

Citrus Crop

Production and Management in NEH Region

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Preface

The North-eastern region of India is considered to be the natural home and a reservoir of various citrus species including mandarin orange. The important species of citrus in the NEH region are necessary with a view to their respective classification, morphology and important role in cultivation. These have commercial propagation and resistant value against biotic and abiotic stress. The selection of mother plants for seed and budwood is the most important criteria for producing healthy planting material. Therefore, the selection of the mother plant should be made from authentic sources with a known pedigree with respect to health, vigour, regular bearing and high yield with good fruit quality. The need to collect and conserve the resources of the citrus has got paramount importance because the numbers of cultivated genotypes are gradually narrowed down. It is also a need to protect the cultivated germplasm since many of the field gene banks are under deteriorated conditions due to several factors. Although the genetic diversity of citrus has got immense potential to raise the quality of fruit production and productivity, the conservation and commercialization of these genotypes have not yet been carried out in depth. Further, the present situation of climate change, depletion of natural resources, faulty agro techniques (Jhum cultivation), increasing demand on the limited resources and changing attitude of the farmers towards some newly introduced cash crops have paved the way for genetic erosion of the valuable resources and most of them are in the verge of extinction.

Although citrus crop cultivation is not a new issue for production and management in NEH region but technical literature focusing the citrus crop cultivation in NEH region is not available abundantly. Therefore, first and foremost, I am cordially thankful to Dr. S. Ayyappan, Chancellor, CAU, Imphal and Former DG, ICAR and Secretary, DARE and Dr. Anupam Mishra, VC, CAU, Imphal for encouraging and motivating us for this publication. We are also thankful to Director Instruction, Director Research, Director Extension Education, CAU, Imphal and Dean, COA, Iroisemba, who encouraged and provided valuable suggestions and ideas to improve the authenticity and quality of this book. The dream seen so far has now been converted into reality due to the very valuable efforts of all the contributors; therefore, my sincere thanks are recorded towards them. Bringing out this book in the existing shape has been possible due to the rigorous and continuous efforts of all the teaching staff of the College of Agriculture, CAU, Imphal.

We are confident this publication will be an essential source of the citrus crop: production and management information for scientists, extension persons, agriculture graduates and farming communities.

— ***Editors***

Editor's biodata



Dr. S. Basanta Singh obtained his Master's and Doctoral Degree in Agricultural Economics from HPAU, Palampur and IARI, New Delhi in 1993 and 1997. Dr. Singh specialized in Natural Resources and Environmental Economics. He had been trained in Land Use Modeling at Iowa State University, Ames, USA and in leadership in the academicians programme (LEAP) in the University of Virginia, USA. A recipient of J.K. Minhas Memorial Gold Medal during his Master's programme and Dr. R.T Doshi Foundation award twice, he published more than 105 research papers in International and National Journals of repute, 32 book chapters and 5 books. He had been a member of various national/state level committees such as Task Force on Development of Horticulture, Organic Farming and Spices in NEH region, Sustainable Development of Agriculture in Mizoram, Oil palm Mission, MIDH, Doubling of Farm Income, RKVY, Farm Machinery, Livestock Mission, Watershed Development, New Land Use Policy, GoM, etc. He also worked as a consultant NEDFi, Guwahati and PI of the World bank project, IDP, NAHEP, CAU, Imphal. His immense potential and achievements in academics, research and extension helped him to serve as Head of the Social Science Division, Joint Director, ICAR Research Complex for NEH Region, Mizoram Centre for seven years, Director of Instruction and also, i/c Director of Research in Central Agricultural University Imphal for more than 4 and half years.



Dr. Shravan M. Haldhar (MSc, PhD, PDF, Thailand) an Associate Professor (Entomology) in the Department of Entomology, College of Agriculture, Central Agricultural University, Imphal, Manipur. He started his career as a Scientist (Agril Entomology) in ICAR in 2009 at CIAH, Bikaner. He was born on 13th October 1979 in Jaipur (Rajasthan), obtained MSc in Agricultural Entomology (2004) from RAU, Bikaner and PhD (2008) from MPUAT, Udaipur. He also developed 07 varieties of ridge gourds (Thar Karni); long melon (Thar Seetal); sponge gourd (Thar Tapish); palak (Thar Hariparna), ivy gourd (Thar Sundari) khejri (Thar Amruta) and muskmelon (Thar Mahak) and registered three traits specific lasora genotype (AHCM-22-1), muskmelon genotype

(AHM/BR-8) and watermelon genotype (AHW/BR-5) in NBPGR, New Delhi. He has published 15 international and 65 national research papers; 16 books/ compendiums; 06 technical bulletins, 02 technical folders; 45 book chapters; and delivered 50 lectures. He is a fellow of 'The Entomological Society of India' and is the recipient of several awards and recognitions including Dr. B. Vasantharaj David Young Scientist Award 2019; Agriculture Today Young Scientist Award 2019; SAAER-Young Scientist Award 2016; AIASA-Scientist of the Year Award 2016 and IIFS-Rashtriya Gaurav Award 2012. Dr. Haldhar has developed 31 technologies related to insect-pest management strategies in arid horticulture crops and applied for one patent on biopesticide "Thar Jaivik 41 EC: Patent Application-201911012592 dated 30-03.19" for insect-pests management. Submitted 07 new DNA Bar-coding sequence data of arid horticulture crops insects to Gen Bank NCBI, USA. He handled the 02 externally funded projects as Centre PI, 02 institute projects as PI and 11 institute projects as Co-PI. Dr. Haldhar is an editor and reviewer of 07 international and national journals. Guided 05 Ph. D. and M. Sc. scholar. He has also attended international training on 'Induced resistance in plants against biotic stresses' at Prince of Songkla University, Thailand from 15 April to 14 July 2022.



Dr. R. K. Dilip Singh has been working last 25 years in the Department of Horticulture, College of Agriculture, CAU, Imphal. He has obtained B.Sc.Agri from Manipur University, Canchipur, Manipur; M.Sc. Agri (Hort) from Assam Agricultural University, Jorhat, Assam and Ph. D. in Horticulture from Dr. Y. S. Parmar University of Horticulture & Forestry, Solan, HP. He has attended (eight) different refresher Courses/Summer Institutes/Winter schools in different places in India. He has published two books as Co-author for vocational courses of higher secondary students. He published 25 research papers in refereed journals, 4 papers in the national congress, 3 papers in the international congress as well as 3 newsletters. He is also a life member of the horticulture society of India, the agriculture science society of NE India, Indian Journal of Hill Farming. He delivered 20 talks on the Radio and 10 in DDK, Imphal on various topics of the horticulture production system. He is also involved in extension activities as a resource person in training (farmer's level) and delivered 80 talks acting as a resource person. He has produced the 20S (thirteen) P.G students in the field of Horticulture (Fruit Science) and 20 (twenty) numbers of students as Co-Guide. He has been acting as an external examiner for the evaluation of both P.G and Ph. D thesis in the field of horticulture as well as question setting and evaluation of papers for AAU, Jorhat, SASRD, Medziphema, Nagaland and Manipur University.



Dr. Narit Thaochan (PhD Agricultural Science) was appointed as Associate Professor (Entomology) in the Agricultural Innovation and Management Division (Pest Management), Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla province, Thailand. He started his career as an instructor and researcher at the Faculty of Natural Resources in 2010. He was born on November 24th, 1980. He received his B.Sc. (Agriculture) in Plant Pathology in 2003 at the Faculty of Agriculture, Chiang Mai University, Chiang Mai province, Thailand. He received a scholarship to study for his PhD under The Royal Golden Jubilee PhD. The program, Thailand Research Fund at Walailak University, Nakhon Si Thammarat province, Thailand and graduated in 2010. He received the Endeavour Research Fellowship in 2015 to do a postdoc at Macquarie University, Sydney, New South Wales, Australia. His main academic area is entomology, especially in the biological control of economic insect pests and entomopathogenic fungal technology. His research works focused on controlling tephritid fruit flies with entomopathogenic fungi and biocontrol agent product development. He has been doing fruit fly research for over 20 years, starting with his graduate studies in 2004. While the fruit fly research work is carried on, indeed, he also investigates the biology of the fruit flies as fundamentals such as life cycle and host preference. Now, he has another research project on rubber leaf fall disease in Thailand. This is a newly emerging disease and a severe problem for rubber plantations in Thailand. He and his colleague established a business unit of biocontrol agents and natural products in agriculture that was granted by the university. He developed pest management products from natural latex and patented 2 products, i.e., rubber fly lure for tephritid fruit flies and rubber para clay for insect repellent. He has published 31 international and 33 national research papers, made 14 presentations at scientific conferences and written 3 books (in the Thai language).



Dr. Ashutosh A. Murkute, after completing PhD from I.I.T., Delhi started his research career as Scientist 'C' at the Defense Institute of High-Altitude Research (DRHAR, DRDO), Leh-Ladakh. Besides developing agro-technologies suitable for high altitudes, he established a prototype for a solar thermal greenhouse and an experimental tissue culture lab at Leh. Dr. Murkute joined ICAR in January 2011 at ICAR - Directorate of Onion and Garlic Research, Pune, where he worked on post-harvest management of onion and garlic. He developed a complete protocol for producing virus-free planting material of garlic through microbubbles using mericlones and established a tissue culture lab for mass production. At ICAR – Central Citrus Research Institute, Nagpur, Dr. Murkute is

working on a citrus improvement program and projects on abiotic stress management. His team released three citrus varieties *i.e.* pummelo (*Citrus grandis*) cv. NRCC Pummelo-5, Grapefruit (*Citrus paradisi*) cv. Flame and Sweet Orange (*Citrus sinensis*) cv. Cutter Valencia through SVRC and Grapefruit (*Citrus paradisi*) cv. NRCC Grapefruit-6 through the institute for commercial cultivation. He worked on many committees at state and national levels as an Expert on Citrus. He has published many research articles in peer-reviewed journals, book chapters, popular articles etc. of national and international repute. He was appointed to I.I.T. Delhi as an Adjunct Professor and also nominated as a Member, Board of Management of Rajmata Vijaya Raje Scindia Agricultural University, Gwalior by the Hon'ble Governor of Madhya Pradesh, apart from being a member of management committees of ICAR institutes.

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