CV **Dr Surinder Singh BANGA**

Date of birth : 06-08-1955 **Place of birth** : Kanpur, India

Nationality : Indian

University titles : Professor

Occupation : ICAR National Professor
Department of Plant Breeding and Genetics
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Publications

Published papers/reviews/book chapters, three bulletins and edited two acclaimed books. The publication impact analysis is presented below.

(a) Books

1. Labana, K.S., S.S. Banga and S.K. Banga (1993) Breeding Oilseed Brassicas (ed. vol.), Monograph Theor. Appl. Genet. No. 19. Springer Verlag-Berlin, Narosa Publishing House- New Delhi, Toppan company (S) Pte Ltd. Singapore. 251p.

2. Banga, S.S. and S.K. Banga (1998) Hybrid Cultivar Development (ed. vol.). Co-publication: Springer Verlag-Berlin, Narosa Publishing House, New Delhi-London. 536 p.

3. Kang, M.S. and S.S. Banga (2013) Combating climate change: an agricultural perspective. CRC Press (In Press).

(b) Bulletins

1. Sidhu, P.S., R.S. Sidhu, R. Singh, V.K. Dilawari, S.S. Banga and J.S. Sandhu (1997). Fifty years of agricultural development in Punjab. Punjab Agril Univ. Press, Ludhiana, 35p.

2. Banga, S.S., S.K. Banga and K.L. Ahuja (1998). Towards canola quality in rapeseed-mustard. Punjab Agril Univ Press, Ludhiana, 12p.

3. Banga, S.K. Gurpreet Kaur, S.S. Banga (2005). *Brassica* Lipid Engineering. ICAR-PAU, Ludhiana, 48p.

(c) Original Research Papers

1. Banga, S.S., B.S. Dahiya and P.S. Sidhu (1980) Genetic architecture of some morphological traits in peas (*Pisum sativam* L.). Genet. Agr.24: 289-293.
2. Banga, S.S. and K.S. Labana (1983) Incidence of parthenogenetic maternals after prickle pollinations of *Brassica juncea* (L.) Coss. Z. Pflanzenzuecht. 91: 227-232.
3. Banga, S.S. and K.S. Labana (1983) Heterosis in Indian mustard (*Brassica juncea* (L.) Coss.). Z. Pflanzenzuecht. 92: 61-70.
4. Banga, S.S. and K.S. Labana (1983). Production of F_1 hybrids by using ethrel induced male sterility in Indian mustard (*Brassica juncea* (L.) Coss.). J. Agric. Sci. Camb. 101: 453-456.
5. Banga, S.S. and K.S. Labana (1983) Ethrel induced male sterility in Indian mustard (*Brassica juncea* (L.) Coss. Z. Pflanzenzuecht. 92: 229-233.
6. Banga, S.S., K.S. Labana and B.N. Medhi (1984) Alternaria incidence in some alloplasmic lines of Indian mustard. Theor. Appl. Genet. 67: 195-197.
7. Banga, S.S. and K.S. Labana (1984) Male sterility in Indian Mustard (*Brassica juncea* (L.) Coss.) - a biochemical characterization. Theor. Appl. Genet. 67: 514-519.
8. Banga, S.S., S.K. Banga and K.S. Labana (1984) Gametic gene transfer in Indian mustard (*Brassica juncea* (L.) Coss.). Heredity 53: 293-297.
9. Banga, S.S. and K.S. Labana (1984) Potentials of an off–season soybean nursery in India. Soy. Genet. Newlett. 11: 42-43.
10. Banga, S.K., S.S. Banga and M. Srivastava (1984) Induced parthenogenesis in Soybean (*Glycine max* (L.) Coss.). Soy. Genet. Newslett. 11: 45.
11. Labana, K.S. and S.S. Banga (1984) Floral biology in Indian mustard (*Brassica juncea* (L.) Coss). Genet. Agr. 30: 131-138.
12. Banga, S.S. and K.S. Labana (1984) Preliminary studies on graft hybridization in *Brassica*. Cruciferae Newslett. 9: 338-39.
13. Banga, S.S. and K.S. Labana (1985) Male sterility in Indian mustard (*Brassica juncea* (L.) Coss.). IV. Genetics and Cytology of MS-4. Can. J. Genet. & Cytol. 27: 487-490.
14. Banga, S.S. (1985) Hybrid pollen-aided induction of matromorphy in *Brassica*. Z. Pflanzenzuecht. 96: 86-89.
15. Banga, S.S. (1985) Mentor pollen for induced matromorphy in *Brassica*. Incomp. Newslett. 17: 8-9.
16. Banga, S.S., K.S. Labana, S.K. Banga and B. Singh (1986) Experimental evaluation of male gametocides in Indian mustard (*Brassica juncea* (L.) Coss). SABRAO J. 18: 31-35.
17. Banga, S.S. and K.S. Labana (1986) Spontaneous haploidy in *Brassica napus*. Cruciferae Newslett. 11: 54-55.
18. Banga, S.S., K.S. Labana and A. Srivastava (1988) Evaluation of '*nap*' cytoplasmic male sterility in *Brassica napus* L. under Indian conditions. Oilseeds J. 5: 13-16.
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21. Banga, S.S. and K.S. Labana (1991) Cytoplasmic – genetic relationship between *Brassica nigra* and *Sinapis allioni*. Cruciferae Newslett. 14/15: 12-13.
22. Banga, S.K., Banga, S.S. and K.S. Labana (1991) Experiments with exogenous DNA uptake in *Brassica juncea* L. Coss. Cruciferae Newslett. 14/15: 12-13.
23. Ahuja, K.L., S.K. Banga and S.S. Banga (1993) Variation for photosynthetic pigments in *Brassica* and allied genera. J. PI. Sci. 9: 90-91.
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29. Banga, S.S., G.S. Sandha, M.L. Gupta and R.S. Sohu (1995) Experiments in hybrid seed production in Indian mustard (*Brassica juncea* L.). Seed Sci & Technol. 23: 51-57.
30. Kirti, P.B., S.S. Banga, S. Parkash and V.L Chopra (1995) Transfer of *Ogu* cytoplasmic male sterility to *Brassica juncea* and improvement of the male sterile through somatic cell fusion. Theor. Appl. Genet. 91: 517-521.
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37. Banga, S.K. and S.S. Banga (1998) Attempts to develop fertility restorers for *oxy* CMS in crop *Brassica*. Acta Hort. 459: 305-311.
38. Banga, S.S. (1998) Genetics and Breeding in *Brassica* oilseeds. Acta Hort. 459: 389-395.
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45. Ahuja, I., P.B. Bhaskar, S.K. Banga and S.S. Banga (2003) Synthesis and cytogenetic characterization of the intergeneric hybrids of *Diplotaxis siifolia* with *Brassica rapa* and *B. juncea*. Pl. Breed. 122 : 447-449 .
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56. Gill, U.S., S.S. Banga, I. Ahuja and S.K. Banga (2006) *In vitro* regeneration from cotyledonary explants of *toria* and brown *sarson* morphotypes of *Brassica rapa* ssp. *oleifera* with a special reference to S-allele homozygotes. J. Oilseeds Res. 23: 26-30.
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58. Garg, H., S.K. Banga, P. Bansal, C. Atri and S.S. Banga (2007) Hybridizing *Brassic .rapa*, with wild crucifers *Diplotaxis erucoides* and *Brassica maurorum*. Euphytica 156: 412-424.
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64. Garg, H., C. Atri , P.S. Sandhu, B. Kaur , M. Renton, S.K. Banga, H. Singh, C. Singh , M.J. Barbetti and S. S. Banga (2010) High level of resistance to *Sclerotinia sclerotiorum* in introgression lines derived from hybridization between wild crucifers and the crop Brassica species *B. napus* and *B. juncea*. Field Crops Res.117: 51-58.
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66. Kumar, S., C. Atri, M.K. Sangha and S.S. Banga (2011) Screening of wild crucifers for resistance to mustard aphid, *Lipaphis erysimi* (Kaltenbach) and attempt at introgression of resistance gene(s) from *Brassica fruticulosa* to *Brassica juncea*. Euphytica 179: 461–470.
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c) Reviews

70. Banga, S.K. and S.S. Banga (2002) Erucic acid heredity in oilseed *brassicas*: A review. J. Oilseeds Res. 19: 1-5.

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72. S.K. Banga, P.B. Bhaskar and S.S. Banga (2005) Genetically engineered systems of male sterility. J.Oilseeds Res. 23: 1-7.

Themes of work in progress

Ongoing work aims at integration of information to allow navigation via. Comparative genomics from genetics loci to chromosome, and development of tagged crop genetic resources. Understanding novel genetic variation following uncoupling and re-coupling of Brassica genomes, molecular-genetic characterization of determinacy, development of heterotic gene pools in *Brassica juncea*.

Delivery of research

Varieties released/identified for commercial cultivation:

Mustard:	National level	: RLC 2 (0- erucic), PBR 357, RL99-22.
	State level	: RLC 1 (0- erucic).
Toria :	State level	: TL 17.
Oilseed Rape :	National level	: GSC 6 (Canola).
	State level	: GSC 6 (Canola), GSC 5 (Canola), PGSH 51 (Hybrid) GSL 2 (Atrazine herbicide resistant).

Ethiopean mustard: National level : PC 5-17.

State level : PC 5.

Basic and strategic research outputs, including germplasm development

- **CMS systems:** Developed *Enarthrocarpus lyratus /Diplotaxis cardaminoides* cytoplasm based sources of cytoplasmic male sterility for *B. rapa / B. juncea / B. napus*. Co-developed refined *ogu* CMS system in *B. juncea* in association with *Brassica* biotechnology group at NRC (PB), IARI, New Delhi.

- **Synthesis of new intergeneric hybrids / amphiploids**: *Diplotaxis siifolia* x *B. rapa, D. catholica* x *B. rapa, Erucastrum canariense* x *B. rapa, E. cardaminoides* x *B. nigra, E. cardaminoides* x *B. rapa, Brassica juncea* x *E. abyssinicum, B. fruticulosa* x *B. rapa, B. juncea* x *D. tennuesiliqua, B.nigra x D. erucoides*. Analysis of chromosome affinities in these hybrids helped in the establishment of genomic relatedness between wild crucifers and crop brassica species.

- **Introgression lines:** Four sets of introgression lines have been developed in *B. juncea* for resistance to sclerotinia rot, frost and drought tolerance. These different sets of lines carry introgressions from *E. cardaminoides*, *D. tennuesiliqua*, *E. abyssinicum* and *Brassica fruticulosa*. Phenotyping of these introgression lines have shown them to be valuable genetic resource base for resistance to the target defensive traits. Genotyping of these lines will help in developing molecular tags for the genes(s) putative for tolerance to several *Brassica* maladies.

- **Resynthesis of digenomic *Brassica* species:** A large number of digenomic *Brassica* species especially *B. juncea* were resynthesized using preselected and prebred monogenomic progenitor species. These were characterized using morphological, genetic and molecular markers. These constitute a new gene pool for key economic traits.
- **Nitrogen/water use efficiency/high temperature stress:** Extensive germplasm screening has allowed the identification of genetic resources for

water/nitrogen use efficiency and resistance to high temperature stress in crop *Brassica* species. Biochemical parameters associated with desired variability were also identified. Diversity Fixed Foundation Set (DFFS) also developed. The set comprises 54 highly self bred (S_6) genotypes to be used for association mapping.

- **Chromosome addition and substitution lines:** Synthesized and characterized B/C-genome chromosome addition lines in *B. rapa*; C-genome chromosome substitution lines in *B. juncea*. At present 7 disomic substitution lines, possibly carrying different A/C substitution in *Brassica* being maintained.

- **New concepts/methods developed**

  i) Developed determinate *Brassica* genotypes.
  ii) Association mapping for establishing linkage of molecular markers (AFLP) with seed coat colour in oilseed *Brassicas*.
  iii) AFLP /SSR/ RAPD markers associated with fertility restorers for *tour* / *lyr* and *carda* CMS systems in *B. napus*.
  iv) Germplasm patterns based on DNA polymorphism generated by SSR markers in *B. juncea*, *B. napus, B. rapa* and *B. nigra*.
  v) Catalogued mustard/ oilseed rape germplasm for nitrogen use efficiency/ drought tolerance. Enzyme GOGAT was directly associated with NUE.
  vi) Matromorphy for rapid approach to homozygosity.
  vii) Hybrid seed production technology for mustard and oilseed rape.
  viii) Procedure to estimate biological penalty (yield loss) associated with cytoplasmic male sterility.
  ix) Concept of heterosis due to amphiploidy (fixed heterosis) vs. classical heterosis in digenomic *B. juncea*. Fixed heterosis was negatively associated with classical heterosis and hence, could be one of the causes of low realizable heterosis in Indian mustard.

Academic qualifications :

i) B.Sc. (Biology) : 1975 – Kurukshetra University, Kurukshetra.
ii) M.Sc. (Plant Breeding) : 1978 – Punjab Agricultural University, Ludhiana.
iii) Ph.D. (Plant Breeding) : 1982 – Punjab Agricultural University, Ludhiana.

Employment record

Position	Employer	From	To	Responsibilities
ICAR National Professor	ICAR	13th Jan.,2010	Till date	Germplasm enhancement in *Brassica juncea*
Head, Dept. of Plant Breeding & Genetics	PAU, Ludhiana	Nov.,2009	12th Jan.,2010	Administration
Sr. Scientist (Oilseeds)/Prof.	- do-	May, 2004	12th Jan.,2010	*Brassica* breeding Teaching, Extensive Research condition
Sr. Oilseeds Breeder	-do-	Jan, 1997	April, 2004	*Brassica* breeding Teaching, Extension
Oilseeds Breeder	-do-	Aug, 1988	Dec, 1996	-do-
Asstt. Prof. Equiv.	-do-	May, 1983	Aug, 1988	-do-
Asstt. Prof.	BAU, Ranchi	Nov, 1982	April, 1983	Soybean Breeding, Teaching

Research contributions

Surinder Banga leads Brassica group at Punjab Agricultural University that have developed an innovative research program on Oilseed Brassicas. The researches primarily aim at germplasm enhancement with focus on heterosis, polyploidy and wide hybridization. His research employs *Brassica juncea* and *B.napus* as core experimental systems. He and his colleagues have studied heterosis due to alloploidy (fixed heterosis) and found that heterosis and genetic diversity in parental diploid species were not predictors of heterosis, combining ability and genetic diversity respectively at alloploid level. They have now developed the concept of uncoupling and re coupling genomes in Brassica amphiploids to allow seamless flow of genetic information among digenomics. The process also allows use of polyploidization to generate novel variation of economic importance. Such changes were associated genome restructuring and size variation in *Brassica juncea*. The results also proved that hybridization of two digenomics may lead to a third digenomic, establishing a possible new route for polyploids to acquire variability under natural conditions. These results have significant implications, not only for the field of Brassica improvement , but also for deploying polyploidy to effectively manipulate gene expression. For the first time genotypes with determinate growth habit could be developed in all three Brassica digenomics. Developed /improved CMS sources (refined *ogu, lyr, carda, fruti)*. In view of rapidly changing climate and consequent requirement of new germplasm resources, the group is now working aggressively on evaluating and exploiting variation available in wild crucifers. Genomic relatedness between *Brassicas* and several wild crucifers could be established. Developed four sets of alien introgression lines which comprise critical gene pools for resistance/tolerance to sclerotinia stem rot, frost, drought tolerance and mustard aphid. Established heterotic germplasm patterns in *B. juncea*. Brassica group has also succeeded in introgressing gene(s) for shattering resistance in *B.napus* from *B.carinata*. Prof. Banga has also co-developed ten high yielding varieties in rapeseed –mustard .