarwal D, Rao SR, Sreevathsa R, Singh AK, Abdin MZ, Pattanayak D & Mohapatra T. 2017. Rapid and efficient *Agrobacterium*-mediated transformation of early scutellum derived calli of *indica* rice. *Indian J Exp Biol* (Accepted).

43. Rao M, Grithlahre S, Prashant B, Pallavi, Singh NK, Dar MH, Singh US & Singh PK. 2016. Genetics of marker assisted backcross progenies of the cross HUR-105 X Swarna-SUB. *Int J Agril Environ Biotechnol* **9:** 499-505.

44. Rawat N, Sandhya, Subaharan K, Eswaramoorthy M & Kaul G. 2016. Comparative *in vivo* toxicity assessment places multiwalled carbon nanotubes at a higher level than mesoporous silica nanoparticles. *Toxicol Ind Health* **33**: 182-192.

45. Rawat S, Ali S, Mittra B & Grover A. 2017. Expression analysis of chitinase upon challenge inoculation to Alternaria wounding and defense inducers in *Brassica juncea. Biotechnol Rep* **13:** 72-79.

46. Repalli SK, Baruah AM, Rai R & Dash PK. 2016. Isolation and cloning of cytokinin oxidase 5 gene from Arabidopsis. *Annal Agril Sci* **37**: 115-122.

47. Sanju S, Thakur A, Sundaresha S, Sharma S, Shukla PK, Srivasthava N, Pattanayak D & Singh BP. 2016. *In vitro* detached leaf assay of host-mediated RNAi lines carrying *Phytophthora infestansAvr3a* effector gene for late blight resistance. *Potato J* **43**: 30-37.

48. Sarkar D, Mahato SP, Kundu A, Singh S, Jayaswal PK, Singh A, Bahadur K, Pattnaik S, Singh N, Chakraborty A, Mandal NA, Das D, Basu T, Amitha Mithra S, Saha D, Datta S, Kar CS, Mitra J, Datta K, Karmakar PG, Sharma TR, Mohapatra T & Singh NK. 2017. The draft genome of *Corchorus olitorius* cv. JRO-524 (Navin). *Genomics Data* **12**: 151-154.

49. Shanmugavadivel PS, Amitha Mithra SV, Chandra Prakash, Ramkumar MK, Tiwari R, Mohapatra T & Singh NK. 2017. High Resolution mapping of QTLs for heat tolerance in rice using a 5K SNP array & *Rice* **10**: doi:*10 DOI 10.1186/s12284-017-0167-0.*

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51. Shivakumara TN, Chaudhary S, Kamaraju D, Dutta TK, Papolu PK, Banakar P, Sreevathsa R, Singh B, Manjaiah KM & Rao U. 2017. Host-induced silencing of two pharyngeal gland genes conferred transcriptional alteration of cell wall-modifying enzymes of *Meloidogyne incognita vis-à-vis* perturbed nematode infectivity in eggplant. *Front Plant Sci* **8:** 473.

52. Shivraj SM, Deshmukh R, Rai R, Belangre R, Agarwal PK & Dash PK. 2017. Genome-wide identification, characterization, and expression profile of aquaporin gene family in flax. *Sci Rep* **7**: 46137.

53. Shoba D, Manonmani S, Raveendran M, Utharasu S, Dhivyapriya, Subhasini, Ramchandar, Valarmathi R, Grover N, Gopala Krishnan S, Singh AK, Jayaswal P, Kale P, Ramkumar MK, Amitha Mithra SV, Mohapatra T, Singh K, Singh NK, Sarla N, Sheshshayee MS, Kar MK, Robin S & Sharma RP. 2017. Development and genetic characterization of a novel herbicide (Imazethapyr) tolerant mutant in rice. *Rice* **10**: doi: *10.1186/s12284-017-0151-8.*

54. Singh A, Septiningsih EM, Balyan HS, Singh NK & Rai V.2017. Genetics, physiological mechanisms and breeding of flood tolerant rice (*Oryza sativa* L.). *Plant Cell Physiol* doi: *10.1093/pcp/pcw206*.

55. Singh D, Singh CK, Taunk J, Tomar RS, Chaturvedi AK, Gaikwad K & Pal M. 2017. Transcriptome analysis of lentil (*Lens culinaris Medikus*) in response to seedling drought stress. *BMC Genomics* **18:** 206.

56. Singh N, Singh B, Rai V, Sidhu S, Singh AK & Singh NK. 2017. Evolutionary insights based on SNP haplotypes of red pericarp, grain size and starch synthase genes in wild and cultivated rice. *Front Plant Sci* doi: *org/10.3389/fpls.2017.00972.*

57. Singh NK et al. 2016. Origin, diversity and genome sequence of mango (*Mangifera indica* L.). *Indian J His Sci* **51**: 355-368.

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64. Tiwari S, SI K, Kumar V, Singh B, Rao AR, Mithra Sv A, Rai **V**, Singh AK & Singh NK. 2016. Mapping QTLs for salt tolerance in rice (*Oryza sativa* L.) by bulked segregant analysis of recombinant inbred lines using 50K SNP chip. *PLoS One* **11**: e0153610.

65. Vemanna VS, Swetha TN, Shekarappa HS, Chndrashekar KB, Sreevathsa R**,** Reddy MK, Tuteja N, Reddy CP, Prasad TG & Udayakumar M. 2016. Simultaneous expression of regulatory genes associated with specific drought adaptive traits improves drought adaptation in peanut. *Plant Biotech J* **14:** 1008-1020.

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Book

Gaur RK, Petrova N, Patil BL & Stoyanova MI. 2016. Plant Viruses: Evolution and Management. Springer Publishers, ISBN 978-981-10-1405-5.

Publications 2017-18

1. Ali S, Mir ZA, Bhat JA, Tyagi A, Chandrashekar N, Yadav P, Rawat S, Sultana M & Grover A. 2017. Isolation and characterization of systemic acquired resistance marker gene *PR1* and its promoter from *Brassica juncea*. *3Biotech* **8**: 10.
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Technology, Commercialization and IPR

I. **Patent application filed:** Four

1. Polynucleotide fragments for expression of genes in plant in response to pathogens and wounding (Application No. 2245/DEL/2015) on 22nd July, 2016.
2. Peptide elicitor of insect and pathogen defense in Brassica. (Application No.201611026697) on 4th August, 2016.
3. Promoter from *Gossypium hirsutum* L. for enhanced expression of foreign genes in late boll developmental stages of cotton. (Application No. 2977/DEL/2015) on 23rd August, 2016.
4. One complete patent application entitled “Generation of stress tolerant transgenic plant”. (Application No. 201611036819) was filed on 17th August, 2017 for India patent rights by NRCPB.

II. MTAs / MoUs signed:

1. Material Transfer Agreement (MTA) with ICGEB, New Delhi pertaining to sharing of rice mutants developed at NRCPB has been signed on 27.05.2016.
2. Material Transfer Agreement (MTA) for LOC_ Os11g47510 gene has been signed with Indian Institute of Maize Research, Pusa Campus, New Delhi on 30.05.2016.
3. Material Transfer Agreement (MTA) for cry1AcF:OcsT and cry2Aa genes gene has been signed with Telangana State Agricultural University Hyderabad on 12.08.2016.
4. Material Transfer Agreement (MTA) for EPSPS gene has been signed with Assam Agricultural University, Jorhat, Assam on 14.09.2016.
5. A Memorandum of Understanding (MoU) has been signed for R & D promotion in partnership mode between ICAR-DMAPR, Anand, ICARNRCPB, New Delhi and Priyamvada Birla Institute of Life Sciences (PBILS), Satna, M.P. on 24.10.2016 to carrying out joint research programmes in the areas of mutual interest in Genomics of Medicinal and Aromatic Plants through externally funded projects
6. Material Transfer Agreement (MTA) with Centre for Research in Agril Genomics (CRAG), UAB, Barcelona pertaining to sharing the Arabidopsis thaliana transgenic seeds carrying pAP2:: uidA gene cassette developed at NRCPB has been signed on 20.02.2018.
7. A Memorandum of Agreement (MoA) has been signed for material transfer and commercial use for cotton transgenic Event-USAD Event no. 78 for R&D promotion between University of Agricultural Sciences, Dharwad and ICAR-NRCPB, New Delhi on 04.08.2017.

III. Germplasm registration: One

Rao M, Bhat SR, Gupta NC, Chamola R, Bhattacharya RC & Singh N. 2017. Yellow sarson germplasm NRCPB rapa-8; a potential parent for resynthesis of *B. juncea*. National identity, IC0623820; registration number INGR17050. No./CONS/PGRC/2017.

Financial statement: Expenditure under CAFT during XI plan

Head	2017-18	2018-19	2019-2020
Training	570214	634661	631077
Recurring Contingency	399991	400000	357890
Books	34263	00	32560
T.A/DA	00	00	22000
Minor equipment	-	-	-
Renovation	-	-	-
Total	1004468	1034661	1043527