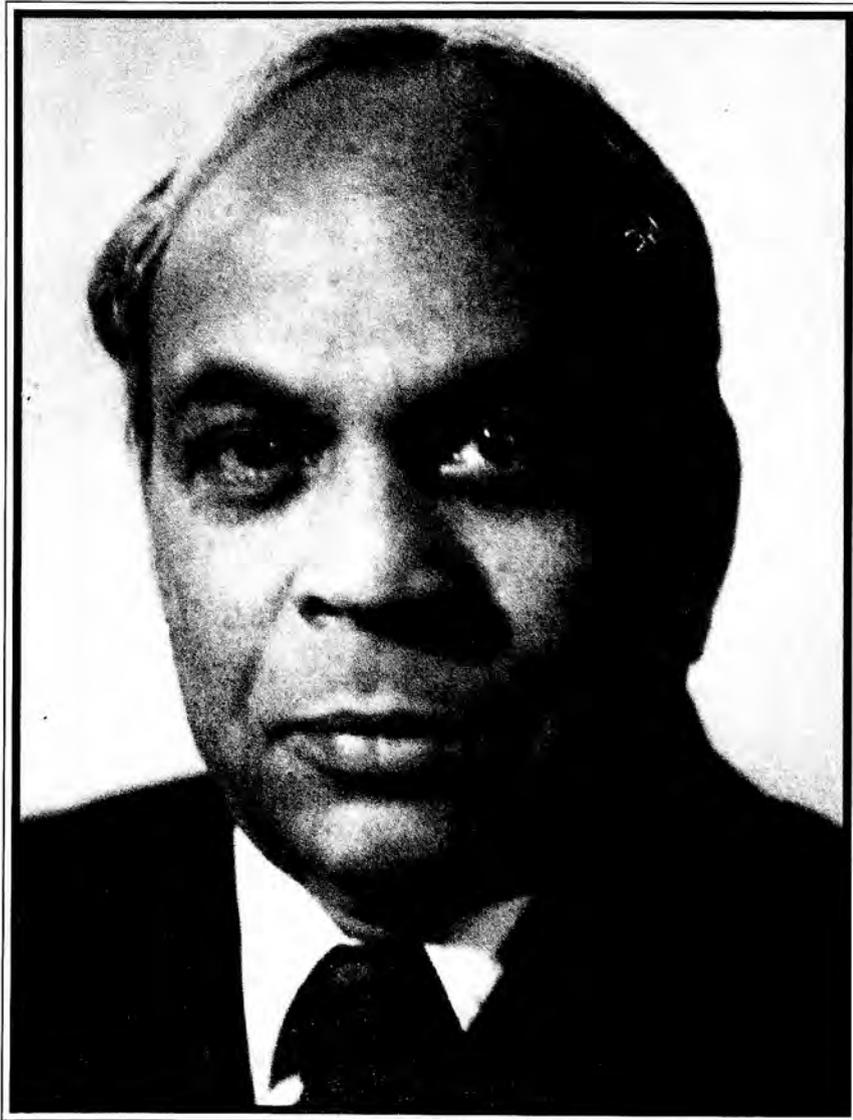


ATMARAM BHAIRAV JOSHI

(17 November 1916 ~ 3 July 2010)

Biog. Mem. Fell. INSA, New Delhi **39** (2011)





A. B. Joshi



ATMARAM BHAIRAV JOSHI

(1916-2010)

Elected Fellow 1962

BIRTH, EARLY LIFE AND EDUCATION

ATMARAM BHAIRAV JOSHI was born on 17th November 1916 at Jabalpur, Madhya Pradesh, and was six years younger of the two sons born to Mrs Bhavanibai alias Shantabai and Mr Bhairav Balwant Joshi, an officer in the State Government Department of Agriculture. Govind, his elder brother, a graduate (BSc), unfortunately died very young (1931). Atmaram was educated in Government High School, Raipur (1925-32) from where he obtained his High School Certificate (First Division, Distinction in Mathematics). He then joined the College of Science, Nagpur and passed Intermediate (1934), and BSc (Hons, 1937) from Nagpur University with Botany as major, and Zoology and Chemistry as minor subjects obtaining First Division.

Atmaram Joshi, or simply 'Ram Joshi' as he was called by his close friends and relatives, subsequently joined the then Imperial (now Indian) Agricultural Research Institute (IARI), New Delhi (then located at Pusa, Bihar) and completed Diploma of Associateship (1940) (Equivalent to MSc) availing the King Edward Memorial Scholarship in 1939. He then joined IARI and worked as Research Assistant (1940-45). In the meanwhile, he submitted his thesis to the Nagpur University and was awarded MSc (Botany, 1945). During 1945, he joined the IARI as Assistant Botanist, a gazetted post at that time, and worked as Assistant Cytogeneticist (1947-54). Upon being selected by the Government of India for the Overseas Doctoral Scholarship, he joined the School of Agriculture, Plant Breeding Institute, University of Cambridge, England (1947) under the supervision of Professor HW Howard, obtained PhD (1950) in Agricultural Botany and got initiated to Cytogenetics and Plant Breeding.

Dr Joshi always considered himself to be a trained botanist and then an agricultural scientist. The change from botany to agricultural research, as he considered, was a big challenge involving development of agricultural science in the 'economic sense'. Dr Joshi did not like compartmentalization in scientific disciplines. He even used to say, "If in any research institute, inter-disciplinary, inter-personal, goal-oriented scientific discussions do not take place, such an institute, no matter big or small, can be pronounced as dead". The concept of multidisciplinary, multi-location field trials under All India Coordinated Crop Improvement Projects,



conceived and successfully put into systemic practical infrastructure later in his career, are an exemplary proof of the correctness of his philosophy.

CAREER

After his return to IARI, Dr Joshi started innovations by revising and incorporating vigorous teaching courses in Genetics and Plant Breeding in line with other European universities. He was promoted to the post of Geneticist (1954), full Professor of Botany (1958) and then assumed charge as Head, Division of Botany (1959). Policy decisions for the reorganization of ICAR, creation of a network of state agricultural universities, and a Postgraduate School in IARI had already been taken in the 1950s. After IARI was formally granted the status of Deemed to be University (1958), Joshi was called upon to take the position of the First Dean of the IARI's Postgraduate School (1959). As Dean of the School, he introduced several innovative changes in its courses and curriculum, rules and regulations, its working, and creation of the posts of Joint Directors for Research, Education, Extension and Administration for its smooth functioning. He also contributed significantly to the overall reorganization of ICAR as an apex and autonomous body to manage agricultural research, education and extension in the country. As member of the Education Commission (The Kothari Commission), he influenced the creation of exclusive agricultural universities in the country with a mandate to establish at least one such university in every state to bring about quick solutions to location and crop-specific, agro-climatic conditions related regional problems of agriculture of that state. In recognition of his immense contributions, he was appointed Director, IARI (1965). However, very soon he took charge as Deputy Director General (DDG) (Crop Sciences), ICAR Headquarters (1966) where he put in place nationwide effective mechanism of coordination, in the form of the All India Coordinated Research Projects bringing in scientists from different universities, institutes and state departments for mutual inter-institutional, inter-disciplinary and complementary cooperation. As DDG and the first Project Coordinator on Wheat (additional charge), he provided overall directions and leadership to the National Coordinators of these projects on different crops including wheat, rice, maize, sorghum, pearl millet, pulses and oil-seeds. The Coordinated Projects provided a mechanism for joint evaluation of new genotypes, hybrids and technologies of crop cultivation, crop rotations, crop protection, fertilizer and irrigation scheduling, etc. at agro-climatically different locations and arrive at collective recommendations for identification and release of new varieties to farmers. If India's experiment with the All India Coordinated Research Projects has succeeded so well, it is undoubtedly due to the leadership provided by him in those early years. This concept of coordinated crop trials at various locations is fundamentally linked to the natural annual and diurnal rotation of the earth, its inclination, availability of the location specific sunshine hours, threshold energy requirement and possibility of meeting



those from the place of growth for any crop species, agro-climatic zones which provide conducive soil and environmental conditions for crops to germinate, sustain crop-stand and produce economic yields. It was not so easy to put all these crop requirements into practical schemes of things. Only a visionary could conceive and do so. Presently, new techniques for improvement of crop-plant productivity such as the gene cloning, mass propagation of virus-free crop/horticultural plants through tissue culture, and molecular-marker-aided selections and breeding are being used. However, any new plant types developed through these techniques will certainly have to pass the tests for economic yields, disease and insect tolerance in multi-location field trials. It is in this context, the concept of the All India Coordinated Crop Improvement Projects, will continue to remain crucial and relevant as the vehicle for transfer of technology. But for the All India Coordinated Research Project on Wheat, which culminated into the first green revolution and saved millions of lives from starvation, India would not have been living in honour as an independent Sovereign State. It was Professor Joshi who evaluated Dr Norman Borlaug's dwarf wheat materials at Sonora and Toluca Valley stations in Mexico during his visit in 1963 and foresaw their potential for a wheat revolution in India. Also, it was at his request that the first lot of seeds of four semi-dwarf wheat varieties: Lerma Rojo, Sonora 63, Sonora 64 and Mayo, bred by Dr Norman Borlaug were received in India for their field trial under the Coordinated Wheat Research Project. In consequence, India could build a buffer stock of 12.5 million tons of food reserve for the first time (1972-73).

Dr Joshi, who prepared the first strategic blueprint, created infrastructure, a permanent strategic working methodology for crop evaluation and improvement to ensure continued sustainability of our agricultural production, deserves a 'National Salute'. Under his leadership and guidance, coordinated crop improvement projects were initiated in 23 crops. India introduced the cultivation of protein-rich soybean crop on commercial scale for the first time, Maharashtra achieved self-sufficiency in hybrid sorghum production, and India made a commercial success of hybrid cotton for the first time in the world, with improvement in both quality and quantity of lint cotton yields. These developments made the country self sufficient in medium and short staple category of cotton lint and created millions of jobs in cotton and other crops related trade and industries. With support from Dr BP Pal, he was instrumental to establish the Plant Introduction Division in IARI and later to create the National Bureau of Plant Genetic Resources for the collection, maintenance, preservation of all existing and exotic plant germplasm from within the country and elsewhere for continual plant breeding and improvement strategies. Personally, he always insisted that all the germplasm collected have no value if it just sits pretty as accessions in our gene banks, in those long-term-storage facilities. He even stressed that a 'frozen bank account' is of no value to its depositors. Plant-genetic wealth is as good as non-existent if it is not systematically evaluated, catalogued and utilized.



wonder, he vehemently opposed local and global commercialization of germplasm and considered patenting and patent rights of seeds and plant germplasm as something like a crime against humanity and ethically immoral.

Dr Joshi returned back to IARI as Director (1972) and retired from there (1977). Known for his comprehensive understanding of agriculture in a multidisciplinary way, sharp memory to remember individual names and anecdotes, witty remarks and comments, social nature, kind heartedness, judicious attitude and proficiency in several languages, he had uncanny ability to win friends in all age groups and from many linguistic and social communities. Having grown with relocation of IARI to New Delhi (1937), he intensely loved the Institute and considered it to be his mother, which provided him freedom and facilities to work, environment to think positively and progress. During his second tenure as the Director (IARI), he took initiative to get the 'Master Plan for IARI and Residences' prepared from the renowned architect and town planner Mr Achyut Kanvinde and get it approved by ICAR before his retirement.

After his retirement from IARI, he was appointed as Vice Chancellor of the Mahatma Phule *Krishi Vishwa Vidyalaya*, Rahuri in Maharashtra and Chairman of the Coordination Committee of the Vice Chancellors of all the four Agricultural Universities in the State. As Vice Chancellor, he brought about qualitative changes in recruitment of competent teachers, quality of research and teaching and practical solutions to regional problems of farmers. As a result, the *Vidyalaya* soon emerged as one of the best centers of learning in agricultural sciences in the country.

RESEARCH CONTRIBUTIONS

Dr Joshi himself conducted pioneering research in genetics, cytogenetics and plant breeding. Bestowed with unusual memory, mental faculties, alert mind, wit and wisdom and command over languages such as English, Hindi, Bengali, Punjabi, Marathi and Sanskrit, he was a gifted popular teacher par excellence. His lectures on 'Mendelian Genetics and Darwins Theory of Evolution' are still remembered with awe by several of his students. He, individually and along with his students, researched on several important crops and plants species such as almost all important species of *Triticum* and its land races, pigeon pea (*Cajanus cajan* (L) Millsp.), Linseed (*Linum usitatissimum* L), Chilli (*Capsicum annuum* L), Berseem (*Trifolium alexandrinum* L), Cotton (*Gossypium arboretum*, *Gossypium herbaceum*, *Gossypium hirsutum*, *Gossypium barbadense* and their land races), besides working on *Coriandrum sativum* L, Genus *Abelmoschus*, *Panicum* L, and Quantitative characters in *Barley*. His work on cotton improvement in Egypt and preparing blue print for overall agricultural education and development in Malaysia and Indonesia are still being considered classic. He published over 300 articles and research papers besides writing innumerable editorials and commentaries on most current researches and



discoveries of those times in his popular journal, *Indian Journal of Genetics and Plant Breeding* (IJGPB). He nurtured both IJGPB and the Indian Society of Genetics and Plant Breeding. His two monographs on *Sesamum-Til* and another on *Cotton* in four volumes are classic and standard references for any beginner even today. Salient features of his research contribution are:

Cytogenetics: In this area of research, his work was directed towards the study of natural and artificially produced polyploids and inter-specific hybrids in crop plants from the standpoint of their evolutionary interrelationships and economic value. Polyploidy was induced using the colchicine technique in chilli, gram, sesamum, brassica, linseed and other crop plants, which indicated the possible role of this new approach to the improvement of cultivated plants. Inter-specific hybridization was undertaken in sesamum with the object of introducing the phyllody resistance of the wild species, *S. prostratum* into cultivated sesame. In the genus *Abelmoschus*, to which the cultivated okra (Lady's finger or Bhindi) belongs, new chromosome numbers were discovered. Cytogenetical studies on them and on their inter-specific hybrids demonstrated the alloplod nature of the cultivated okra and threw light on the evolutionary status of this group of species. Through these studies, okra species completely immune to the yellow vein mosaic virus disease were discovered. Varieties of these species are still prevalent in the vegetable markets all over the country. His successful work on inter-specific hybridization between bajra (*Pennisetum typhoides*) and *P. squamulatum* and cytogenetical observations showed that the latter species is an autoalloplod. Cytological studies on a number of grass species, e.g. *Cenchrus ciliaris*, *C. setigerus*, *Pennisetum pedicellatum*, *Chrysopogon montanus*, *Panicum colloratum* and *Heteropogon contortus* revealed the existence of intraspecific chromosome races and made possible the isolation of a number of economically useful strains. Further, his studies on interspecific hybrids of hexaploid species of *Avena* threw considerable light on the origin of the cultivated oats.

Plant Breeding: Early work done by Professor Joshi covered a wide variety of crop plants, namely linseed, sesamum, pigeon pea, cotton, essential-oil-bearing plants, forage grasses and wheat. Particularly in linseed, pigeon pea and wheat, the main emphasis was to breed newer crop plant varieties tolerant or resistant to various diseases. He successfully evolved a large number of rust-resistant strains of linseed and wilt-resistant strains of pigeon pea. Not only this, he introduced a biometrical approach for improvement of the yield and other quality and economic characters in linseed, cotton, pigeon-pea and wheat using correlation and regression analysis and diallel-cross technique for successfully breeding varieties with improved yields and in cotton for improved ginning out-turn and staple length. These researches provided fundamentally valuable and crucial information for practical breeding.

In case of a large number of species of pasture grasses suitable for cultivation in arid and semi-arid regions in India, he evolved a large number of economically



useful strains using simple breeder-selection techniques. He also used the male-sterility technique for the detection of the extent of sexuality in the predominantly apomictic species. In case of essential-oil-bearing spice plants, such as ajwain, coriander, fennel and dill, several strains with increased oil content and yield were developed for commercial cultivation. He was also instrumental in isolation of an important strain of chilli, which was completely resistant and immune to the mosaic virus disease and became an important source for breeding its more virus resistant varieties.

Multi-location, Multi-disciplinary Coordinated Wheat Improvement Project: One of the best known works of Professor Joshi is his concept and initiation of the All India Coordinated Wheat Improvement Project with possibility of conducting yield and other agronomic and disease-resistance trials of newly bred wheat varieties at various locations and different agro-climatic conditions, considerably reducing thereby the time required for comprehensively screening varieties for various economic traits and for early release to farmers for commercial cultivation. He himself provided leadership to the All India Coordinated Wheat Improvement Project by assuming the responsibility as the First Project Coordinator in addition to his own responsibilities as DDG (Crop Sciences). The infra-structure laid by him and the systemic methodology he prepared for the Coordinated Project came handy in successful evaluation of the Mexican dwarf wheat varieties evolved by Dr Norman Borlaug and the subsequent onset of the first ever 'Green Revolution' witnessed by the country. The role model of wheat project was soon replicated for improvement of 25 other crop species in the country, which saved not only millions of lives in the country from starvation but made the country almost self-sufficient with a sizeable amount in buffer for contingent emergencies.

AWARDS AND HONOURS

Throughout his scientific and administrative career spanning over five decades, Professor Joshi handled several prestigious assignments nationally and internationally as Member of the Prime Minister's Scientific Advisory Committee and Advisor in several international organizations under the FAO/UNDP, CGIAR, World Bank, IBPGR, CIMMYT-Mexico and ISNAR-Netherlands. He was honoured by several universities with honorary doctorate degrees, academies and scientific societies with fellowships for his contribution to the cause of education and agriculture in particular and by the President of India with Padma Shree.

OTHER QUALITIES

A connoisseur of Hindustani Classical Music and an accomplished flutist, he was married on May 7, 1937 to an equally prolific thinker, freelance writer, multilingual translator and a versatile painter, Ms Vimala Joshi (Nee Miss Vimala Gangadhar).



Kawaley) who was always a constant source of inspiration, sincere guide and a trusted companion to him.

Professor Atmaram Bhairav Joshi, as a strict disciplinarian and a conscious individual about personal physical, physiological and mental health, led a very contented, hale and hearty life for over eight decades, until he was unexpectedly caught with pneumonia in 2003 and suffered bouts of fainting. This was diagnosed as *sinus bradycardia* which caused insufficient blood supply to the brain. For this a pacemaker was implanted as an aid to pump enough blood through his arteries and to be able to breathe properly. A voracious reader, scientific critic, logical analyst, master strategist, superb administrator and fundamentally a noble man at the heart, Dr. Joshi had no regrets in life, no enemies, no desires, no cravings for personal glory. He only listened patiently to all those who approached him with problems or advice and he would suggest several ways to get to the roots of the problem and seek solutions. Backed up by his rich experience, capacity for original unbiased thinking and sincerity of convictions, Dr Joshi ever remained a teacher even to the stalwarts in the area of agricultural research.. Unfortunately, he lost his voice in the last part of his life that only allowed him to speak in very feebly audible and yet very clear words. Detailed diagnosis revealed that he had a condition called aortic arch aneurysm, a swelling on his aorta that was pressurizing the recurrent pharyngeal nerve, which is responsible for movement of the vocal chords. Due to this pressure, one of his vocal cords was paralyzed in the open position. As a result of the recurrent bouts of asthma, his health had become a cause of concern both to his family and to the Doctors attending on him. Then on July 3rd 2010, he suddenly called out repeatedly-- "Open the door, Open the door" and with that opening of the mysterious door- he suddenly slipped into oblivion and passed away.

REMEMBERING PROFESSOR JOSHI

A special felicitation volume '*Profile in Solitude*' edited by Professor AV Moharir was published to celebrate his 91st birthday on 17th November 2007. This volume details developments in Indian agriculture since independence, and personal accounts and memoirs of some celebrated individuals from the agricultural field about Professor Joshi as fellow colleague, associate in projects, philosopher, guide, mentor of career, teacher, planner, administrator, friend and as the finest cultured human being.

His wife, only son Jayant, daughter-in-law and two grand daughters, survive Professor Joshi.

Dr. ANIL VISHNU MOHARIR
A-408, Vasundhara Apartments
Sector-6, Plot-16, Dwarka
New Delhi-110 075
E-mail: amoharir@rediffmail.com



BIBLIOGRAPHY

- 1941 (With PAL BP and RAMANUJAM S) Colchicine-induced polyploidy in crop plants II. Chilli (*Capsicum annuum*), *Indian J Genetics*, **1**: 28.
- (With RAMANUJAM S) Colchicine-induced polyploidy in crop plants. 1. Gram (*Cicer arietinum* L.), *Indian J Agric Sci*, **11**: 835.
- 1942 (With RAMANUJAM S) Inter-specific hybridization in Nicotiana: A cytological study of the hybrid *N.glaucegrab* X *N.Plumbaginifolia* vir., *Indian J Genetics*, **2(2)**: 80.
- 1943 (With VISWANATH B, et al.) *Crystostegia grandiflora* R. Br.: A War time source of vegetable rubber, *J Sci Ind Res*, **1**: 335.
- 1947 (With RAMANUJAM S) Chromosome number of *Sesamum laciniatum* Klein, *Nature*, **161**: 99.
- (With RAMANUJAM S) The use of wild species in breeding improved varieties of cultivated til (*Sesamum orientale* L.) and some consideration on the origin and distribution of *S. orientale*, *Indian J Genet*, **11**: 100.
- (With HARDAS MW) Chromosome number of *Abelmoschus tuberculatus*, A species related to the cultivated Bhindi, *Curr Sci*, **22(12)**: 384.
- 1953 Polyploidy and organic evolution, *Symp Organic Evolution*, **Bull No. 7**, Nat. Inst. Sci., India.
- 1954 (With HARDAS MW) A Note on the chromosome numbers of some plants, *Indian J Genet*, **14**: 47.
- (With RAMANUJAM S) Identity and taxonomic status of *Sesamum ekambaramii* Naidu, *J Bombay Natur Hist Soc*, Aug-Dec Issue, pp. 52.
- 1955 (With HOWARD HW) Meiotic irregularities in hexaploid oats-IV: Hybrids between *Avena sativa* (Spring and winter varieties) *A. fatua*, *A. steritis*, *A. byzantina* and *A. nuda.*, *J Agric Sci*, **46(2)**: 183.
- (With HOWARD HW) Meiotic irregularities in hexaploid oats. III: Further observations on the frequency of univalents and other meiotic irregularities in spring X winter variety hybrids of *Avena sativa*, *J Agric Sci*, **45(3)**: 380.
- (With SIKKA SM) Exploitation of hybrid vigour in bajra (*Pennisetum typhoides*), *ICAR Conf Workers on Millets*, Kolhapur, Maharashtra, Paper No. 34.
- (With SIKKA SM) Collection and maintenance of millets varieties and types grown in India, *ICAR Conf Workers on Millets*, Kolhapur, Maharashtra, Paper No. 35.
- 1956 (With HARDAS MW) Allopolyploid nature of okra, *Abelmoschus esculentus* L. Moench, *Nature*, **178**: 1190.
- (With HARDAS MW) A Chromosome number new to *Linum*, *Nature*, **178**: 499.
- (With JESWANI LM and DESHPANDE RB) Inheritance of some fruit characters in chilli, *Indian J Genet*, **16**: 138.
- (With HARDAS MW) Ploidy in two Bignoniaceous garden climbers, *Indian J Genet*, **16(1)**: 57.
- Heterosis or hybrid vigour helps fight hunger and want, *Everyday Sci*, **4(3, 4)**: 10.
- 1957 Genetics of resistance to diseases and pests, *Indian J Genet*, **17**: 305.
- Evaluation of various methods of cotton breeding, *Eighth Conf Cotton Growing Problem*, Coimbatore.



- 1957 (With SIKKA SM and MITTAL SP) Pistil-less-off-type plants in Bajra, *Pennisetum typhoides* STAPF and Hubbard, *Curr Sci*, **26**: 114.
- Genetics of resistance to diseases and pests, *Indian J Genet*, **17(2)**: 305 (Special Symp Issue *Genetics and Plant Breeding in South Asia*, Indian Society of Genetics and Plant Breeding, January).
 - (With PATI BD and MANCHANDA PL) Chromosome numbers in some grasses, *Curr Sci*, **28**: 454.
 - (With MISRA RC, RAO GRK and GULATI KC) Determination of essential oils using modified trap developed at IARI, *Indian J Genet*, **6**: 201.
 - (With KEDARNATH S and RAMANUJAM S) Chromosome pairing in two sesquiploid hybrids and its bearing on genome relationship in the genus *Sesamum*, *Indian J Genet*, **19(2)**: 201.
 - (With RAO SBP) The Role of breeding jassid resistant varieties of cotton in India, *Indian Cotton Grow Rev*, **13**: 270.
- 1960 (With HARDAS MW) Cotton improvement through interspecific hybridization and the role of wild germplasm, *Indian Cotton Grow Rev*, **14**: 82.
- (With SWAMINATHAN MS) Pusa's Gamma Garden will produce economic crop varieties by inducing mutations, *Indian Farming*, **10(7)**: 20.
 - (With KEDARNATH S and BATCHA MGBR) Correlation studies in *Linum usitatissimum* II. Effect of morphological grouping in types on the correlation coefficient relating to yields and some of the components of yield, *Indian J Genetics*, **20**: 50.
 - (With KEDARNATH S and BATCHA MGBR) Correlation studies in *Linum usitatissimum* III. Effect of morphological grouping type on the correlation coefficient relating to oil content and oil quality, *Indian J Genetics*, **20(1)**: 69.
 - (With PAL BP and KAMRA SK) What seed testing means? *Indian Farming*, **10(6)**: 17.
 - (With SIKKA SM) *Cotton in India. A Monograph*. Vol-I, Breeding, Chapter –VI, pp. 137-335; Cytology, Chapter-VII, pp. 336-402; Genetics, Chapter-VIII, pp. 403-466, Indian Central Cotton Committee, Bombay, India.
 - (With PATI BD) Pistil-less and functional male sterile off type plants in blue panic grass (*Panicum antidotale* Ritz.), *Curr Sci*, **29(2)**: 63.
 - (With PATI BD) Male sterile off type plants in pasture grass *Sehima Nervosum*, *Curr Sci*, **29(7)**: 285.
 - (With PATI BD) Grasses that defy draught, *Indian Farming*, **10(5)**: 25.
 - (With HARDAS MW) Cotton improvement through inter-specific hybridization and the role of wild germplasm, *Indian Cotton Grow Rev*, **14(2)**: 82.
 - (With CHAVDA DH and SATYANARAYANA KV) A study of characters contributing to ginning out turn in some varieties of *Gossypium hirsutum* L., *Indian Cotton Grow Rev*, **14(5)**: 373.
 - (With KOHLI SP and NEGI LS) Two Superb Hill N.P. 829 the successor to Ridley, *Indian Farming*, **10(8)**: 6.
 - Report on the work done by Late Miss Georgette, *Euphytica*, **9(3)**: 289.



- 1960 Heterosis and its exploitation in cotton improvement-Intra hirsutum crosses, *Indian Cotton Grow Rev*, **14(1)**: 1.
- (With SINGH HB and JOSHI BS) Why not sow Pusa Sawani? *Indian Farming*, **10 (1)** 6.
- (With PATI BD and VOHRA SK) Chromosome number in some forage grasses, *Curr Sci*, **30(10)**: 393.
- 1961 (With PATI BD and HARDAS MW) Auto-allopolyploid nature of *Pennisetum squamulatum* Fresen, *Nature*, **189**: 419.
- (With SINGH JOGINDER and DHAWAN NL) New Host plants of the top shoot borer of Maize. *Chillo zonellus* swin, *Curr Sci*, **30(3)**: 109.
- (With SINGH HB) Kent, an oat of note, *Indian Farming*, **11(8)**: 7.
- (With SINGH DALJIT) The Phenotypic constant method for the calculation of theoretical frequencies of individuals in the different phenotypic classes in F₂ II. Application of the method, *Indian J Genetics*, **21**: 229.
- (With AHLUWALIA M and SHANKER K) "Improved ghana" is a better bajra, *Indian Farming*, **11(5)**: 12.
- (With HARDAS MW and GANGULI PL) Multiple allelism for petal colour in *Linum glandiflorum* Desf., *Curr Sci*, **30(3)**: 109-110.
- Choose the right wheat, *Indian Farming*, **11(7)**: 30.
- These new species will pay you well, *Indian Farming*, **10(10)**: 26.
- Better seeds better crops, *Indian Farming*, **11(6)**: 9.
- (With JAIN SK and HUKERI PD) Inheritance studies on some components of yield in a cross of two *Gossypium hirsutum* varieties. I-Boll number and boll weight, *Indian J Genetics*, **21(2)**: 98.
- (With RAMANUJAM S and SISODIA NS) Breeding for quantitative character in Linseed-II. Genetic correlations and correlated genetic response with special reference to tillering and earliness, *Indian J Genetics*, **21(2)**: 122.
- (With RAMANUJAM S and PILLAY PNC) Breeding for quantitative characters in Linseed-I. Utility of diallel crosses in the selection of parents, *Indian J Genetics*, **21(2)**: 112.
- (With RAMANUJAM S and PILLAY PNC) Breeding for quantitative characters in Linseed-I. Utility of diallel crosses in the selection of parents, *Second Conf Oil-Seed Research Workers of India, Chennai*.
- (With RAMANUJAM S and SISODIA NS) Breeding for quantitative characters in linseed-II. Correlated genetic response with special reference to tillering and earliness, *Second Conf Oil-Seed Research Workers of India, Chennai*.
- (With PATI BD and HARDAS MW) Auto-allopolyploid nature of *Pennisatum squamulatum*, *Nature*, **189**: 419.
- *Sesame in India, A Monograph*, Indian Central Oilseed Committee.
- (With SINGH HB and MITTAL SP) Why be indifferent to soybean, *Indian Farming*, **12(7)**: 15.
- (With RAO MV and AGRAWAL RK) Inheritance studies in wheat VIII. Inheritance of seedling reaction to forms. 34, 21-A, 15-C and its colour mutant of *Puccinia graminis tritici*, *Indian J Genetics*, **22(1)**: 26.



- 1961 (With SINGH HB and MITTAL SP) Someday Soybean may come into its own, *Indian Farming*, **12(8)**: 15, 22.
- (With PATI BD) Pusa Giant Napier: Low water requirement, two-fold yields, *Indian Farming*, **12(6)**: 7, 18.
- (With JAIN KBL and RAO MV) Inheritance studies in wheat II. Inheritance of field resistance of Rio Negro and Yaqui 53 to brown rust of wheat, *Curr Sci*, **31**: 160.
- (With AHLUWALIA M, SHANKAR K and JAIN KBL) A diallel cross study of combining ability for some quantitative characters in pearl millet-II. Tillering, height and yielding ability, *Indian J Genetics*, **22(1)**: 45.
- 1963 Production breeding, *Indian J Genetics*, **23(2)**: 109.
- Role of plant breeding in agricultural production, *Sci Parliament*, **1(3)**: 65.
- Role of science and irrigation in agricultural production, *Indian J Fwr Riv Valley Devel*, **13(11)**: 6.
- (With JESWANI LM and GUGLANI PL) Genetics of field resistance of linseed varieties to rust, *Indian J Genetics*, **23**: 306.
- (With DESHPANDE RB and JESWANI LM) Breeding of wilt resistant varieties of pigeon pea, *Indian J Genetics*, **23**: 58.
- (With AGRAWAL RK and RAO MV) Inheritance of loose-smut resistance in inter-varietal cross of *Triticum aestivum*, *Indian J Genetics*, **23(2)**: 135.
- (With JESWANI LM) Inheritance of resistance to wilt in linseed, *Indian J Genetics*, **24**: 92.
- (With JESWANI LM and PRASAD R) Inheritance of seedling resistance to race I of *Melampsora Lini.*, *Indian J Genetics*, **24**: 82.
- 1965 The IARI Post Graduate School, *J Post Graduate School IARI*, **3(1)**: 38.
- 1966 (With DHAWAN NL) Genetic improvement in yield with special reference to self-fertilizing crops, *Indian J Genetics*, **26A**: 101.
- (With GADWAL VR and HARDAS MW) in *Evolutionary Studies in Wild Crops Driver Change in Indian Subcontinent*, edited by Hutchinson J (IARI Library Accession No. 633.57612/HD 76E) pp. 101-107.
- (With RAJAN SS) Sesamum breeding at the Indian Agricultural Research Institute, *J Post Graduate School IARI*, **4(1,2)**: 136.
- 1967 Cereal Research: Aims at filling up India's Food gap, *Indian Farming*, **16(11)**: 6, 47.
- Newer vistas in crop yields, Editorial Page, *Indian Farming*, **17(9)**: 3, 58.
- Planning for research crops, in *Proc Symp Science and India's Food Problems*, 6-8 October, New Delhi, pp. 546-547.
- 1968 "Triple Dwarf" wheat: A word of caution, *Indian Farming*, **18(5)**: 3.
- Arecanut development possibilities, Editorial Page, *Indian Farming*, **18(4)**: 3.
- Achievements and prospects of crop breeding, *Agro-Indus J*, **1(5)**: 33.
- Achievements and prospects of crop breeding in India, *Indian Farming*, **18(2)**: 4.
- (With GADWAL VR and JAIN KBL) Response to selection of early generation for various quantitative characters in wheat, *J Post Graduate School IARI*, **6(2)**: 211.



- 1968 (With SINGH MUNSHI and KADAPPA SN) A genetic analysis of yield and some fibre properties in *Gossypium arboreum* in *Contributions in Statistics and Agricultural Sciences*, Dr VG Panse Memorial Volume, Indian Society of Agricultural Statistics, pp. 264-278.
- (With GADWAL VR and IYER RD) Interspecific hybrids in *Abelmoschus* through ovule and Embryo culture, *Indian J Genetics*, **28**: 269.
- (With AHLUWALIA M and SINGH DALJIT) Early testing for combining ability and genetic shift in selection for high yield and better quality of grain in *Pennisetum typhoides B (S&H)*, *Proc Annual Meeting ASA/CCSA/SSSA*, 10-15 November, New Orleans, Louisiana, USA.
- (With AHLUWALIA M) A study of genetic diversity in Indian and exotic populations of *Pennisetum typhoides B (S&H)*, *Proc XII Internat Congress of Genetics*, Tokyo, Japan.
- (With TANDON JP and JAIN KBL) Genetic Analysis of yield in a six row and two row varietal cross in Barley-I: Genetics of yield and its primary components. *Indian J Genetics*, **28(3)**: 239.
- 1969 Prospects of sugar beet in India, *Indian Farming*, **19(2)**: 4.
- 1970 Cotton: The tasks ahead, *Indian Farming*, **20(2)**: 3.
- (With PARODA RS) Genetic architecture of yield and components of yield in wheat, *Indian J Genetics*, **30**: 298.
- 1972 Indian Agriculture at the cross roads, *Greenpath*, 3.
- (With AGRAWAL RK and STEWART DM) *Improvement of crop productivity, Egypt, Interim Report*, UN Development Program; FAO, Rome, Italy. pp. 104.
- (With JOSHI BS and RAMANUJAM S) Association of yield and other characters in coriander, *Indian J Genetics*, **32(3)**: 411-420.
- 1973 Agricultural Research Service of Developing Countries, in *Proc (I Str) FAO/SIDA Seminar Plant Scientists*, Africa, Near East Cairo, 1-20 September, pp. 37-39.
- Advances in development of improved and high yielding crop varieties in India and future prospects, in *Proc (I Str) FAO/SIDA Seminar. Plant Scientists*, Africa, Near East Cairo, 1-20 September, pp. 176-185.
- (With KADAPPA SN and PATIL AS) A comparison of four methods of breeding in autogamous species, *Gossypium hirsutum L.*, in *Proc Second General Meeting, SABRAO*, New Delhi.
- 1975 Advances in development of improved and high yielding crop varieties in India and future prospects, *Inf Bull Cereal Imp Prod*, **12(142)**: 7.
- 1979 Breeding methodology for autogamous crops, *Indian J Genet*, **39(3)**: 567.
- (With PATIL NS and UMRANI MB) Drought prone grass of Maharashtra, *Proc Int Symp Development and Transfer of Technology for Rainfed Agriculture and SAT farmer*, Patancheru, pp. 221-230.
- 1981 (With BHAT MG, SINGH MUNSHI and MEHTA SL) Correlation among hairiness and other characters imparting resistance to jassids (*Amrasca devastans* Dist.) in Cotton (*Gossypium hirsutum L.*), *J Indian Soc Cotton Improve*, **6 (2)**, 80-85.
- (With CHARATEE SD and PATWARDHAN AD) Treatment and disposal of effluents from textile mills, *Indian Chem Mfr*, **19(4)**: 11.



- 1981 (With BHAT MG, MEHTA SL and SINGH MUNSHI) Biochemical basis of resistance to jassid (*Amrasca devastans* Dist) in cotton (*Gossypium* spp.), *Crop Improv*, **8(1)**: 1-6.
- (With BHAT MG and SINGH MUNSHI) Possibility of breaking association between hairiness and jassid (*Amrasca devastans* Dist) resistance in cotton (*Gossypium hirsutum* L.), *Indian J Agric Res*, **15(4)**: 236.
- 1982 (With SINGH RAVINDER and SINGH RNP) Epoxy Resinas bonding agent for concrete repairs under water, *Indian Concr J*, **56(12)**: 322.
- (With SINGH RNP and SINHA SN) Optimization of the trough shape of folded-plate structures, *Note P.I.C.W.E.2*, **73(Dec)**: 811.
- (With VAIDYA SM and MURTY BR) Two-most suitable indexes for lodging for wheat, *Curr Sci*, **51(13)**: 667.
- (With BHAT MG and SINGH MUNSHI) Inheritance of hairiness and other characters associated with jassid resistance in American cotton, *Indian J Genet*, **42(3)**: 376-380.
- (With BHAT MG and SINGH MUNSHI) Hairiness in relation to resistance to jassid (*Amrasca devastans* Dist) and other insect pests and quality characters in cotton (*Gossypium* spp.): A Review, *Agric Rev*, **3(1)**: 1.
- (With BHAT MG and SINGH MUNSHI) Relative loss of seed cotton yield by jassids and bollworms in some cotton genotypes (*Gossypium hirsutum* L.), *Indian J Entomology*, **46(2)**: 169.
- (With BHAT MG and SINGH MUNSHI) Antibiotic effects of cotton genotypes on jassid *Amrasca devastans* (Distant), *Indian J Entomology*, **47(1)**: 1.

