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Handbook of Nutraceuticals

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Potential Food Nutraceutical Ingredients

Anshu Sharma, Jyoti Rani, Pavneet Kaur, Shailendra K. Dwivedi, and Munisha Sharma

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Abstract

Nutraceuticals are products with food extracts or bioactive ingredients of foods which have shown great health benefits to their consumers in the last few years. The functional ingredients present in food have a great potential to act as nutraceuticals when taken in proper amount as they are capable enough to prevent and even cure diseases. The organic functional ingredients generally obtained from plants and animals have exhibited great potential in the prevention or cure of many chronic diseases as dietary supplements to replace pharmaceutical drugs

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Nutrient Requirements in Health and Disease

Shailendra K. Dwivedi, Kanika Issar, and Vivek Tiwari

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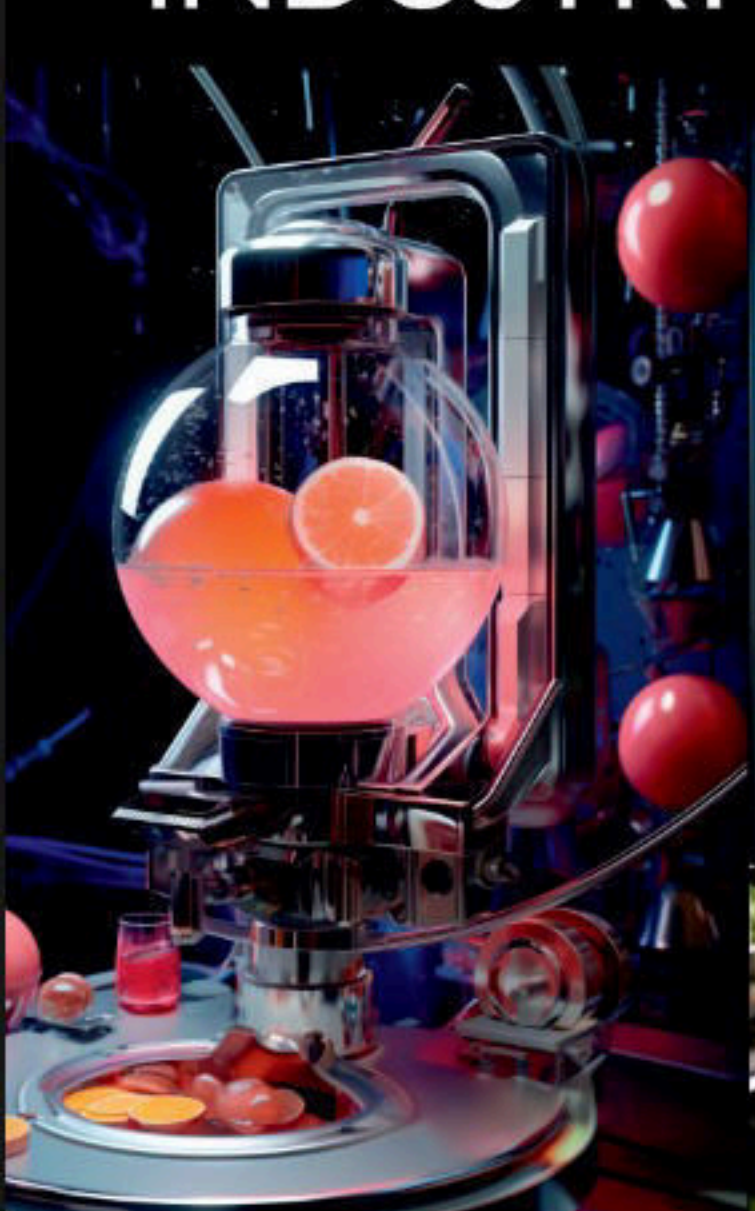

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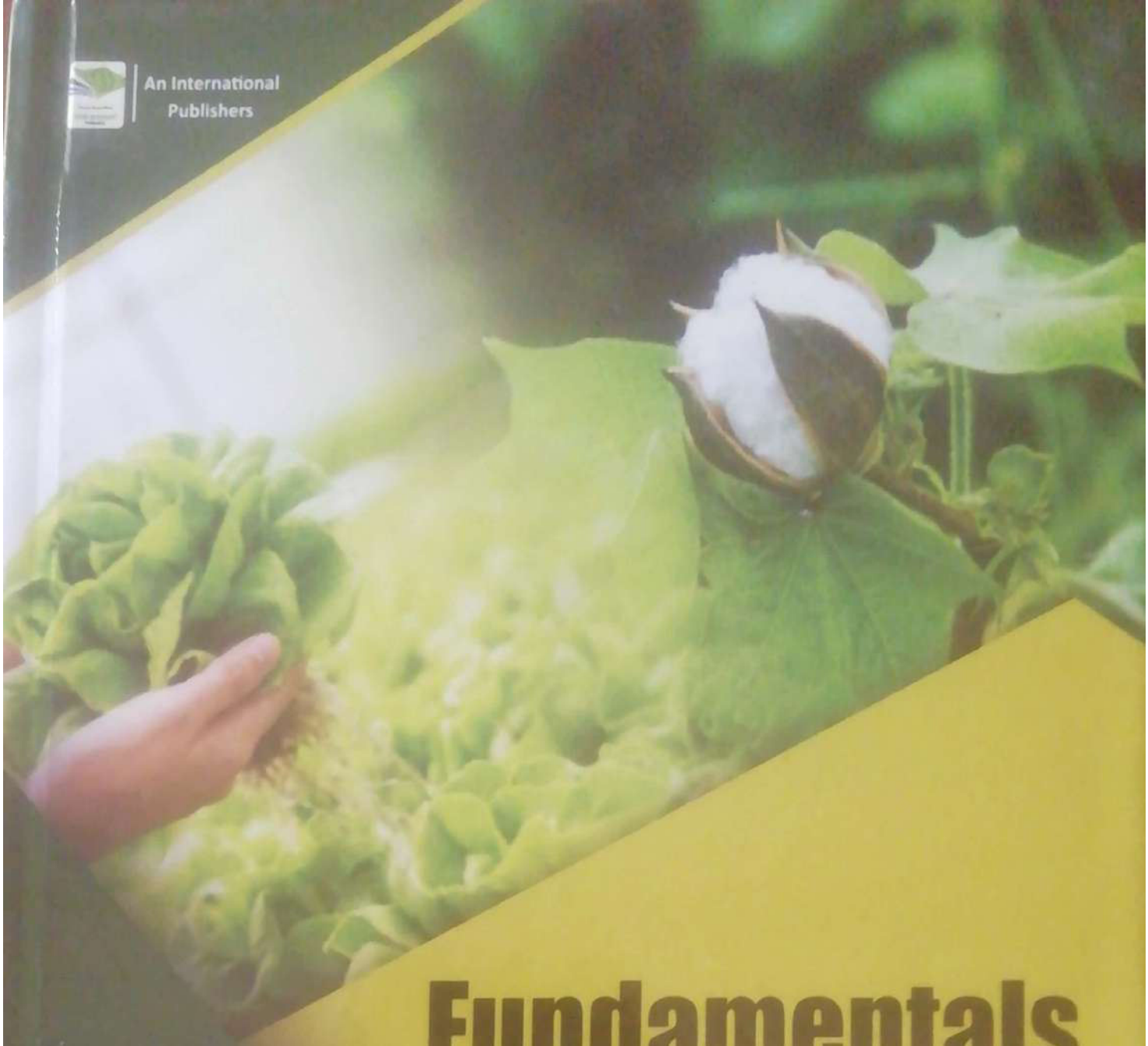

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- Dr. Janmejay Sharma
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एस. सी. श्रीवास्तव
लाखन सिंह मोहनिया

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लेखक-परिचय

डॉ. अमिता शर्मा, राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर में वैज्ञानिक (कृषि वानिकी) के पद पर पदस्थ हैं। इन्हें शिक्षण, अनुसंधान एवं प्रसार में 20 वर्षों का अनुभव है। इन्होंने एम.एस.सी. व पीएच.डी. के शोध कार्य मे 20 से अधिक छात्रों का मार्गदर्शन किया। साथ ही 40 से अधिक शोध पत्र एवं 15 लोकप्रिय लेख प्रकाशित किए। इनके द्वारा 2 अन्य पुस्तकें भी प्रकाशित की गई हैं।

डॉ. जन्मेजय शर्मा, राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर में वैज्ञानिक (सस्य विज्ञान) के पद पर पदस्थ हैं। इन्हें शिक्षण, अनुसंधान एवं प्रसार में 5 वर्षों से अधिक का अनुभव है। इन्होंने एम.एस.सी. व पीएच.डी. के शोध कार्य में 10 से अधिक छात्रों का मार्गदर्शन किया। साथ ही 18 से अधिक शोध पत्र एवं 10 लोकप्रिय लेख प्रकाशित किए हैं। इनके द्वारा 1 अन्य पुस्तक भी प्रकाशित की गई है।

डॉ. शरद चंद्र श्रीवास्तव, राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर में वरिष्ठ तकनीकी अधिकारी (कृषि अर्थशास्त्र) के पद पर पदस्थ हैं। इन्हें शिक्षण, अनुसंधान एवं प्रसार में 20 वर्षों का अनुभव है। इन्होंने एम.एस.सी. व पीएच.डी के शोध कार्य मे 29 छात्रों का मार्गदर्शन किया। साथ ही 47 शोध पत्र प्रकाशित किए। इनके द्वारा 2 अन्य पुस्तकें भी प्रकाशित की गई हैं।

लाखन सिंह मोहनिया, राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर में अनुसंधान विद्वान (पीएच.डी.) शोधार्थी के रूप में कार्यरत है। इन्होंने राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर से कृषि में स्नातक और सस्य विज्ञान में स्नातकोत्तर किया। साथ ही कृषि वैज्ञानिक चयन मंडल द्वारा आयोजित होने वाला नेट क्वालीफाई किया एवं 7 शोध पत्र और 10 लोकप्रिय लेख प्रकाशित किए हैं। इनके द्वारा 2 अन्य पुस्तकें भी प्रकाशित की गई हैं।

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This book entitled "New Horizon in Climate Smart Agriculture" considers the most typical of the expected impacts of climate change on crop production, and the opportunities that exist for adapting to these changes and mitigating climate change through the sustainable intensification of crop production. This book aims to address post-graduate students and research scholars.

Dr. Shailendra Singh has done M.Sc. (Ag) from University of Agricultural Sciences, Dharwad, Karnataka and Ph. D. from Maharana Pratap University of Agriculture and Technology, Udaipur Rajasthan in the discipline of Agronomy with ICAR fellowships. He has more than 8 years experience of research and teaching. He started his carrier as Assistant Professor in 2015 from Navsari Agricultural University, Gujarat. Presently he is serving S.K.N. Agriculture University, Jobner, Rajasthan. During his professional journey he has published 12 research papers, 2 books and several extension publications. He has guided two masters students and acted as minor advisor for five research scholars.

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Dr. Janmejay Sharma is presently working as scientist in AINP Arid Legumes, Department of Agronomy College of Agriculture RVSKVV, Gwalior Dr. Sharma passed M.Sc (Ag) Agronomy from JNKVV Jabalpur in 2009. He completed Ph.D in Agronomy from RVSKVV, Gwalior. He has published 23 research paper 13 extension bulletins, 7 book chapters, 2 book, 1 practical manual and 8 popular articles so for He has guided 7 masters and 2 Ph.D students and also acting as minor advisor of masters and Ph.D students.

Dr. Sudarshan Chicham did his graduation, post graduation and doctorate in agronomy from RVSKVV, Gwalior (M.P). Ph.D. worked was completed ICAR- CPRI-RS (Central Potato Research Institute - Regional Station Gwalior (M.P.). He has research worked as a ""Evaluation of micro irrigation for improving Productivity and water use efficiency in Potato". He has published 6 research papers, 5 popular articles so for.

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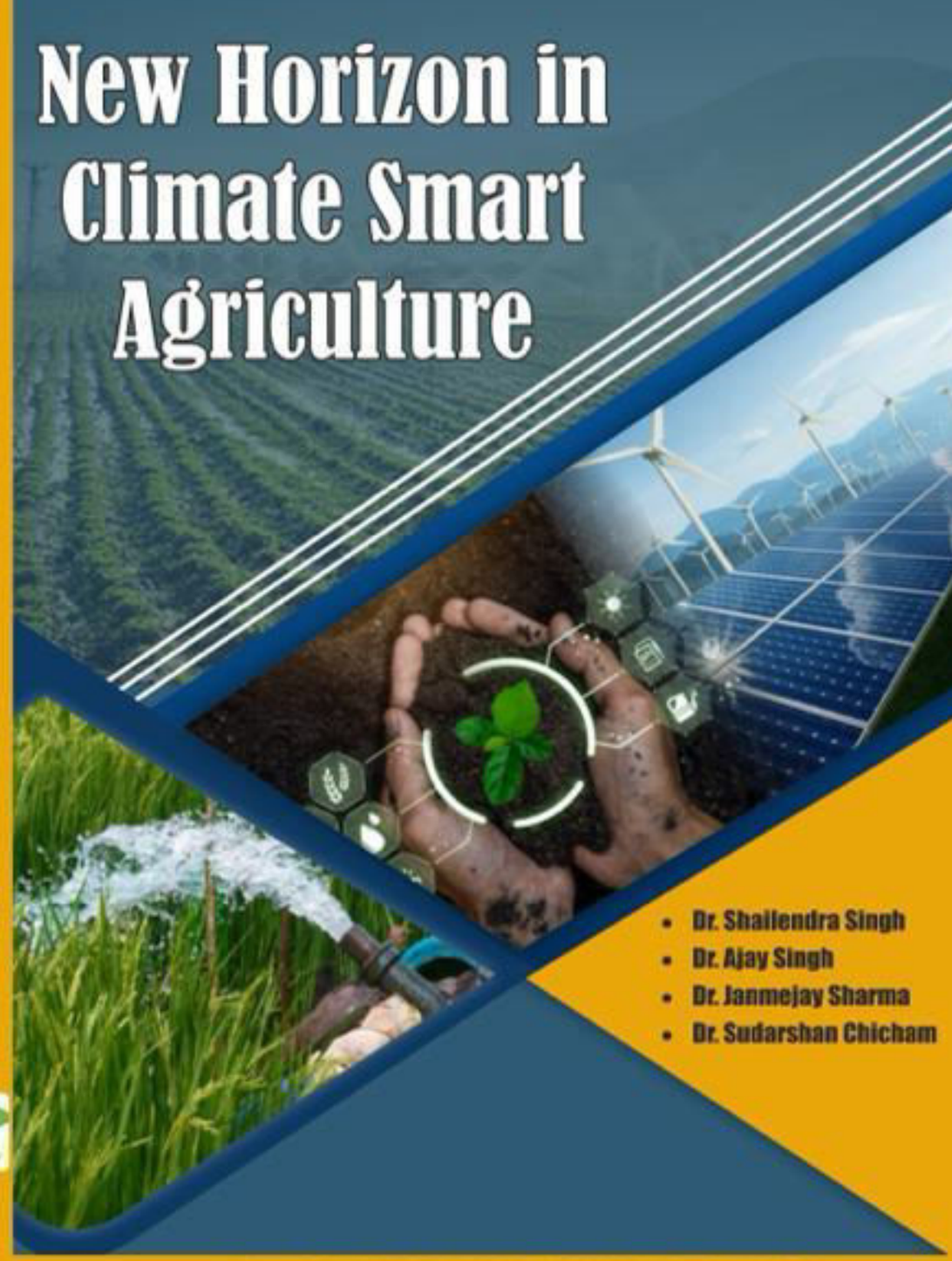

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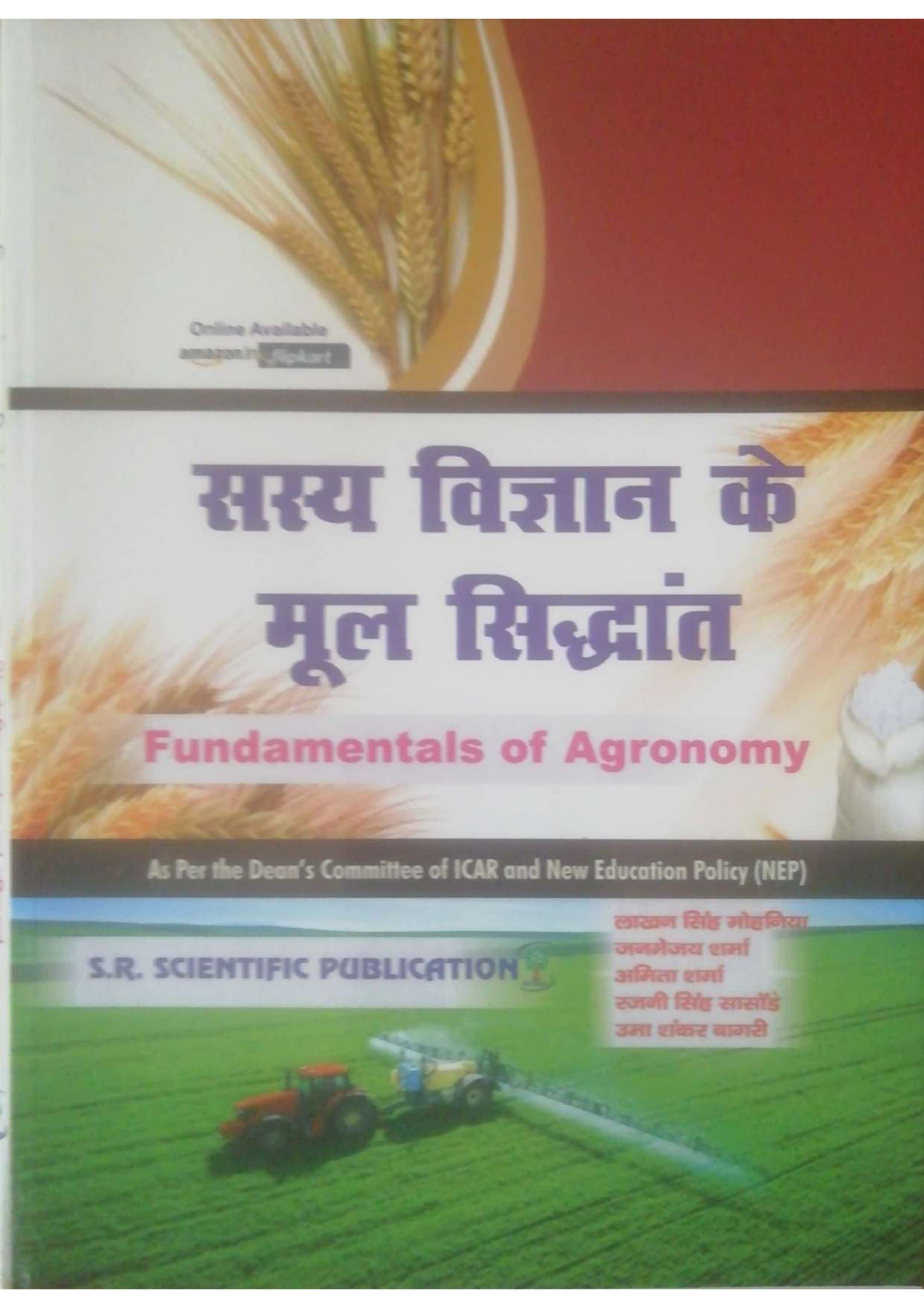

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डॉ. धन सिंह मंडलोई वर्ष 2003 से राजमाता विजयाराजे सिंधिया कृषि विष्वविधालय, ग्वालियर–के,एन,के उधानिकी महाविद्यालय, मंदसौर (म.प्र.) में प्रक्षेत्र विस्तार अधिकारी के पद पर उन्होंने 14 वर्षों तक कार्य किया हैं। इन्होने इसके पष्चात र्वतमान में वर्ष 2016 से राजमाता विजयाराजे सिंधिया कृषि विष्वविधालय, ग्वालियर में तकनीकी अधिकारी (उधानिकी) के रूप में कृषि विज्ञान केंद्र, धार (म.प्र.) पिछले छः वर्षों से है। इन्होने अपनी बी.एससी. (कृषि) आर.ए.के. कृषि महाविद्यालय, सीहोर वर्ष 2000 में जे.एन.के.वी.वी., जबलपुर (म.प्र.) तथा एम.एससी. (उधानिकी) फल विज्ञान से उधानिकी महाविधालय, मंदसौर (राजमाता विजयाराजे सिंधिया कृषि विष्वविधालय), ग्वालियर (म.प्र) से की है। उन्होंने कृषि वैज्ञानिक भर्ती बोर्ड, नई दिल्ली से उधानिकी (फल विज्ञान) में नेट पास किया है। उन्होंने आदिवासी किसानों, विस्तार कर्मियों और विभिन्न लाइन विभागों के साथ कृषि/बागवानी में काम करने का 19 से अधिक वर्षों का अनुभव किया है। डॉ. धन सिंह मंडलोई को आई. सी.ए.आर, नई दिल्ली से सर्वश्रेष्ठ कृषि विज्ञान केन्द्र पुरस्कार (राष्ट्रीय 2020) से सम्मानित किया गया। उन्हें सोसाइटी ऑफ ट्रॉपिकल एग्रीकल्चर, नई दिल्ली से साइंटिस्ट ऑफ द ईयर 2020, एटीडीएस, उत्तर प्रदेश से बेस्ट कृषि विज्ञान केन्द्र एक्सटेंशन साइंटिस्ट अवार्ड 2020 से सम्मानित किया गया है। एवं उन्होंने राष्ट्रीय और अंतर्राष्ट्रीय पत्रिकाओं में 04 पुस्तकें, 15 शोध पत्र, 04 पुस्तक अध्याय और 21 लोकप्रिय लेख, 5 विस्तार बुलेटिन प्रकाशित किए हैं।

डॉ. मनोज कुमार कुरील ने जे.एन.के.वी.वी, जबलपुर से कृषि में स्नातक और फल विज्ञान में विशेषज्ञता में उधानिकी में स्नातकोत्तर उपाधि उसी विश्वविद्यालय द्वारा उन्हें प्रदान की गई। उन्होंने 2004 में राष्ट्रीय पात्रता परीक्षा (नेट) उत्तीर्ण की। वर्ष 2003 में वरिष्ठ उधानिकी विकास अधिकारी के रूप में अपना पेशेवर करियर शुरू किया और 2007 में सहायक निदेशक, उधानिकी के रूप में पदोन्नत हुए, लेकिन शिक्षण पेशे से ग्रस्त होने के कारण उन्होंने आकर्षक पद छोड़ दिया और कृषि महाविद्यालय, खंडवा, राजमाता विजयाराजे सिंधिया कृषि विष्वविधालय, ग्वालियर में सहायक प्रोफेसर (उधानिकी) के रूप में शामिल हो गए। वर्ष 2017 में और तब से वहां सेवा दे रहे हैं। इनकी दो पुस्तकें, हैं। और उन्होंने अंतरराष्ट्रीय और राष्ट्रीय पत्रिकाओं में लगभग 21 शोध पत्र प्रकाशित किए हैं और विभिन्न पत्रिकाओं में विभिन्न लोकप्रिय लेख लिखे हैं। शिक्षा के अलावा वह महाविधालय के सहयोगी एनसीसी अधिकारी के रूप में भी कार्यरत हैं। उन्हें 2014 में अधिकारी प्रशिक्षण अकादमी, कैम्पटी (महाराष्ट्रा) में एनसीसी (महानिदेशक के बैटन ऑफ ऑनर) के राष्ट्रीय पुरस्कार से सम्मानित किया गया था।

डॉ. प्रवीण बर्डे का जन्म 20 मार्च 1981 को ग्राम गढ़वा पोस्ट बिसनूर तहसील मुलताई जिला बैतूल मध्य प्रदेश में हुआ था। उन्होंने बी.एस.सी. (बागवानी) और एम.एससी। उद्यानिकी फल विज्ञान के.एन.के. उद्यानिकी महाविद्यालय मंदसौर (जे.एन.के.वी.वी., जबलपुर) मध्य प्रदेश और पीएच.डी. उद्यानिकी (फल विज्ञान) डॉ. बी.आर. अम्बेडकर सामाजिक विज्ञान विश्वविद्यालय महू (म.प्र.) वे वर्तमान में राजमाता विजयाराजे सिंधिया कृषि विष्वविधालय, ग्वालियर में फल अनुसंधान स्टेशन, इटखेड़ी, भोपाल (म.प्र.) में उद्यानिकी सहायक के पद पर हूँ। उन्होंने उद्यानिकी अनुसंधान और शैक्षणिक क्षेत्र में व्यापक अनुभव है। प्रासंगिक अनुशासन में उनके उत्कृष्ट योगदान के लिए उन्हें जनपरिषद सोसाइटी से युवा वैज्ञानिक पुरस्कार मिला। 7 शोध पत्र प्रकाशित, 10 लेख, 9 पर्चे, कई राष्ट्रीय और अंतर्राष्ट्रीय सम्मेलन में भाग लिया और प्रशिक्षण कार्यक्रम में दिए गए कई व्याख्यानों ने प्रशिक्षण समन्वयक के रूप में प्रशिक्षण आयोजित किया।

डॉ. संतोष कुमार मैढा पुत्र श्री नानूराम मैढा का जन्म 01 जनवरी 1986 को रतलाम, मध्य प्रदेश में हुआ था। उन्होंने बी.एससी. (उधानिकी) की डिग्री और एम.एससी। (उधानिकी) के.एन.के. से वनस्पति विज्ञान की डिग्री उद्यानिकी महाविद्यालय मंदसौर (राजमाता विजयाराजे सिंधिया कृषि विश्वविधालय) ग्वालियर मध्य प्रदेश। डॉक्टर ऑफ फिलॉसफी (पीएचडी) उधानिकी, महात्मा गांधी चित्रकूट ग्रामोदय विश्व विद्यालय, चित्रकूट, सतना (म.प्र.) और वर्ष 2022 में डिग्री पूरी की और वह वर्तमान में सरकार में सहायक प्रोफेसर (उधानिकी) के पद पर कृषि महाविद्यालय बोरवट बांसवाड़ा, राजस्थान हैं।

डॉ. प्रवीण कुमार गुर्जर वैज्ञानिक उधानिकी पद पर राजमाता विजयाराजे सिंधिया कृषि विश्वविधालय, ग्वालियर कृषि विज्ञान केंद्र, लहार (म.प्र.) में वर्ष 2007 से हूँ। इन्हीनें जे.एन.के.वी.वी, जबलपुर से कृषि में स्नातक और फल विज्ञान में विशेषज्ञता में उधानिकी में स्नातकोत्तर उपाधि उसी विश्वविद्यालय द्वारा उन्हें प्रदान की गई। इन्हीनें स्नातक स्नातकोत्तर उपाधि एवं पीएचडी विधार्थीयो को पढाया तथा लगभग 20 विधार्थीयो गाईड किया गया। इनकी तीन प्रयोगिक पुस्तकें, 7 विस्तार बुलेटिन हैं। और उन्होंने अंतरराष्ट्रीय और राष्ट्रीय पत्रिकाओं में लगभग 40 शोध पत्र प्रकाशित किए हैं और विभिन्न पत्रिकाओं में विभिन्न लोकप्रिय लेख 45 लिखे हैं।

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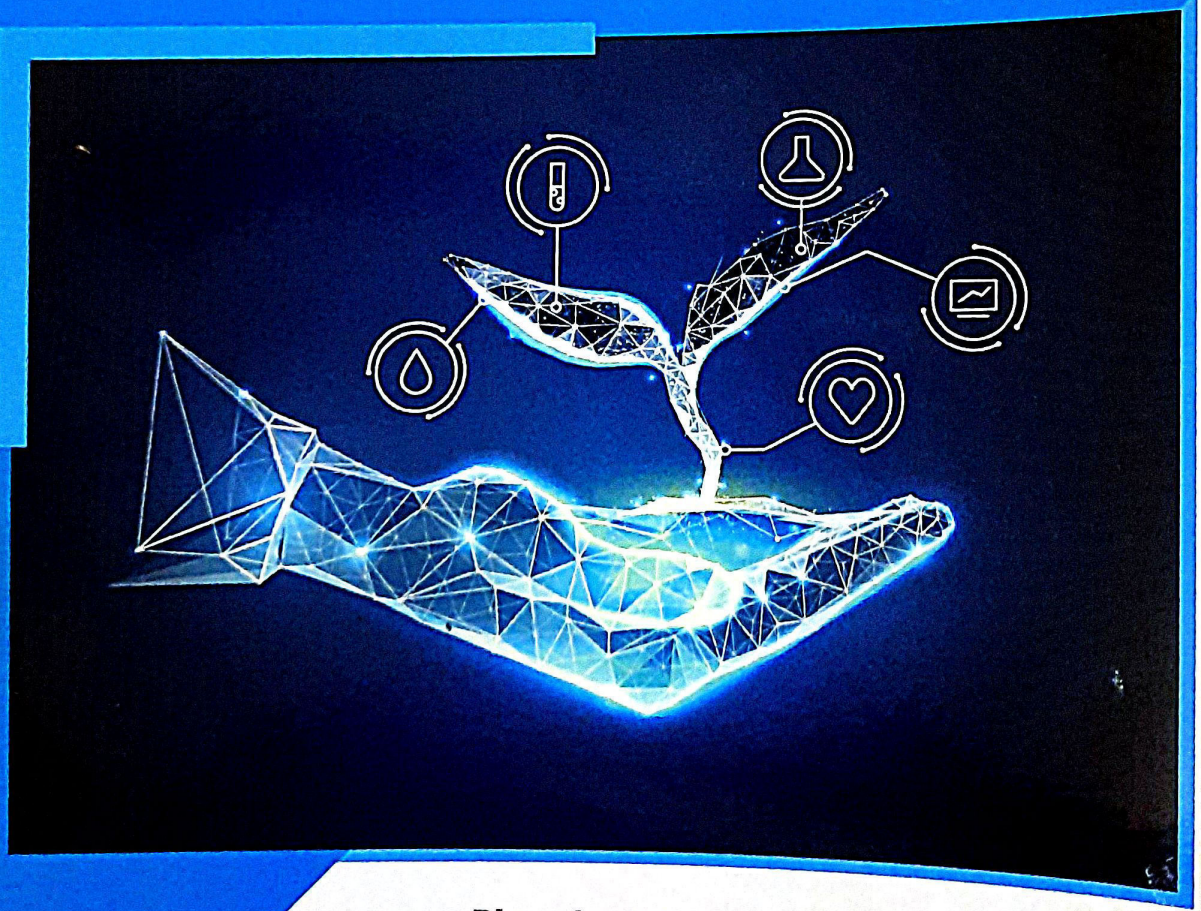

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and D.R. Saxena
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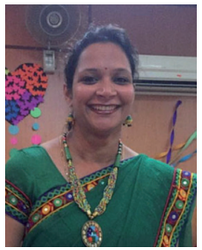
In South East Asia maize-wheat cropping system is important as it remains to be staple part of diet but production is limited by low fertilizer efficiency, inadequacy of current fertilizer recommendations, and the ignorance of nutrients. Currently recorded average maize and wheat yields compared with the yield potential for a given variety and climate indicate significant opportunities to further increase their productivity through site-specific, integrated nutrient and crop management based on crop requirements, soil test values and yield targets. This nutrient omissions study was conducted at research farm, IARI, New Delhi, India suggests that the recommended dose for the maize-wheat cropping system is sub-optimal and establishes STCR based nutrient application as more scientific management of nutrients in the cropping system. Omission of P, K and Zn in the cropping system highlighted the significance of P and K application to both the crops but the effect of K omission is more pronounced as compared to P omission in the system. While Zn may be conveniently omitted from the system due to high DTPA extractable Zn status in soil.



I am a groundnut scientist working under *Government of India* since 2016. Growing up at Rajasthan and studying at IARI, New Delhi inspired in me a desire to be a scientist devoted to the nature and nation. I was awarded with gold medal during my master's and received a prestigious International award from IPNI, USA for my doctoral research work.

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Due to constant decrement in soil fertility status, the production and productivity of groundnut in India is decreasing. Although, the chemical fertilizers are known to increase production but our complete reliance on chemicals has led to poor soil health and pollution problems which in turn affects crop yield. There is an urgent need to explore an alternative strategy for sustainable production of crops. Liquid biofertlilizers, one of the best modern tools for agriculture, when integrated with chemical fertilizers boost up the crop yield as well as improve soil fertility status. They aid in meeting the nutrient demands of crop by enhancing their availability and absorption by the plants. Taking into account these facts, this book represents the results obtained from the M.Sc. thesis study about Integrated Nutrient Management in kharif groundnut. It also emphasizes on studying the effect of integration of chemicals and liquid biofertilizers on soil health and various quality parameters of groundnut crop concerning economics of INM practices in groundnut cropping.

Neelam Singh pursuing Ph.D. in Agronomy at RVSKVV. The author holds M.Sc. on INM in groundnut & has articles and book chapters about the theme published in several journals. She graduated the B.Sc. in Agriculture at MGCGVV in 2016. She is recipient of INSPIRE fellowship by DST, New Delhi & a gold medalist in both her B.Sc. & M.Sc. degree program.

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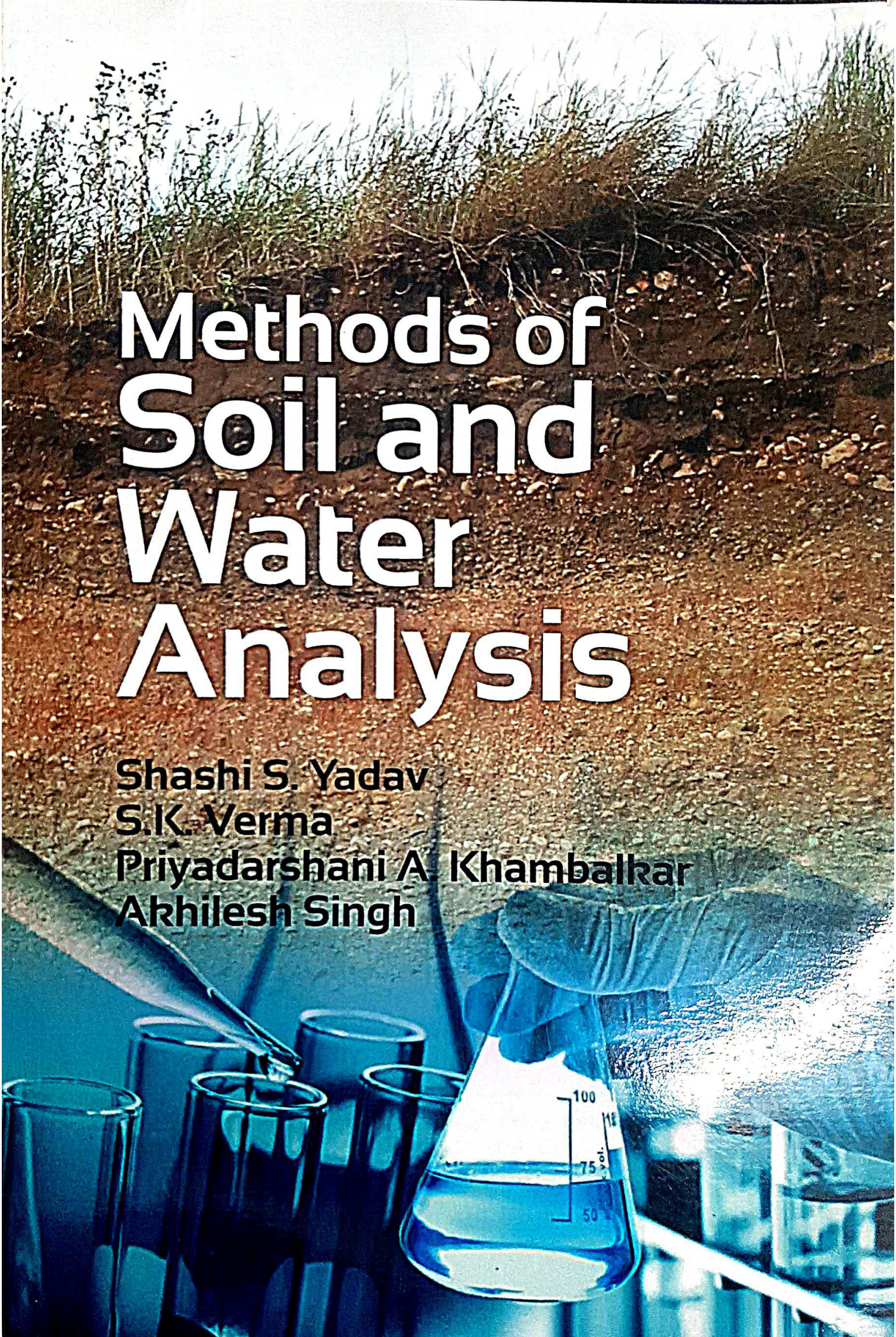
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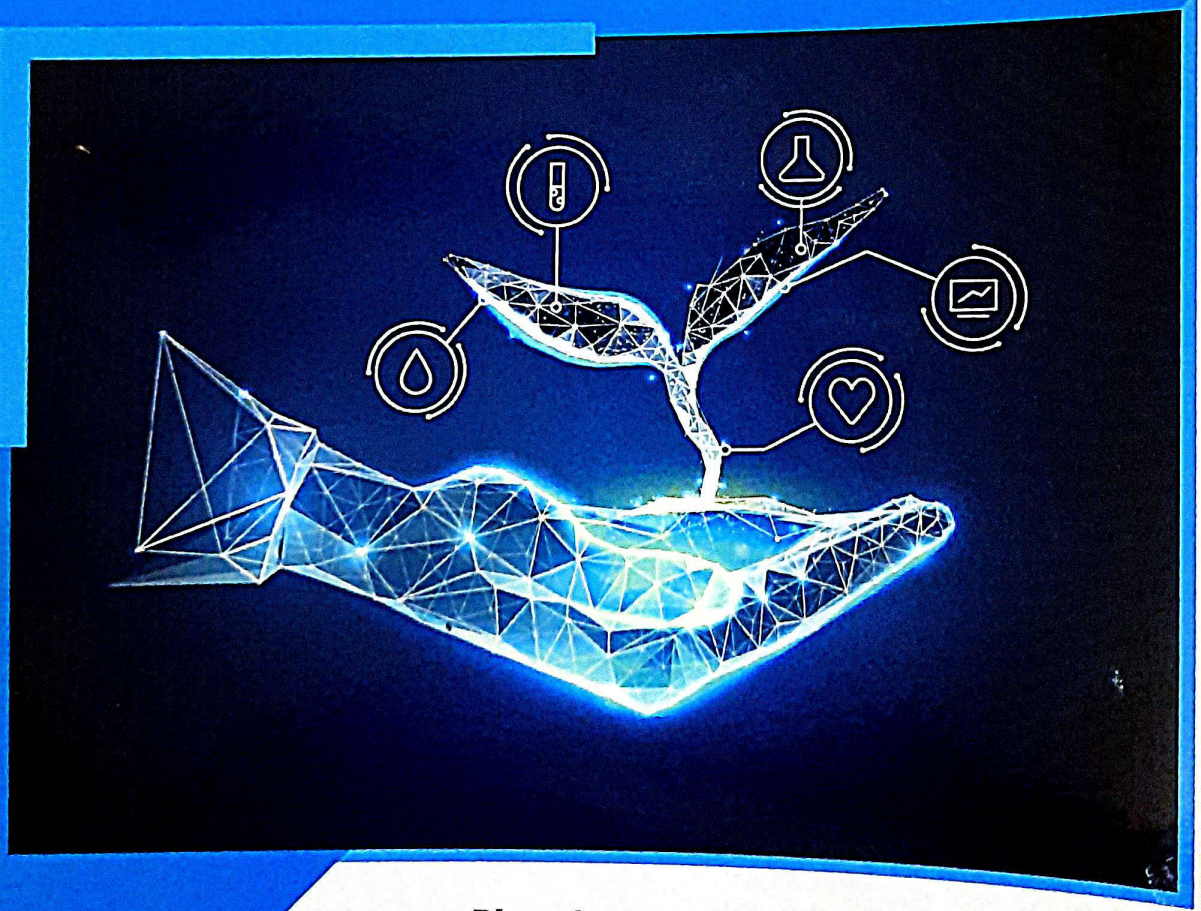

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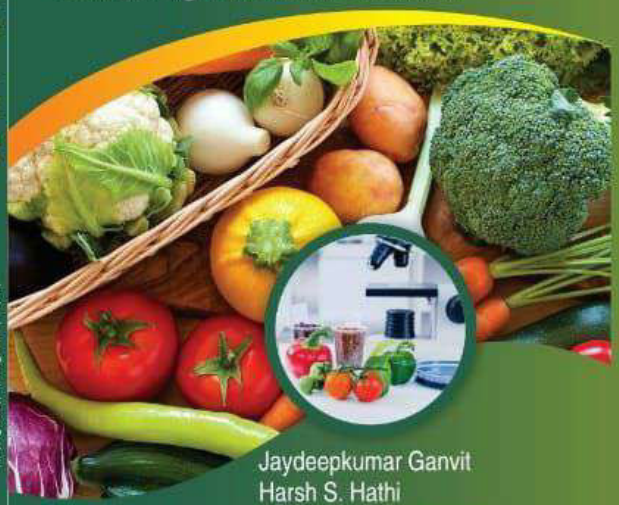

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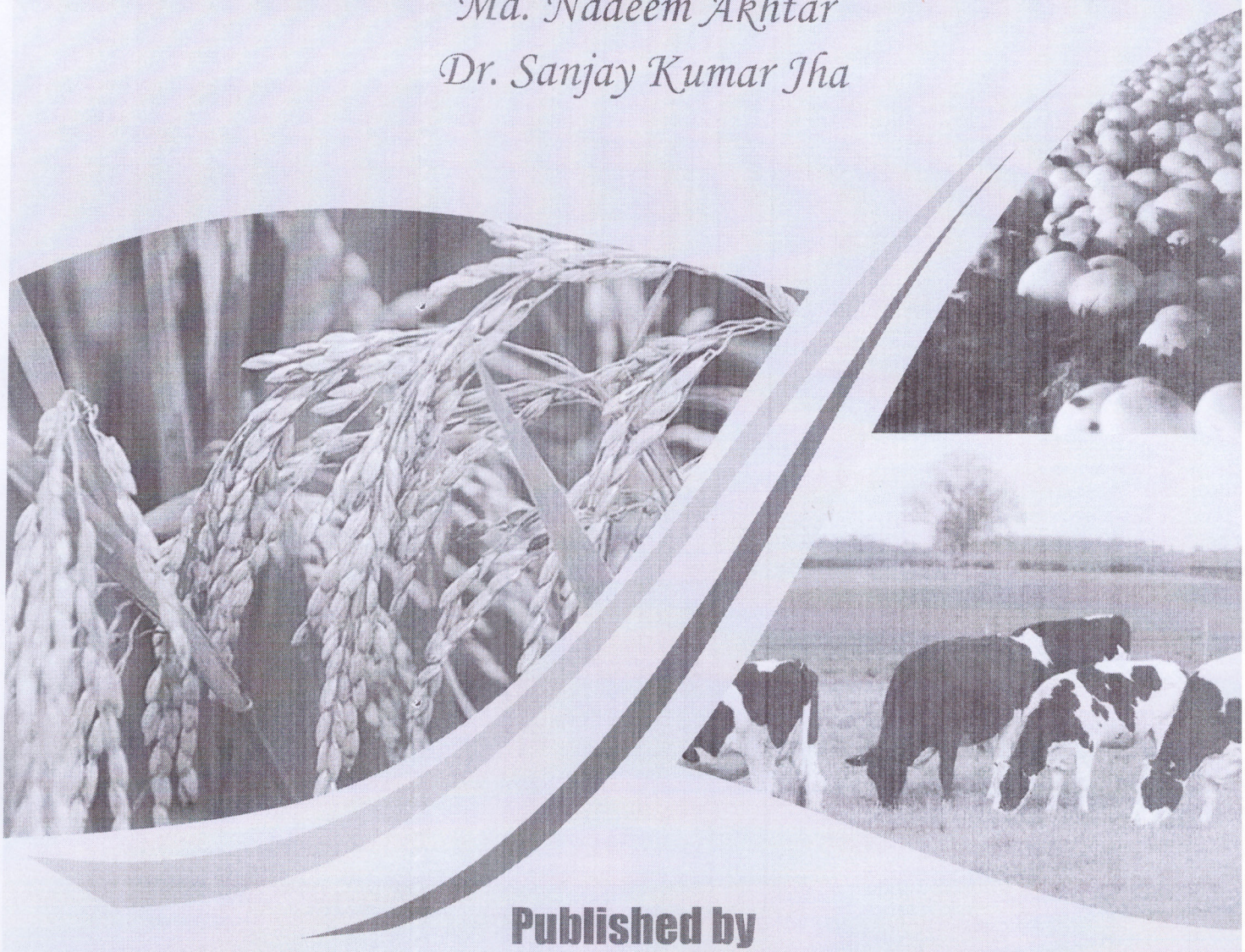

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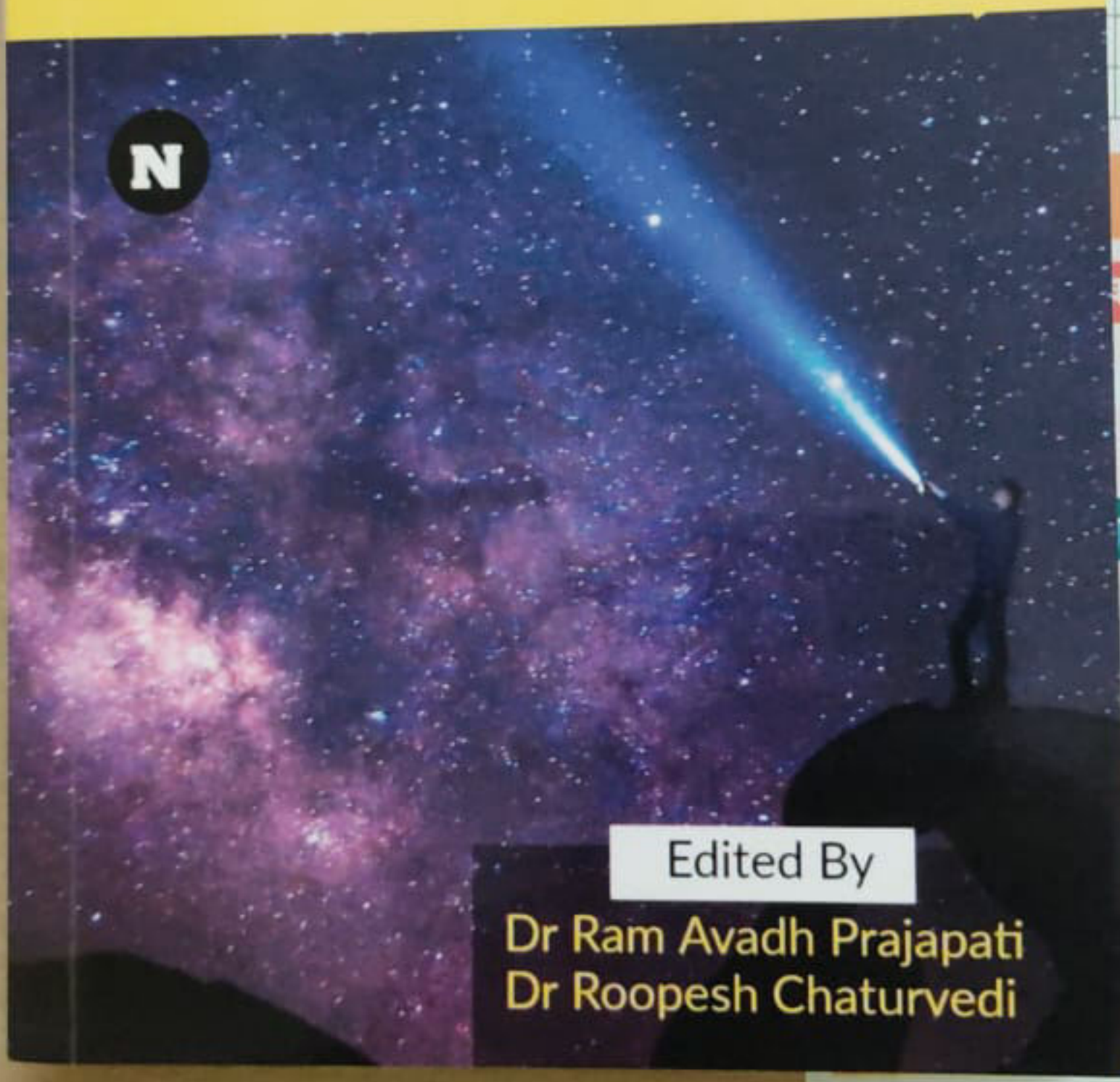

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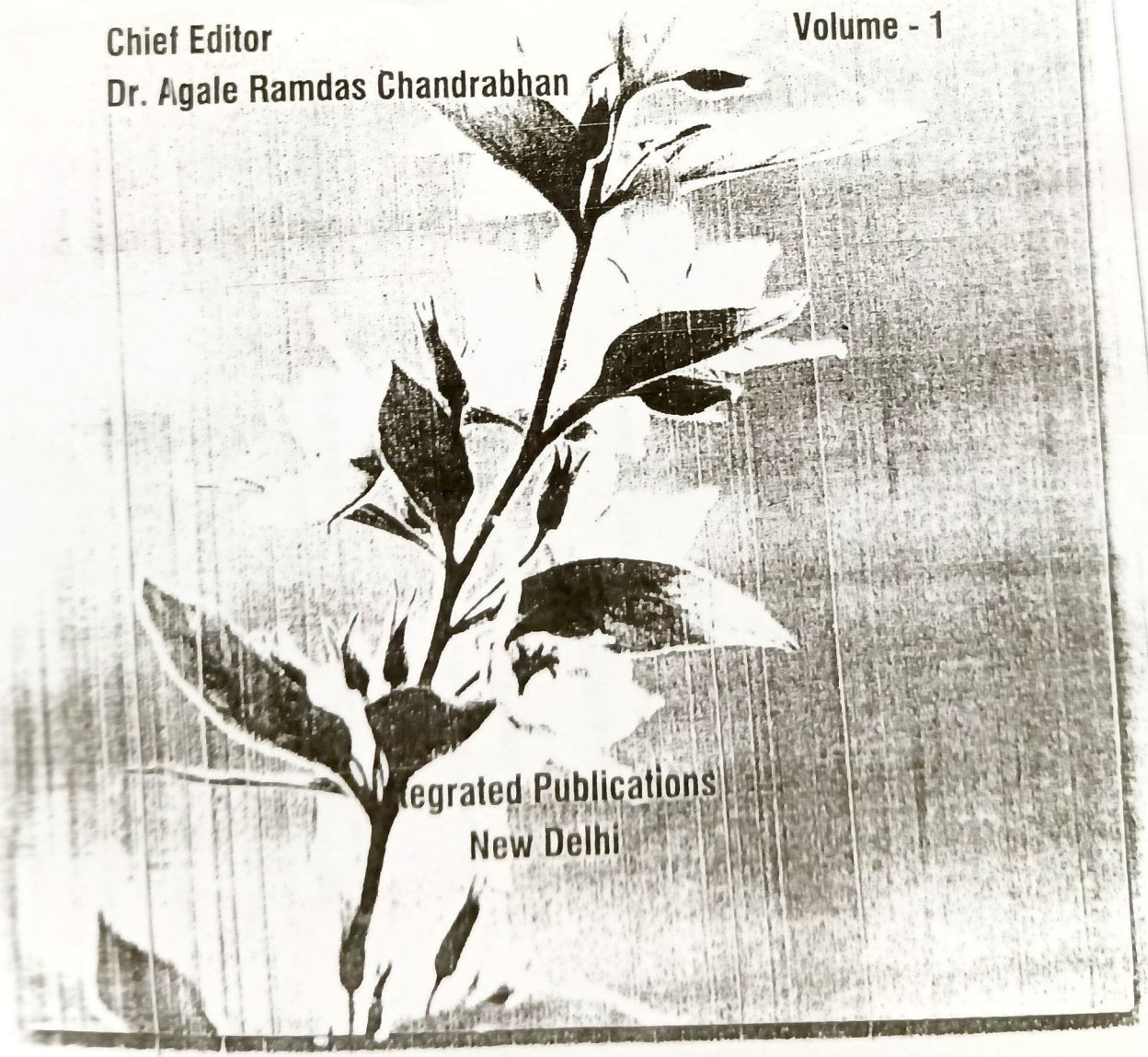

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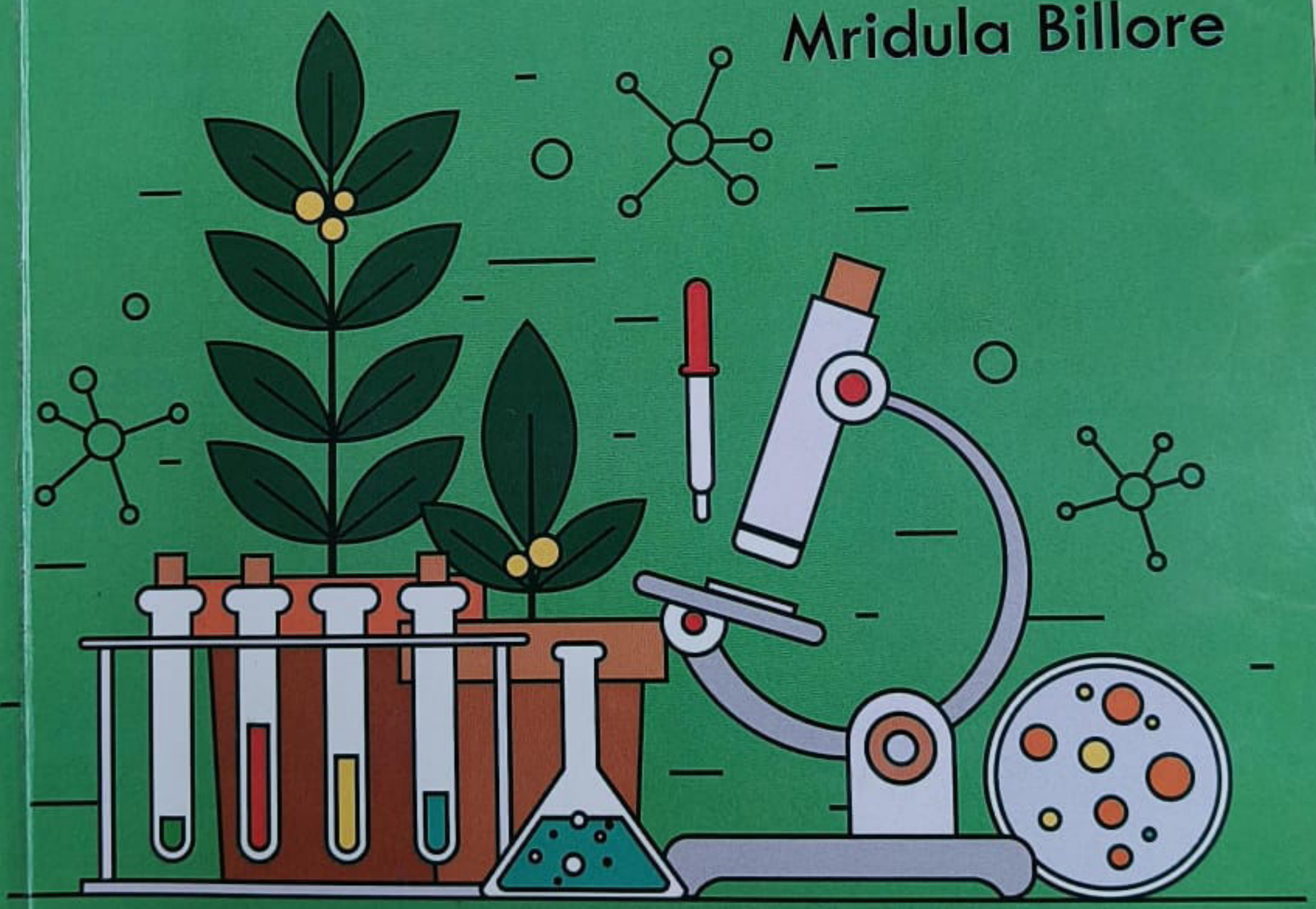

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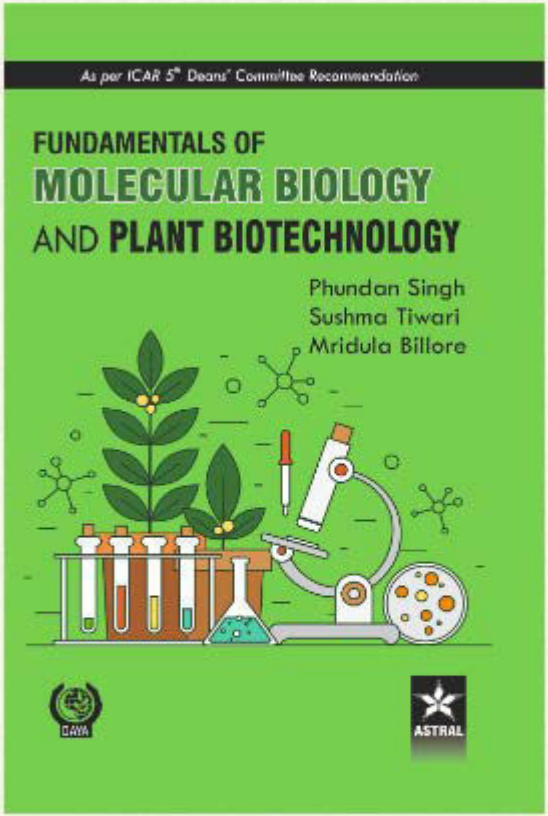

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POSTHARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

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POSTHARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

(As per Vth Dean's Committee's Recommendations)

M.K. Kureel
D.S. Mandloi
K.V. Singh
Rajesh Lekhi

BIOTECH

Contents

OBJECTIVE QUESTIONS ON FRUIT CROPS

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Arjun Kashyap, Rajesh Lekhi
Niharika Rathore, Ajay Dangi
Brajraj Singh Kasana

SR.SCIENTIFIC

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About The Authors

Dr. Arjun Kashyap is born at Morena on 14-07-1989 and completed his school education at Ujjain MP. After completion of higher secondary he did his B.Sc. (Ag), M.Sc. (Horti.) and Ph.D in fruit science from RVSKVV Gwalior. He is very good student and qualified ICAR NET two times in 2015 and 2016 in fruit science. have two book chapters in reputed books and have also many popular articles and technical folder published by various magazines and from department of horticulture College of agriculture Gwalior. Dr. Kashyap has 14 research papers in different reputed NAAS rated journal in his short academic career. Dr. Kashyap was also awarded 5 times from different societies for best poster presentation during various national seminars.

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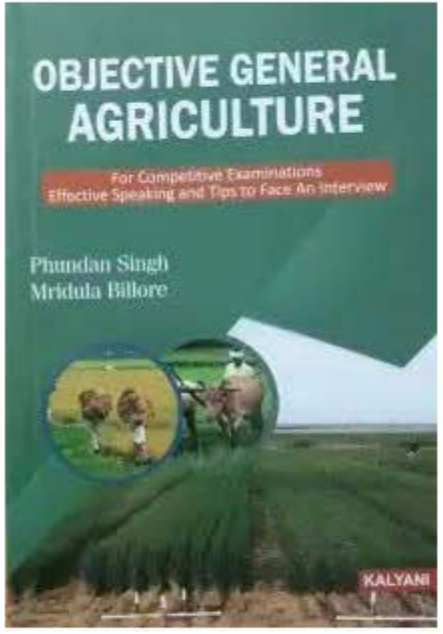

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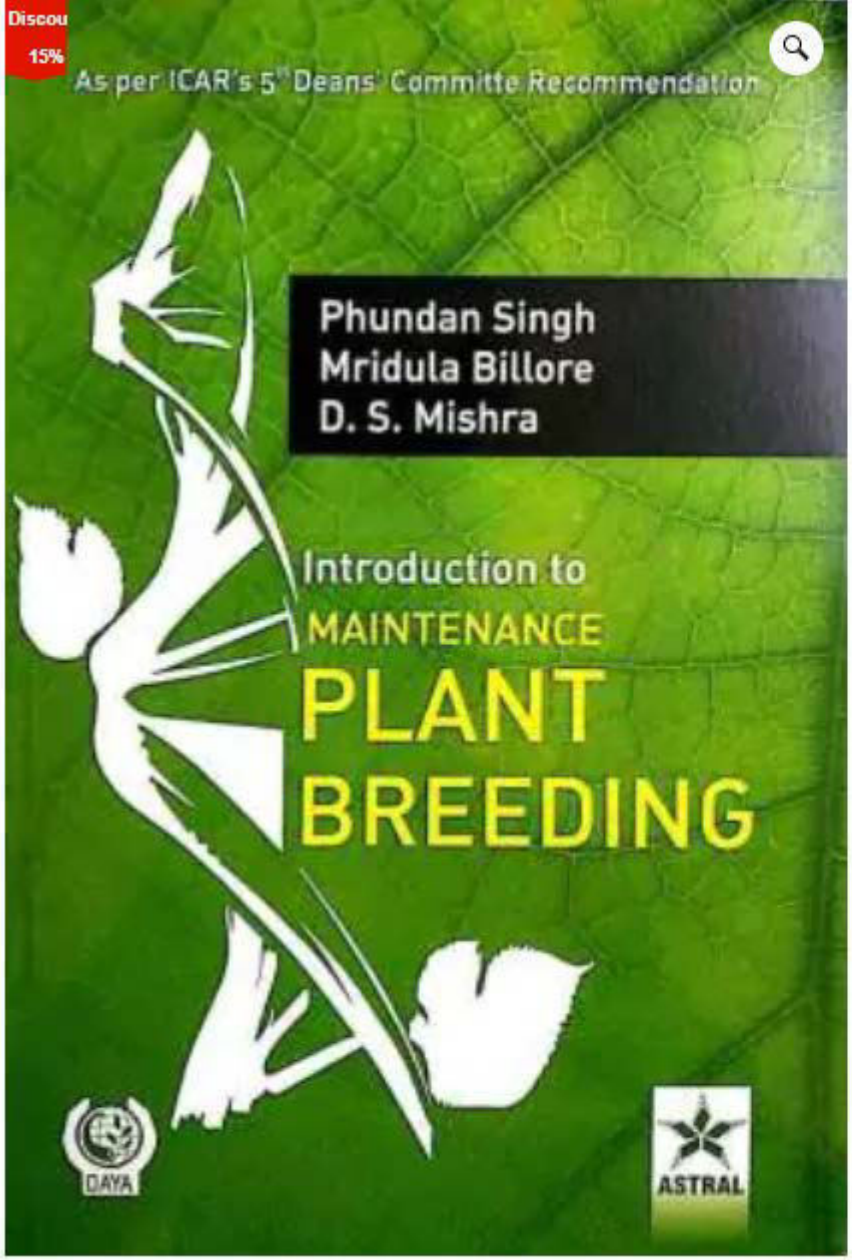

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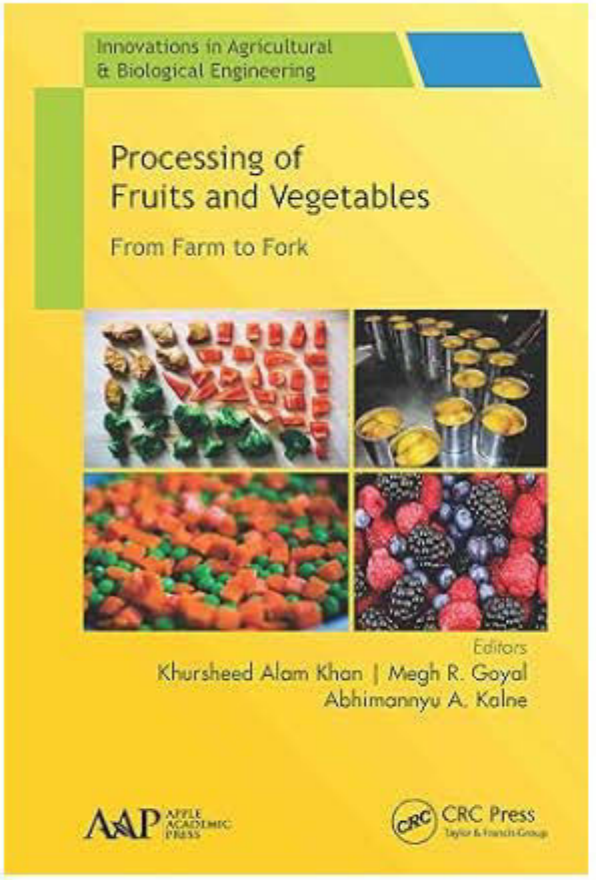

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by Khursheed Alam Khan (Editor), Megh R. Goyal (Editor), Abhimannyu A Kalne (Editor) | Format: Kindle Edition

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- processing and antioxidant/enzyme profiles of fruits and vegetables (role of antioxidants and enzymes in processing, use of solar energy in processing, and techniques used in making processed products from fruits and vegetables)
- novel processing technologies in fruits and vegetables (ultraviolet light, pulsed light technology, hurdle technology, physical and biochemical properties)
- the challenges and solutions in waste reduction, negative effects of processing, and effects of processing on vitamins of fruits and vegetables

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Criteria 3.4.5 Book Chapters

6 Farm Management Principles

Dr. Sumit B. Wasnik[1] and Dr. Sneha Pandey[2]

[1]Assistant Professor (Guest Faculty), RSV CARS, Bemetara (CG)
[2]Assistant Professor (Guest Faculty), Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (MP)

Abstract

Nobody can deny the fact that it is the endeavor of the farming community only that helps realize the higher farm production. Farm management, includes making and implementing of the decisions involved in organizing and operating a farm for maximum production and profit. Farm management draws on agricultural economics and fall under microeconomics. In this chapter we studied about eight principles of farm management viz., comparative advantage, opportunity cost, theory of cost, product substitution, factor substitution, diminishing marginal return, equi-marginal returns and time comparison. These principles provide the farmer to find the practical solution of farm related problems such as production, marketing as well as management of on farm resources. Along with efficient resource management these principles guide to achieve profit maximization level at farm. Thus, farm management tools help farmer in solving farm related problems for successful farm business.

Keywords: Costs, Diminishing Return, Farm management, Input, Principles, Rational, Output.

Introduction

The prosperity of any country depends upon the prosperity of farmers, which in turn depends upon the rational allocation of resources among various uses and adopting

Chapter - 9

Farm Management and Efficiency Analysis

Dr. Sumit B. Wasnik[1] and Dr. Sneha Pandey[2]

[1]Assistant Professor (Guest Faculty), RSV CARS, Bemetara (CG)
[2]Assistant Professor (Guest Faculty), Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (MP)

Abstract

The present chapter entitled 'Farm Management and Efficiency Analysis' is intended to present the management related decisions of the farm resources and farm efficiency measuring tools for sound farm planning by any individual. The chapter includes various farm related decisions to be achieved by the principles of farm managing at the most profitable levels, types of farm, farm resource management, farm production economics, risk and uncertainty in farming, and finally the various farm efficiency analysis tools. The theory of optimal decision making in the organization and management of a farm for profit maximization is the foundational theory of farm management. In the context of increased commercialization there is a greater need to improve the managerial abilities of the farmer. So far, the managers in general have responded admirably to the technological changes that accrued in Indian agriculture. All farm management tools as well as farm efficiency tools are helpful to the farmers in solving their managerial problems for successful operation on the farm business. In concluding that the farmers need of decision making to evaluate the farm businesses will definitely be achieved on the guidelines of resources management and efficiency measures for the profit maximization of farm.

Keywords: Efficiency, Farm, Farm Management, Production Economics, Risk and Uncertainty.

Chapter - 19

Agricultural Marketing and Consumer Behaviour

Dr. Sneha Pandey[1] and Dr. Sumit B. Wasnik[2]

[1]Department of Agricultural Economics, Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, (Madhya Pradesh)

[2]Department of Agricultural Economics, RSV CARS, Bemetara IGKV (Chhattisgarh)

Abstract

The interaction between buyers and sellers is called Market. A Market is an institution or a process that allows and sellers to interact. A market is not necessarily a **Marketplace,** which is a physical location where buyers and sellers go to exchange goods. In marketing, understanding consumer behavior has become very important for businesses. Consumer behavior refers to the study which analyzes how consumers make decisions about their wants, needs, buying or act with respect to a product, service or organization. It is very critical to understand the behavior of consumers to analyze the behavior of potential consumers towards a new product or service. It is also very useful for companies to identify opportunities which have not yet been met. In marketing, understanding consumer behavior has become very important for businesses. Consumer behavior refers to the study which analyzes how consumers make decisions about their wants, needs, buying or act with respect to a product, service or organization. It is very critical to understand the behavior of consumers to analyze the behavior of potential consumers towards a new product or service. It is also very useful for companies to identify opportunities which have not yet been met. In this chapter we are going to understand about agricultural marketing, Characteristics of market, classification of market, functions of market and market functionaries. This chapter also describes consumer behavior, types of consumer behavior, importance of consumer behavior and factors affecting consumer behavior.

Chapter 17

Constraints and Prospect in Rainfed Region

Balkrishan Singh[1], Nisha Singh[2], Janmejay Sharma[3], Ajay Bhadauria[4], Jaideep Singh Bhadauria[5] and Sudhir S. Bhadauria[6]

[1]Soil Conservation Inspector under Department of Agriculture, Jhansi Uttar Pradesh
[2]Scientist Department of Agronomy under College of Agriculture RVSKVV, Gwalior
[3]Scientist Department of Agronomy under College of Agriculture RVSKVV, Gwalior
[4,5]Block Technological Manager ATMA Department of Agriculture M.P
[6]Deputy Commissioner Ministry of Agriculture, New Delhi

Rainfed farming is a significant agricultural practice globally, providing sustenance to millions of farmers in regions where irrigation is limited. However, it faces numerous challenges and offers both promising prospects and potential risks. The problem lies in its heavy reliance on rainfall, making crops vulnerable to erratic and insufficient precipitation patterns, leading to crop failures, food insecurity, and economic distress for farmers. Climate change exacerbates these challenges, causing unpredictable weather patterns, frequent droughts, and more intense storms. As a result, farmers struggle to adapt their traditional practices to cope with the changing climate, hindering agricultural productivity and income stability.

Despite these issues, rainfed farming also holds prospects. Implementing sustainable water management practices, such as rainwater harvesting and conservation techniques, could mitigate water scarcity. Additionally, embracing climate-resilient crop varieties and modern agricultural technologies can enhance productivity and income. Furthermore, governmental support, infrastructural investments, and farmer training programs can create a conducive environment for rainfed farming's growth. In brief, addressing the challenges through sustainable practices and technological advancements could unlock the potential of rainfed farming,

Chapter 15

Production Technology of Cabbage (*Brassica oleracea* var. Capitata)

Balkrishan Singh[1], Nisha Singh[2], Ritu Sharma[3], Shweta Sharma[4]
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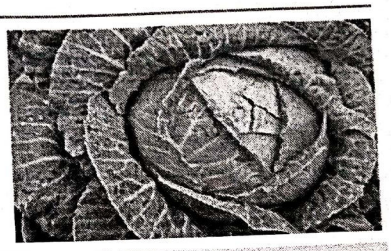
[3]RHEO Gwalior, [4]M.Sc. Agronomy, RVSKVV, Gwalior

Botanical name: *Brassica oleracea* var. capitata
Family : Brassicaceae/ Cruciferae
Origin: Mediterranean region
Chromosome no. 2n=2x:18
Type of fruit: Siliqua



INTRODUCTION

It is an important Cole crop. From nutrition point of view, it ranks very high. It is used alone or mixed with other vegetables like pea or potato etc. Young green heads contain more vitamin A than old ones. The peculiar flavour in cabbage head is because of a glycoside sinigrin, which carries sulphur. Cabbage contains vitamin U, which is very useful in ulcer in stomach.

The word cabbage is introduced from the French word *Cobache* meaning head. The head of cabbage is ended with various thick overlapping smooth leaves, which envelop a smooth terminal bud. Sometimes-small heads of 5 or 7.5 cm diameter are formed, which are known as cabbage sprouts, having no commercial importance. The heads of cabbage are classified as round or ball head, flat or drumhead and conical head *etc.*

Climatic requirement:

It grows generally in cool and moist weather, and is very hardy to frost. In hot and dry weather, its quality becomes poor due to the enlargement of fibres and bitter taste, and much of the flavour is lost due to excessive high temperature. The cabbage plants do not form heads at a temperature above 30°C. Germination is best at a soil temperature of 13-16°C. Well-hardened seedlings tolerate -2 to -5°C temperature.

Chapter 10

Climate Smart Agriculture and Carbon Sequestration

Priyadarshani A Khambalkar[1], Murlidhar Sadawarti[2], Ekta Joshi[1] and Shashi Yadav[1]

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Climate change has become the known fact witnessing all over the world and its impact is been seen in very severe way in recent years which is becoming threat to lives and livelihoods. The climate change mainly driven by increase in atmospheric CO_2 concentration which is triggered by the combustion of fossil fuels, deforestation and bad agricultural practices. Agriculture is most vulnerable to global climate change due to their direct dependence on climatic factors such as devastating floods, cyclones, droughts, storms, heat waves, melting of glaciers, changes in pattern and rate of precipitation severly affecting crop productivity leading to the yield loss. Climate smart agriculture is the statigic farming which is sustainable, economical viable and envoirnmaent friendly, includes known techniques like mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agroforestry, improved grazing and improved water management and innovative practices like more dependable weather forecasting, early-warning systems and climate-risk insurance. Climate-smart agriculture practices like conservation tillage, cover crops, biochar applications, bioenergy cropping and balance supply of nutrients helps to enhance soil organic carbon (SOC) sequestration and to reduce greenhouse gas emissions while ensuring crop productivity which plays major role in enhancing soil biomass. Adaptation methods like resource-conservation technologies, cropping-system technologies, and socio-economic or policy interventions imparts significant positive impact in sequestering C in soil and helps to develop suitable mitigation options to reduce the production of GHGs

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Chapter- 20

Status of DTPA-Extractable Micronutrient Cations in Major Rapeseed-Mustard Growing Area of Madhya Pradesh

Brajkishor Rajput
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In balanced plant nutrition, the role of micronutrients is well established. However, exploitive nature of modern agriculture involving use of high analysis NPK fertilizers coupled with limited use of organic manures and less recycling of crop residues are important factors contributing accelerated exhaustion of micronutrients from soil. Enhanced removal of micronutrients as a consequence of adoption of high yielding varieties and intensive cropping together with a shift towards high analysis NPK fertilizers coupled with limited use of organic manures and less recycling of crop residues are important factors contributing accelerated exhaustion of micronutrients from the soils and resulted in the depletion of micronutrient cations from the soil reserves (Dhane and Shukla 1995). Deficiency of micronutrients may either be primary, due to their low total contents or secondary, caused by soil factors reducing their availability to plants. The emergence of micronutrients deficiency has generally been considered as secondary. The availability of micronutrient cations are influenced by several factors such as pH, $CaCO_3$, organic matter, soluble salts, cation exchange capacity and texture of soils. For an effective correction of a micronutrient deficiency in the field, it is necessary to understand the reasons of its deficiency in the soil.

Mustard (*Brassica juncea* L.) is one of the major *rabi* season oil seed crops. In Madhya Pradesh, it is cultivated in 7.57 million hectare with corresponding production of 7.37 million tonnes and an average productivity of 1035 kg/ha. More than 70 percent of this area lies in northern Madhya Pradesh, particularly in the district of Morena, Bhind and Gwalior. (Anonymous, 2009).There are reports of reduction in yield even due to constant use of NPK fertilizers. The reduction in the yield is generally traced due to deficiency of secondary and micronutrients. The micronutrient deficiencies which were sparse and sporadic initially (Takkar and Randhawa, 1980) are now widespread. Inventory of the available

Chapter - 5

In vitro Morphogenesis in Gladiolus (*Gladiolus hybridus* Hort.) From Corm Slice

M.K. Tripathi, Sushma Tiwari, Niraj Tripathi, Ram Kanya Malviya, Deepa Bhatt, P.N. Tiwari and Sharad Tiwari

Abstract

Corm slice explant of gladiolus (*Gladiolus hybridus*) was inoculated on MS medium supplemented with different auxins and cytokinins in variable concentrations as alone in addition to in diverse combinations. Inoculation medium MS2B.5D (MS + 2.0 mgl^{-1} BAP + 0.5 mgl^{-1} 2,4-D) evidenced fine for callus initiation. While MS medium augmented with BA in range of 2.0-3.0 mgl^{-1} in amalgamation with 0.5 mgl^{-1} NAA revealed higher shoot proliferating competence, numbers of shoot (s) per explant along with shoot of higher length. In terms of *in vitro* rooting response, higher root proliferating efficacy was recognized on rooting medium MS.5IB.5Kn (MS + 0.5 mgl^{-1} IBA + 0.5 mgl^{-1} Kinetin), whereas numbers of root (s) with higher length were recovered on rooting medium MS.5IB (MS+0.5 mgl^{-1} IBA). Phenotypically usual plantlets were developed and afterward shifted to pots and hardened in Environmental Growth Cabinet and Net House during initial bearing period and relocated to field efficaciously.

Keywords: *Gladiolus hybridus*, corm slice, direct and indirect organogenesis, plantlet regeneration

Abbreviations: B_5: Gamborg's medium; MS: Murashige and Skoog's medium; Wh: White's medium; BA: 6-benzylaminopurine; TDZ: Thidiazuron; Zea: Zeatin;Kn-Kinetin; NAA: α-Naphthalene acetic acid;2, 4-D: 2, 4-dichlorophenoxyacetic acid;2, 4, 5-T: 2, 4, 5 trichlorophenoxyacetic acid;GA_3: Gibberellic acid and IBA: Indole-3-butyric acid

Introduction

Gladiolus (*Gladiolus hybridus* Hort.) belonging to the family Iridaceae is one of the most imperative bulbous marketable decorative plants cultivated for cut flowers [1-2]. Owing to its wonderful inflorescence with various colours brands it gorgeous for use in herbaceous borders, beddings,

horticulturae

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Article

Optimization of Different Factors for Initiation of Somatic Embryogenesis in Suspension Cultures in Sandalwood (*Santalum album* L.)

Manoj Kumar Tripathi [1,2,*], Niraj Tripathi [3], Sushma Tiwari [2], Gyanendra Tiwari [1,4], Nishi Mishra [2,5], Dilip Bele [1], Rajesh Prasad Patel [6], Swapnil Sapre [5] and Sharad Tiwari [5]

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Abstract: *Santalum album* (L.) is a prized tropical tree species of high therapeutic and industrial importance. The wood of these naturally grown plants is extensively harvested to acquire therapeutically important metabolite santalol and be used for additional functions such as in wood statuette industries. Due to high demand, it is crucial to maintain a sufficient plant population. An easy protocol for establishing cell suspension culture initiated from the loose embryogenic callus mass of sandalwood was realized by shifting 6–8-week-old morphogenic calli acquired from the mature embryonic axis and cotyledon explant cultures in fluid media. The asynchronous embryogenic cultures were sloughed with clumps of flourishing cell clumps and embryos of various progressive phases along with diffident non-embryogenic tissues. The frequency of embryo proliferation was evidenced to determinethe expansion pace of embryogenic masses under diverse conditions. The intonation of initiation and creation of cell suspension was under the directive of the influence of exogenous plant growth regulators amended in the nutrient medium at different concentrations and combinations. Maximum relative growth rate (386%) and clumps/embryoids in elevated integers (321.44) were accomplished on MS nutrient medium fortified with 2.0 mg L^{-1} 2,4-D in association with 0.5 mg L^{-1} BA and 30.0 g L^{-1} sucrose raised from mature embryonic axis-derived calli. Plantlet regeneration in higher frequency (84.43%) was evidenced on MS medium amended with 1.0 mg L^{-1} each of TDZ and GA_3 in conjunction with 0.5 mg L^{-1} NAA and 20.0 g L^{-1} sucrose. Mature embryonic axis-derived calli were found to be constantly better than mature cotyledon-derived calli for raising profitable and reproducible cell suspension cultures. Regenerants displayed normal growth and morphology and were founded successfully in the external environment after hardening.

Keywords: cell clumps; cell suspension culture; plantlet regeneration; *Santalum album*; somatic embryogenesis

Citation: Tripathi, M.K.; Tripathi, N.; Tiwari, S.; Tiwari, G.; Mishra, N.; Bele, D.; Patel, R.P.; Sapre, S.; Tiwari, S. Optimization of Different Factors for Initiation of Somatic Embryogenesis in Suspension Cultures in Sandalwood (*Santalum album* L.). *Horticulturae* **2021**, *7*, 118. https://doi.org/10.3390/horticulturae7050118

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1. Introduction

Santalum album (L.) is a prized tropical tree species belonging to Santalaceae [1]. It is an occupant of the Indian subcontinent. synonymous with prehistoric Indian culture and convention [2]. Santalol, a secondary metabolite in *S. album*, is identified as sandalwood oil, being exceedingly priced in the perfumery traffic owing to its sugary, constant perfume and

Chapter - 5

Effect of Plant Growth Regulators on *in vitro* Morphogenesis and Regeneration of *Amaryllis belladonna* L. from Different Explants Cultures

M.K. Tripathi, Niraj Tripathi, Sushma Tiwari, Devendra K. Payasi, Deepa Bhatt, Yashi Singh Tomar and Sharad Tiwari

Abstract

Bulb scale, leaf disc and mature embryos explants *viz*., were inoculated on diverse fortifications of MS medium to accomplish the best *in vitro* response. For bulb scale explant culture, induction medium MS2N.5B evidenced better for callus initiation. Nutrient medium MS.4Td displayed higher shoot proliferating competence, while number of shoot (s) per explants and shoot of higher length were recognized on culture media MS2N.5B/ MS3N.5B. In respect to leaf disc culture, induction medium MS2D.5B/ MS3D.5B encouraged higher degree of callus induction. Whereas, higher morphogenic calli formation was showed by inoculation medium MS2N.5B/MSN.5B. However, plantlets in higher frequencies were attained on regeneration medium MS.5Td/MSB. Cultured mature embryos initiated calli in higher frequencies on culture medium MS2D.5B, while nutrient medium MSN.5B revealed higher number of shoot proliferating explants. While, number of shoots per explant in higher proportions were attained on nutrient medium MSN.5B/MSB. Nevertheless, shoot of higher length was recovered on culture medium MSB. Higher *in vitro* rooting response (root proliferating efficiency, number(s) of roots and mean root length) was investigated on rooting medium MS2IB. The plantlets were transferred to pots and hardened in Environmental Growth Cabinet followed by Net House during initially weaning period and subsequently transferred to field efficaciously. Phenotypic normal plants were obtained.

Keywords: Amaryllis belladonna, bulb scale, mature embryo, leaf disc, organogenesis, somatic embryogenesis and plantlet regeneration

Abbreviations: MS-Murashige and Skoog medium; Wh-White's medium; B_5: Gamborg's medium; NAA-α-Naphthalene acetic acid; 2,4-D-2,4-dichlorophenoxyacetic acid; 2,4,5-T-2,4,5-trichlorophenoxyacetic acid;

Chapter - 6

Plant Regeneration from Cultured Cormel Explants in Gladiolus (*Gladiolus hybridus* Hort.)

MK Tripathi, Niraj Tripathi, Sushma Tiwari, Ram Kanya Malviya, PN Tiwari and Sharad Tiwari

Abstract

Cormel of gladiolus (*Gladiolus hybridus*) was inoculated on diverse modifications of MS medium supplemented with various auxins and cytokinins in different concentrations as alone along with in diverse combinations. Regarding *in vitro* response, culture medium MS2D.5B/MS2N.5B (MS + 2.0 mgl^{-1} 2,4-D + 0.5 mgl^{-1} BA + 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar/MS + 2.0 mgl^{-1} NAA + 0.5 mgl^{-1} BA + 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar) encouraged higher callus initiation. Inoculation medium MS2N.5B/MSN.5B(MS + 2.0 mgl^{-1} NAA+ 0.5 mgl^{-1} BA+ 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar/MS + 1.0 mgl^{-1} NAA+ 0.5 mgl^{-1} BA+ 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar) displayed higher shoot proliferating efficiency and shoot of higher length, Whilst, higher number of shoot (s) per explant showed by regeneration medium MS3B/MS2B (MS + 3.0 mgl^{-1} BA+ 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar/MS + 2.0 mgl^{-1} BA+ 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar). For *in vitro* rooting, higher root proliferating ability was recognized with rooting medium MS.5IB.5Kn (MS + 0.5 mgl^{-1} IBA + 0.5 mgl^{-1} Kinetin + 15.0 gl^{-1} sucrose + 7.5 gl^{-1}agar), whereas number of root (s) with higher length were convalesced on rooting medium MS.5IB (MS+0.5 mgl^{-1} IBA+15.0 gl^{-1} sucrose+ 7.5 gl^{-1} agar). Phenotypically normal plantlets were attained and subsequently transferred to pots and hardened in Environmental Growth Cabinet and Net House and transferred to field efficaciously.

Keywords: *Gladiolus hybridus*, cormel, direct organogenesis, indirect organogenesis, plantlet regeneration, cormlet formation

Abbreviations

MS: Murashige and Skoog's medium; B_5: Gamborg's medium; Wh: White's medium; BA: 6-benzylaminopurine; TDZ: Thidiazuron; 2-ip: N-isopentenyl amino purine; Kn-Kinetin; NAA: α-Naphthalene acetic acid; 2,

Chapter - 8

Effect of Diverse Plant Growth Regulator Concentrations and Amalgamations in Plantlet Regeneration in *Rauvolfia serpentina* (L.) Benth from Cell Suspension Culture

M.K. Tripathi, G. Tiwari, Sushma Tiwari, Niraj Tripathi, Mohini Sharma, Nishi Mishra and Sharad Tiwari

Abstract

Institution of embryogenic cell suspension culture from the embryogenic callus culture of *Rauvolfia serpentina* (L.) was endeavored by shifting 4-6 weeks-old asynchronous embryogenic calli raised from mature embryo and cotyledon explants cultures in liquid culture. The cultures acquired were swamped frequently with clumps of proliferating globular embryos with modest non-embryogenic tissues. The number and size of somatic embryos/clumps was documented to compute growth of embryogenic tissues under numerous conditions. Initiation and proliferation of embryogenic suspension culture was prejudiced by different exogenous plant growth regulators supplemented to the nutrient medium at changing extent. For the establishment of suspension cultures, MS medium amended with 2.0 mg l^{-1} 2,4-D in association with 0.5 mg l^{-1} BAP was found to be the most operative. For succeeding subculturing, the abridged level of 2,4-D (1.0 mg l^{-1}) in association with 0.5 mg l^{-1} BAP encouraged somatic embryogenesis at a faster proportion. Frequent and efficient plantlet regeneration attained on MS medium fortified with 0.5 mg l^{-1}, each of BAP, TDZ and NAA. Higher *in vitro* rooting (root proliferating efficiency, numbers of roots and root of higher length) was displayed by rooting medium amended MS basal medium with 0.1 mg l^{-1} IBA. An arrangement of 65% relative humidity and 28 °C temperature regime revealed higher survival of regenerants (~95%) tracked by 60% RH and 30 ºC (~90%). Later about 85% plants survived after transplantation under the field conditions.

Keywords: *Rauwolfia serpentina* L, mature embryo and cotyledon, cell suspension cultures, cell clumps, relative growth rate and plantlet regeneration

Chapter 7
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Biotechnological Approaches for Genetic Improvement of Crops

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ABSTRACT

Biotechnological approaches are being used widely in modern plant breeding for genetic improvement of crops for targeted traits and yield. The conventional breeding methods are mostly based on hybridization and selection of advance breeding lines. Advance biotechnological methods are rapidly being employed for achieving improved varieties in less span of time with desirable traits. These methods include plant tissue culture, molecular breeding, and transgenic methods. Plant tissue culture is helpful in getting somaclonal variants, embryo rescue, and for mass propagation of plants through micropropagation, while molecular breeding is being applied for marker assisted selection, varietal characterization, foreground and background selection and transgenics approaches are being used to transfer gene from different background in genome of crop plants. High throughput genotyping, next generation sequencing and genome editing are some of the recent biotechnological tools being applied for successful crop improvement programme. Current book chapter focused on overview of some of the important biotechnological tools being applied for crop improvement.

Keywords: Crop improvement programme; plant breeding; genetic improvement; molecular breeding.

1. INTRODUCTION

Crop improvement techniques have a long history and they had been applied since the beginning of domestication of the first agricultural plants. Since then, various new techniques have and are being developed to further increase the commercial value and yield of crops. End of the year 2050 the world population is anticipated to reach up to 10 billion. In this situation, increasing food crop production by 60% over the following decades is necessary to ensure global food

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Chapter 19

Integrated Farming System (IFS) for Sustainable Livelihood Security

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INTRODUCTION

Integrated farming systems (IFS) is an eco-friendly approach in which waste of one enterprise becomes the input of another thus its make more efficient use of resources from the farm. IFS as a mixed farming system that consists of at least two separate but logically interdependent parts of a crop and livestock enterprises. IFS helps in improving the soil health, weed and pest control, increase water use efficiency and maintains water quality. In integrated farming system the use of harmful chemical fertilizers, weed killers and pesticides should be minimized and also provide safeguards to the environment from the adverse effects. Integrated farming system improves economic condition of the small and marginal farmers which enhanced the education, health and social obligations and overall improvement in livelihood security. Though IFS approach the use of chemicals (fertilizers and pesticides) can be reduced to provide chemical free healthy food to the society.

To meet the multiple objectives of poverty reduction, food and nutritional security, competitiveness and sustainability, several researchers have recommended the farming systems approach to research and development. A farming system is the result of complex interactions among a number of inter-dependent components, where an individual farmer allocates certain quantities and qualities of four factors of production, namely land, labour, capital and management to which he has access (Mahapatra, 1994). Farming systems research is considered as a powerful tool for natural and human resource management in developing countries including India. This

CHAPTER - 14

Natural Resource Management in terms of Crop Germplasm in India

Jaya Rathore, Pramod Kumar and R.S. Sikarwar

INTRODUCTION:

The sums total of hereditary material i.e. all the alleles of various genes, present in a crop species and its wild relatives are referred to as germplasm. This is also known as genetic resources or gene pool or genetic stock. Germplasm can be a seed or another parts of the plant e.g., a leaf, a piece of stem, pollen or even just a few cells that can be turned into a whole plant. Germplasm contains the information for a species, genetic makeup a valuable natural resource of plant diversity which plays a vital role for sustainable crop production.

NEED FOR MANAGEMENT/CONSERVATION OF CROP GERMPLASM:

A wide genetic base is essential for the development of new genotypes capable of surviving under heterogeneous environment. Selecting, collecting, exchanging, and preserving crop germplasm resources are not new activities or issues. They are in fact as old as agriculture itself, as old as our knowledge of growing crops for food. But what is new, and pressing, is how to make national and international decisions about managing these activities for the future.

There is a global recognition that biodiversity at all levels e.g., gene pools, species and biotic communities is important for many reasons but it is being rapidly diminished by habitat destruction and other damaging influences resulting from human population growth, climate change, pollution and economic expansion. Habitat destruction, genetic homogeneity in farming systems and alien species invasion are some of the causes of genetic erosion. Loss of genetic diversity has serious implications on economic and social development of any nation.

Therefore, conservation, management and sustainable use of crop germplasm are the fundamental to ecologically sustainable.development and food security of a nation.

STRATEGIES FOR CONSERVATION OF CROP GERMPLASM

There are two broad strategies for conservation of crop germplasm

1. **IN-SITU CONSERVATION-**

   In in-situ conservation, crop germplasm is maintained in the natural habitats where they occur, whether as uncultivated plant communities or in farmer's fields as part of existing agro-ecosystems. Development of natural park, biosphere reserves, or gene sanctuaries are the methods for achieving in situ conservation of natural biodiversity. NBPGR, New Delhi, established gene

Chapter - 6

In vitro Regeneration of Sandalwood *(Santalum album* Linn.) Employing Different Explants

M.K. Tripathi, G. Tiwari, Sushma Tiwari, Niraj Tripathi, Devendra K. Payasi and Sharad Tiwari

Abstract

Sandalwood belonging to family Santalaceae is one of the imperative tree species of the tropical forests known for its essential oil employed extensively in perfumery. Three explants *viz*., mature cotyledons, hypocotyls and mature embryos of sandalwood were inoculated on diverse supplementation of MS medium to investigate its *in vitro* response. *In vitro* morphogenesis (somatic embryogenesis and/or organogenesis) leading to plantlet regeneration was prejudiced suggestively owing to various plant growth regulators. Induction media (MS + 2.0 mg l^{-1} 2,4-D) evidenced suitable for callus induction. Nutrient media (MS + 0.5 mg l^{-1} 2,4-D+0.5 mg l^{-1} BA/MS + 1.0 mg l^{-1} 2,4-D+0.5 mg l^{-1}BA) induced direct somatic embryogenesis and average number of somatic embryos per explant in higher proportion. Whilst, Induction media (MS + 1.0 mgl^{-1} 2,4-D+0.5 mgl^{-1} BA/MS + 2.0 mg l^{-1} 2,4-D+0.5 mgl^{-1} BA) boosted the frequency of indirect somatic embryogenesis. Culture media (MS + 2.0 mg l^{-1} NAA+0.5 mg l^{-1} TDZ) encourages direct organogenesis and plantlet regeneration *via* direct organogenesis and nutrient medium MS + 1.0 mg l^{-1} NAA+0.5 mg l^{-1} TDZ) supported indirect organogenesis. Regeneration medium (MS + 2.0 mg l^{-1} TDZ+1.0 mg l^{-1} GA_3) regenerated plantlets in higher occurrences acquired from somatic embryos, whereas plantlet regeneration *via* indirect organogenic mode was obtained in higher ratio on regeneration medium (MS +1.0 mgl^{-1} TDZ+1.0 mgl^{-1} GA_3 +0.5 NAA) for the most of the explants cultures. The plantlets were transferred to pots and hardened in Environmental Growth Cabinet and Net House during initial weaning period and transferred to field efficaciously.

Keywords: Santalum album, mature cotyledon and embryo, hypocotyls, organogenesis, somatic embryogenesis, plantlet regeneration

Abbreviations: MS-Murashige and Skoog medium; BA-6-benzylaminopurine; TDZ-Thidiazuron; Kn-Kinetin; NAA-α-Naphthalene

Chapter 7
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Influence of Plant Growth Regulators on *In vitro* Morphogenesis in *Plumbago Zeylanica* Linn.

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ABSTRACT

The Present investigation was aimed to recognize the most responding explants, plant growth regulators and calculate their optimal concentrations and other physical aspects unveiling *in vitro* morphogenesis in higher rates *via* culturing nodal sections and leaf discs explants. Leaf disc and nodal section explants of *Plumbago zeylanica* were inoculated on basal media amended with diverse concentrations and combinations of different auxins and cytokinins as alone as well as in amalgamations. For inoculated nodal section, nutrient medium MS2N.5B (MS+2. 0 mgl^{-1} NAA+ 0. 5mgl^{-1}BA) evidenced appropriate for higher degree of callus initiation (91.69%), whereas culture medium MS2B (MS+2.0 mg l^{-1} BA) displayed higher shoot proliferating competence (84.14%). While, nutrient medium MS2B.5N (MS+2.0 mg l^{-1} BA+0.5 mgl^{-1}NAA) formed shoot(s) in higher numbers (11.12) along with of bigger length (7.11 cm). For cultured leaf disc, inoculation medium MS2N (MS+ 2.0 mgl^{-1}NAA) induced callus in higher percentage (91.12%), nevertheless greater morphogenic calli formation (45.58%) and plantlets regeneration were attained on culture medium MSN.5Td (MS+1.0mgl^{-1}NAA + 0.5 mgl^{-1} TDZ). In current investigation, MS medium amended with either IBA or NAA at the concentration of 0.1 mg l^{-1} was proved to be optimal for inducing higher *in vitro* rooting response *i.e.*, root proliferation, number(s) of roots and root length. Regenerants were established efficaciously under the field conditions after hardening with normal phenotypic characters.

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Chapter 8
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Plant Regeneration in *Rauvolfia serpentina* (L.) Benth *via* Organogenic Mode

M. K. Tripathi [a, b*], G. Tiwari [c, d], Sushma Tiwari [b], Niraj Tripathi [e], Nishi Mishra [b], Yashi Singh Tomar [b], D. S. Uikey [c] and Sharad Tiwari [f]

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ABSTRACT

An effectual protocol for rapid propagation of *Rauvolfia serpentina* has been standardized in present investigation. Leaf discs and nodal segments were inoculated on MS medium supplemented with diverse auxins and cytokinins in variable concentrations as individual along with in different amalgamations. to recognize the most responding explants, plant growth regulators and calculate their optimum concentrations and other culture conditions revealing *in vitro* morphogenesis tracked by plantlet regeneration in higher frequencies by means of nodal segments and leaf discs culture of locally adapted cultivar. For nodal segment culture, basal MS media amended with 2, 4-D/ NAA at the concentration of 2.0 mgl^{-1}as alone or in association with 0.5mgl^{-1} TDZ were evidenced meaningly better for callus initiation. However, higher shoot proliferating competence, numbers of shoots per explant with maximum length were recognized on inoculation media reinvigorated with TDZ in the range of 0.2-0.5 mgl^{-1} as sole as well as in association with 0.5mgl^{-1}NAA (more than 92% nodal segments initiated shoots, >10.5 shoots/explant and mean shoot length>3.85 cm). Nevertheless, for inoculated leaf disc, maximum callus and morphogenic callus formation along with plantlet regeneration were investigated on culture media supplemented with 2.0 mgl^{-1} auxins: 2,4-D and/or NAA in amalgamation with 0.5$mgl^{-1}$of a cytokinin BA and/or TDZ (more than 76% leaf discs initiated morphogenic calli with >80% regeneration frequencies). Rooting

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Genomics Approaches for Restoration and Conservation of Agro-Biodiversity

14

R. S. Tomar, Prabha Singh, Sushma Tiwari, Manoj Kumar Tripathi, Sanjay Singh, K. Bhojaraja Naik, Chandan Kumar Singh, and Shailesh Kumar Singh

Abstract

Agro-biodiversity provides foods for living biota along with several things for easy living and survival on the planet. It is in various forms and goods like firewood; approximately two billion population globally utilize firewood as a source of energy for cooking and heating; fiber, like cotton, wool, silk, and flax; drugs, approximately 25% of drugs utilized come from plants; and for construction of household and utilization of timber wood as furniture, sports goods, and many. Nowadays it is an alarming threat because of the reduction in free space, smaller and fragmented habitats, and overexploitation by human for urbanization and fulfillment of their needs. This degradation and destruction have caused imbalance in the nature which has resulted in several calamities and disasters in the recent past. So it is important to protect and conserve the agro-biodiversity to

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Chapter 7
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Massive *In vitro* Propagation from Cultured Nodal Segment of Three *Citrus species*

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ABSTRACT

Nodal sections excised from *in vitro* grown saplings of three citrus *species viz*., *Citrus aurantiafolia*, *Citrus reticulata* and *Citrus sinensis* were inoculated on diverse modifications of basal MS medium for manifold shootlet production. *In vitro* morphogenesis followed by plant regeneration speckled significantly among species and culture medium fortification. In this investigation, shootlets were developed directly *via* auxiliary bud proliferation along with from callus tissue. Culture medium MS5N.5B/MS5N.Kn (MS + 5.0 mgl^{-1} NAA + 0.5 mgl^{-1}BA/Kn) convinced callusing in higher rates. Nutrient medium MS.1Td.5N/MS.5B.5N (MS + 0.1 mgl^{-1} TDZ/0.5 BA + 0.5 mgl^{-1} NAA) boosted plantlet multiplying competence. Whereas, plantlets per explant in higher frequencies (s) of bigger length were recognized on nutrient medium MS.1Td or MS.2Td (MS + 0.1/0.2 mgl^{-1} TDZ). In respect to *in vitro* rooting, root initiating efficacy in higher frequencies was verified on medium MS.5IB (MS + 0.5 mgl^{-1} IBA), while roots in greater numbers were documented on rooting medium MS2IB.5Kn (MS + 2.0 mg l^{-1} IBA + 0.5 mg l^{-1} Kn), whereas nutrient medium MS.5IB.5B (MS + 0.5 mg l^{-1} IBA + 0. 5 mg l^{-1} BAP) improved mean root length. In respect to interspecific *in vitro* response, usually, Acid lime tracked by Mandarin and Sweet orange performed authoritatively for the almost culture stages. The *in vitro* developed shootlets were efficaciously adapted and shifted under field conditions.

Keywords: Citrus aurantiafolia; citrus reticulata; citrus sinensis; nodal segment culture; direct and indirect organogenesis and plantlet regeneration.

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Chapter 11
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Assessment of Groundnut Germplasm Lines for Foliar Fungal Diseases and Population Structure Analysis using Gene Based SSR Markers

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ABSTRACT

Introduction: Peanut (*Arachis hypogaea* L.) is an exceptional cash crop having versatile applications of each plant part. Rust and late leaf spot (LLS) are two main foliar fungal diseases of groundnut and can cause yield damage up to 70%. Employment of fungicide is expensive approach and it is not environment-friendly also, consequently breeding new cultivars with genetic resistance is sustainable, eco-friendly and cost-effective method.
Aim: The present investigation aimed to screen groundnut germplasm lines employing allele specific molecular markers against foliar fungal diseases (LLS and rust).
Study Material: The present investigation contained 30 uncharacterized germplasm lines along with 4 check varieties of peanut. A set of 4 gene based SSR molecular markers were designated for screening of groundnut germplasm lines against foliar fungal diseases *i.e*., LLS and rust.
Results: For polymorphic SSR markers, a total of 14 alleles were identified, with an average of 3.5 alleles per locus. With an average of 0.47, the gene diversity and Polymorphic Information Content (PIC) values ranged between 0.3972-0.5778. In a UPGMA tree based on SSRs, the genetic links between peanut genotypes are shown. Four major demographic groups were formed using principle coordinate analysis (PCA) depending on origin. The population structure of the 34 genotypes was assessed employing STRUCTURE v2.3.3 software based on SSR markers. The optimum K value was determined by employing Structure Harvester, where the highest peak was observed at delta K = 2. The number of sub populations (K) was identified based on maximum likelihood and delta K (dK) values, with two core and pure groups and an admixture group. Present investigation identified four germplasm lines *viz*., AH8054, CS21181, CS708 and Akola White that may be used as foliar disease resistant cultivar for groundnut hybridization and improvement programme.

Keywords: Groundnut germplasm; SSR markers; population structure; PCoA.

1. INTRODUCTION

Peanut (*Arachis hypogea* L.) is one of the most important oilseed crops grown in the semi-arid tropics. It is an imperative self-pollinated oilseed crop cultivated in more than 100 nations with diverse agro-climatic situations on around on ~27.9 Mha land with worldwide yield of 47 metric tons in 2017 [1-5]. India positions leading with occupying cultivated area of 5.31 Mha (FAOSTAT 2017). Groundnut is one of the most important crops grown during the Kharif season, with Gujarat leading the way, followed by Andhra Pradesh, Tamil Nadu, Rajasthan, and Karnataka. The cultivated peanut (*Arachis hypogaea* L.) is an allotetraploid (2n = 4x = 40) with a genomic size of 2891 Mbp that evolved from a single hybridization and polyploidization event in South America. Peanut sub-genomes contain about

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Chapter 7
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Standardization of *In-vitro* Regeneration Protocol in *Gerbera jamesonii Bolus* Ex Hooker F.

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ABSTRACT

Introduction: The gerbera belong to the family Asteraceae is the chief cut flowers and ranks among the top ten cut flowers in the universe. For commercial propgation of this plant species, planting material is required on large-scale which requires the employment of plant tissue culture techniques for massive *in vitro* propagation.
Study Objectives: In this investigation**,** an effort was made to compute optimal concentration of plant growth regulators added in culture medium and optimize other physical factors exhibiting higher *in vitro* response by culturing mature embryo *in vitro*.
Results: Nutrient media MS3D.5B (MS + 3.0 mgl^{-1} 2, 4 D + 0.5 mgl^{-1}BA + 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar powder) evidenced more appropriate for callus initiation. Inoculation media MS2N.5iP/MS3N.5ip (MS + 2.0/3.0mg l^{-1} NAA + 0.5 mgl^{-1}2-ip + 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar) displayed higher *in vitro* response *i.e.,* numbers of shoot proliferating explants and numbers of shoot (s) per explant. While, shoot of higher length was recovered on culture medium MSB/MS2B (MS + 2.0/3.0 mgl^{-1}BA + 30.0 gl^{-1} sucrose + 7.5 gl^{-1} agar). Enhanced *in vitro* rooting response (root proliferating efficiency, numbers of roots and root of higher length) were documented on rooting medium MS.1IB (MS + 0.1 mgl^{-1}IBA + 15.0gl^{-1} sucrose + 7.5 g l^{-1} agar). The regenerants were transferred to pots and hardened in Environmental Growth Cabinet and net House and subsequently shifted to field conditions efficaciously. Phenotypic normal plants were acquired.

Keywords: Gerbera jamesonii; mature embryo culture; direct and indirect organogenesis; direct and indirect somatic embryogenesis and plantlet regeneration.

ABBREVIATIONS

MS : Murashige and Skoog medium;
NAA : α-Naphthalene acetic acid;
2, 4-D : 2, 4-dichlorophenoxyacetic acid;
2, 4, 5-T : 2, 4, 5 - trichlorophenoxyacetic acid;
BA : 6-benzylaminopurine;
Kn : Kinetin;
TDZ : Thidiazuron;
2-ip : N-isopentenyl amino purine;
IBA : Indole-3-butyric acid.

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Chapter 1
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Plantlet Regeneration from Cultured Nodal Segments in Sandalwood (*Santalum album* Linn.)

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ABSTRACT

Study Objectives: An effort has been made to compute the optimal quantity of plant growth regulators to be added in culture medium and other physical factors exhibiting higher *in vitro* morphogenesis with 'elite' lines of sandalwood by culturing nodal segment.
Results: Higher percentage of direct somatic embryogenesis, number(s) of somatic embryo per explant and plantlet regeneration *via* direct organogenesis were evidenced on MS medium augmented with a moderate concentration of TDZ (1.0 mgl^{-1}) in combination with comparatively a lower concentration of NAA (0.5 mgl^{-1}). A comparative higher concentration of BAP (1.0-2.0 mgl^{-1}) in amalgamation with a lower concentration of NAA (0.5 mgl^{-1}) encouraged frequency of indirect somatic embryogenesis. From culture media fortified with a greater concentration of BA at 4.0 mgl-^{1} in combination with a lower concentration of NAA, the proportion of organ development directly from the surface of cultured explants was recovered (0.5 mgl-^{1}). Maximum plantlets regenerated *via* somatic embryogenesis (direct and/or indirect) on regeneration medium fortified with 2.0 mgl^{-1}TDZ in combination with 1.0 mg $l^{-1}GA_3$, while plantlets in higher frequencies *via* indirect organogenesis was achieved with regeneration medium modified with relatively lower concentration of TDZ (1.0 mg l^{-1}) in amalgamation with 0.5 mgl^{-1} GA_3 and 0.5 mg^{l-1} NAA. The plantlets were transferred to pots and hardened in Environmental Growth Cabinet and Net House during initial weaning period and shifted to field magnificently. Morphologically usual plants were obtained.

Keywords: Santalum album; nodal segment culture; somatic embryogenesis; organogenesis; plantlet regeneration.

ABBREVIATIONS

MS-Murashige and Skoog Medium; BA-6- Benzyl aminopurine; TDZ-Thidiazuron; KN-Kinetin; NAA-Naphthalene acetic acid; 2,4-D-2,4-Dichlorophenoxyacetic acid; 2, 4, 5-T - 2, 4, 5-Trichlorophenoxyacetic acid; IBA-Indole-3- Butyric acid; GA_3: Gibberellic acid.

1. INTRODUCTION

Sandalwood is medium-sized hemi parasitic trees and distinguished members are Indian sandalwood (*Santalum album* L.) and Australian sandalwood (*Santalums picatum*). Indian sandalwood belonging to the family santalaceae which is one of the imperative tree species of tropical forests since it crops essential oil in the heartwood which is employed widely in the enrage and perfumery industry [1,2,3].

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Chapter 11
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Production of Synthetic Seed from Encapsulated Nodal Segments of Giloe (*Tinospora cordifolia* Willd.)

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ABSTRACT

Tinospora cordifolia (Willd.) Miers is generally acknowledged as giloe belong to the family Menispermaceae employed for medicinal purpose, particularly in Ayurveda for curing different diseases.

Standardization of the concentration of encapsulation matrix and hardening solution affecting the frequency of germination to plant idyllic synthetic seeds of *Tinospora cordifolia* tracked by an efficient plantlet regeneration.

The current investigation was carried out at Plant Tissue Culture & Genetic Transformation Laboratory, Department of Plant Molecular Biology & Biotechnology, College of Agriculture, Gwalior, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, M.P., India during 2017 to 2020.

A procedure was recognized for encapsulation of nodal segments of *Tinospora cordifolia* excised from 18-month-old *in vitro* derived plants for short-term conservation and further propagation. Conservation strategies prerequisite to be implemented for constant supply to encounter the ever-increasing demands and sustainable utilization of resources. Diverse concentrations and combinations of gelling matrix *viz*., sodium alginate and complexing agent *i.e*., Calcium chloride were experienced to optimize amalgamation to achieve uniform beads.

The best gelling composition was established using 2.5% sodium alginate and 100 mM calcium chloride. The maximum conversion rate of encapsulated beads was attained on Murashiage and Skoog's medium amended with 2.0 mgl^{-1} BAP in association with 0.2mgl^{-1} NAA. Well, established regenerants were hardened successfully, acclimatized and established first under net house circumstances tracked under field conditions.

In this research, syn seed production procedure in giloe (*Tinospora cordifolia*) has been standardized. Current method warrants feasible tactic for multiplication, conservation and germplasm exchange through artificial, seed development.

Keywords: Giloe; synthetic seed; micropropagation; encapsulation; germplasm conservation; plantlet regeneration.

ABBREVIATIONS

$CaCl_2.2H_2O$: Calcium chloride; BA: Benzyl adenine; IBA: Indole-3-butyric acid; NAA: α-naphthalene acetic acid; MS: Murashiage and Skoog medium; PGR: Plant growth regulators.

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Chapter 4
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Morpho-physiological and Molecular Characterization of Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] Germplam Lines for Drought Tolerance

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ABSTRACT

Objectives: The present investigation was commenced to analyze presence of possible genetic diversity among different pearl millet germplasm lines by means of diverse drought linked morpho-physiological traits along with SSR molecular markers.
Study Design: In the present investigation, 96 pearl millet germplasm lines were screened against drought using different morphological and physiological traits along with SSR markers.
Place and Duration of the Study: The present study was conducted at College of Agriculture, Gwalior, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, M.P., India during July 2019 to December, 2020.
Methodology: The study was conducted to record different morphological and physiological traits related to drought tolerance and susceptibility. Thirty-five microsatellite markers were also used in laboratory to analyze the variability among pearl millet genotypes under study.
Results: Pearl millet genotypes were grouped according to their morpho-physiological characteristics. Among 35 SSR markers, twenty-two were successfully amplified across all germplasm lines and seven SSR markers were found to be polymorphic and fifteen markers were monomorphic. All seven polymorphic SSR markers were used consequently for amplification of all the 96 germplasm lines. The range of PIC value was 0.0939 to 0.2980 with an average of 0.2274. The highest PIC value was recorded for the markers Xibmsp26 and Xibmsp29 (0.2980) followed by Xibmsp03 (0.2392), Xibmsp29 (0.2392), Xibmsp06 (0.2289) and Xibmsp07 (0.1948) while the lowest for the marker Xibmsp01 (0.0939). The range of major allele frequency value was 0.7604 to 0.9479 with an average of 0.8363. The range of genetic diversity value was 0.0987 to 0.3644 with an average of 0.2665.
Conclusions: According to the morpho-physiological data a total of 22 pearl millet genotypes were found to be grouped distantly from rest of the genotypes. These genotypes may be drought tolerance as they are linked with drought tolerant morpho-physiological traits however, rests of the genotypes were found to be susceptible against drought.

Keywords: Pearl millet; drought tolerance; genetic diversity; polymorphism; molecular markers.

1. INTRODUCTION

Pearl millet is a C_4, annual and diploid species. It belongs to family poaceae. The present legitimately believed name of pearl millet is *Pennisetum glaucum* (L.) R. Br. [1]. It is supposed to have originated from West Africa [2,3] from where it spread into India and other countries. It is cultivated in the arid tropical region and semi-arid areas of Asia and Africa [4]. It is a primary food for most of the countries

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Chapter 1
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Biotechnological Interventions to Combat against Charcoal Rot and *Rhizoctonia* Root Rot Diseases of Soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

Soybean is a prime legume in a world's oilseed cultivation set-up. Yield of soybean hampered by several biotic and abiotic stresses including drought. Among different biotic stresses, Charcoal rot and *Rhizoctonia* root rot are the leading diseases for a huge damage in soybean production and still there is no prominent work has been done effectually to address these problems. Biotic stresses can be controlled by using an integrated management approach either by cultural practices including crop rotation, tillage, irrigation, or chemical control like seed treatments could be employed to diminish damage instigated by fungal pathogen in soybeans. The current study was conducted with the objective to characterize soybean genotypes for yield and its accrediting characters along with validation of gene-based SSR molecular markers against charcoal rot and *Rhizoctonia* root rots diseases. On the basis of different traits, genotypes *viz.,* JS335, JS20-69, JS97-52, KDS980 and KDS992 were found to be the most divergent and promising genotypes and may be employed as parents in future hybridization programme to breed tolerance/ resistance against *Rhizoctonia* root rot and charcoal rot by means of conventional and/or molecular breeding approaches.

Keywords: Molecular breeding; hybridization; fungal diseases; oil seed; SSR markers.

1. INTRODUCTION

Soybean [*Glycine max* (L.) Merr] (2n=40) is a commercially imperative dicot legume in a world's oilseed cultivation scenario, having a prominent position in terms of high productivity, profitability and maintaining soil fertility too [1-5]. On account of its miscellaneous usages and limitless benefits, it is rightly called as "golden bean", "miracle bean" or "wonder crop" of the 20th century [4]. Soybean contributes to our country's economy and foreign earnings by donating 42 percent and 25 percent of national oilseeds and edible oil production, respectively. [6-11]. It encompasses essential amino acids predominantly glycine, tryptophan and lysine, analogous to cow’s milk and animal proteins. After the United States, Brazil, Argentina, and China, India ranked fourth in terms of worldwide soybean producing area (11 million ha) and fifth in terms of production (11 million metric tonnes). Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Andhra Pradesh are India's top soybean-producing states, with 96 percent of production subsidized in decreasing order of production.

Yield of soybean hampered by several biotic [12-16] and abiotic stresses including drought [17-21]. Comprehensive gamut biotic stress which decreases both yield and seed quality is Charcoal rot instigated by the soil borne polyphagous fungus *Macrophomina phaseolina* (Tassi) Goid. This

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Chapter 11
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Analysis of Genetic Differences in fatty Acids and Oil Contents among Brassica *juncea* (Linn.) Czern & Coss Genotypes

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ABSTRACT

Study Objectives: The experimentation was steered to assess erraticism among 188 Indian mustard genotypes owing to assorted biochemical parameters *viz*., palmitic, oleic, linoleic, linolenic and erucic acids accompanied by oil composition.
Location of Study: Experiment was carried out at Department of Genetics and Plant Breeding, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, India
Results: Analysis of variance designated the presence of considerable extent of variation among premeditated Indian mustard genotypes which advocate better promises for their enhancement. Genotypic and phenotypic coefficient of variation was investigated to be higher for oleic acid pursued by erucic and palmitic acids. Erucic, oleic, palmitic, linoleic and linolenic acids had determined heritability and genetic advance. Significant negative correlation of erucic acid was recognized with palmitic, oleic, linoleic and linolenic acids. Genotypic and phenotypic path coefficient analysis had the higher positive direct effect of palmitic acid on erucic acid, while highest negative direct effect on erucic acid was demonstrated by linoleic, oleic, linolenic acids and oil content. Genetic deviation employing Euclidean distance cluster congregated the genotypes into eighteen diverse groups. Amongst entirely considered biochemical strictures, erucic acid was investigated to be low in 9, modest in 57 and higher in 122 genotypes. In group investigation of qualitative parameters, extreme inter cluster distance was documented between cluster 18 (Karishma) and cluster 12 (Maya). Consequently, these genotypes may be employed as parentages in Indian mustard breeding arrangement for enhancement of various qualitative parameters.

Keywords: Indian mustard; biochemical parameters; correlation coefficient; path coefficient; quantitative traits; principle component analysis.

1. INTRODUCTION

Brassica genus is uninterruptedly acquiring industrial standing owing to the incidence of oil annoying species for instance *Brassica juncea*, *B. carinata*, *B. rapa* and *B. napus* in it [1]. Explicit nutritional standards are elementary standards to choose the oil for comestible and industrial purposes. Among all the mustard species *B. juncea* has acquired higher adaptableness as oilseed crop in India, China and Pakistan attributable to higher oil contents up to 44% [2-4]. In addition to oil content diverse biochemical traits for instance essential and non-essential fatty acids are also well-thought-out to warrant industrial along with nutritional reputation of mustard oil [5-7]. Among different nutritive strictures of edible oil fatty acids similar to oleic, linolenic, erucic, palmitic and linoleic acids is very significant. Indian mustard (*B. juncea*) genotypes have been testified with higher portions of erucic

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Chapter 7
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Characterization of Soybean Genotypes on the Basis of Yield Attributing Traits and SSR Molecular Markers

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ABSTRACT

Soybean is well-thought-out to be a main crop as an important foundation of nutrients to humans and animals. The current investigation has been executed to recognize different soybean genotypes on account of diverse morpho-physiological traits and SSR molecular markers. Data for different morpho-physiological traits were documented from experiment conducted under field conditions in RBD design whereas molecular work was conducted in laboratory with 32 microsatellite markers to analyze the existence of possible diversity among different soybean genotypes. Morpho-physiological investigation evidenced the incidence of substantial magnitude of variability. Phylogenetic tree based on morpho-physiological traits grouped the genotypes into major and minor cluster. Major cluster had fifty genotypes while minor cluster had only three genotypes. Among polymorphic 32 microsatellite markers, the highest genetic diversity (0.66) was documented for the marker Satt520 whilst lowest (0.037) for the marker Satt557 with an average of 0.35. The highest PIC value also was 0.59 prearranged by same marker *viz*., Satt520 and lowest 0.036 by marker Satt557. An average major allele frequency was 0.69 while, an average PIC value was 0.32. Microsatellite markers-based data also congregated the genotypes into one major and one minor cluster. Molecular analysis based on microsatellite markers confirms the presence of genetic variability among genotypes under the investigation. Data obtained from the present research may contribute towards improvement of soybean genotypes to advance high yielding varieties by considering assorted genotypes with good agronomical traits in breeding scheme.

Keywords: Breeding; genetic diversity microsatellites; sustainable agriculture; soybean; variability.

1. STUDY OBJECTIVES

The present study was conducted to characterize different soybean genotypes on the basis of different morpho-physiological traits and SSR molecular markers.

2. INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is among one of the major crops, disbursed as human foods as well as animal feed [1-6]. It is also an ironic foundation of indispensable amino acids in addition to oil. The role of soybean and its components as therapeutic agents, antioxidants, isoflavones *etc*. has been recognized. Multipurpose nature of soybean makes it valuable in the field of industrial formulations, agriculture sector and pharmaceuticals [7-13]. Due to its high protein content, its flour is commonly

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Chapter 4
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Screening of Soybean Genotypes against Drought on the Basis of Gene-Linked Microsatellite Markers

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ABSTRACT

Soybean is elegant to be a key crop attributable to its significant contribution as vegetable oil and protein in human diet. Nevertheless, inopportunely, its production has been exaggeratedly declined due to the ordinariness of drought related stress. In present investigation, total 12 SSR molecular markers were employed for screening of 53 soybean genotypes to determine the effectiveness of existing markers in genetic diversity analysis as well as their validation on the basis of their connotation with drought tolerant gene. Among applied drought tolerance gene-linked SSR molecular markers, the highest genetic diversity (0.6629) was documented with marker Satt520 while lowest (0.0370) was for the marker Satt557 with an average of 0.3746. The highest PIC value was 0.5887 prearranged by similar markers *viz*., Satt520 and lowest 0.0363 by Satt557 with the mean worth of 0.3063. Dendrogram constructed owing to banding profile of used markers was able to victimize some putative drought tolerant genotypes *i.e*., JS97-52, JS95-60 from rest of the genotypes. The findings of the current investigation may contribute towards improvement of soybean to bread drought tolerant varieties in future.

Keywords: Climate change; molecular diversity; drought; microsatellites; sustainable agriculture; water stress.

1. STUDY OBJECTIVES

The current chapter was intended to determine the efficacy of existing SSR molecular markers in genetic diversity analysis in addition to their validation based on their implication with drought tolerant gene in soybean genotypes.

2. INTRODUCTION

Soybean is the imperative crops owing to its application as a spring of vegetable oil along with proteins throughout the world [1-9]. Production and productivity of soybean has been declined due to different biotic [10-12] and abiotic [13-18] stresses. Among different abiotic factors, drought is prime stress which envisaged to be increased in future [19] as well. It is a serious issue because of its role in reduction of production of important crops including soybean. Accessibility of passable water provisions in growth along with development of plants. But, alteration in weather is a leading reason of drought conditions in many portions of the world. Drought stress may mainly harm to the susceptible crop varieties. So, it is desirable to recognize drought tolerant varieties among the available varietal resources or advance a new variety with tolerant mechanism against drought to develop drought tolerant varieties.

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Chapter 3
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Identification of Low and High Erucic Acid Containing Genotype(S) in Indian Mustard Employing Molecular Markers

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ABSTRACT

In traditional *Brassica* oilseeds, the incidence of erucic acid is well-thought-out as anti-nutritional issue for human ingesting as these reasons toxic possessions on the heart at higher enough dosages. As such there is a pressing necessity to restrain the erucic acid content and develop varieties having low erucic acid through conventional and/or molecular breeding approaches. Genetic enhancement of crops can be augmented when there is a broad genetic variation and information on these genetic possessions is available. The current investigation was carried out with 48 *Brassica* genotype (s) with the intention to recognize genotype (s) with low and high erucic acid content on the basis of molecular markers. For the investigation, a total of 50 SSR molecular markers were chosen for the amplification of genomic DNA. Out of these, only 23 SSR molecular markers were found to be polymorphic. A total of 109 alleles were recognized with an average of 4.47 alleles per locus for polymorphic SSR markers. Genetic diversity ranged between 0.55 for marker Na10-D07 to 0.77 for marker BRMS-098 with a mean worth of 0.68. Polymorphism information content (PIC) value of the markers varied from 0.51 for SSR Na10-D07 to 0.73 for the primer BRMS-098 with an average value of 0.62. The dendrogram was constructed and major three clusters were formed. Most of the genotypes were clustered conferring to the sites they established. Genotypes evidenced with low erucic acid content displayed higher similarity and grouped together. Mustard genotypes recognized with higher genetic variability with convenient traits may be employed for crop improvement programmes in future.

Keywords: Indian mustard; fatty acid; oil quality; erucic acid, SSR markers.

1. STUDY OBJECTIVES

The present study was conducted with 48 *Brassica* genotype (s) with the aim to distinguish genotype(s) with low and high erucic acid content based on employment of molecular markers.

2. INTRODUCTION

India is the world's third-largest producer of mustard seeds. Indian mustard [*Brassica juncea* (Linn.) Czern & Coss] is an ordinary amphidiploid (2n=36) that is the outcome of an interspecific cross between *Brassica campestris* (2n=20) and *Brassica nigra* (2n=16) followed by natural chromosomal doubling [1]. In India, it is mostly grown for its oil seeds. India, as one of the world's largest oilseed producers, contributes around 7% of the worldwide total. Oilseed harvests are also important in the Indian economy. Foremost rapeseed mustard producing countries of the world are Canada, China, France, Germany, Poland, UK, India, Australia, Russia and Ukraine [2-3]. In 2016-17, the total area, production, and productivity of rapeseed mustard cultivation in India were 6.65 million hectares, 7.10

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CLIMATE CHANGE: PERSPECTIVES AND IMPACT ON INDIAN AGRICULTURE

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The Intergovernmental Panel on Climate Change (IPCC) reported that humankind is causing global warming through the emission of greenhouse gases (GHGs), particularly carbon dioxide (CO_2) and methane (CH_4) (Stocker *et al.,* 2013). The GHGs play a vital role on the climate system by absorbing the long wave infrared radiation and causes warming the earth's atmosphere. Thus, radiation emitted from the surface through the atmospheric window is higher compared to radiation from the stratosphere (Schmithusen *et al*., 2015). CO_2 levels have been consistently increasing since preindustrial time and its daily mean value reached 400 ppm in May 2013 at the reference site of Mauna Loa, Hawaii (Monastersky, 2013). Most regions in the world are warming because of increasing concentrations of atmospheric CO_2 (Sid Perkins, 2015). This increase is caused by human activities, which is subsequently contributing to increase the earth's surface temperature (Huang *et al.,* 2015). Arid and semi-arid areas comprise about 30% of the Earth's land surface. Climate change and climate variability will likely have a significant impact on these regions. The variability of environmental factors may result in significant effects on regional climate and global climate (Wang *et al.,* 2010), especially the radiative forcing, via the biogeochemical pathways affecting the terrestrial carbon cycle. Global climate change has serious impacts on humans and ecosystems.

This climate change altered the atmospheric concentration which leads to warming of the global temperature by 0.7° C till the recent past. It has been estimated that the Climate Change will lead to increase in temperature between 1.8 and 4° C in the years to come. This increasing temperature has caused global warming and created consequent environmental changes (Singh *et al*., 2011) which lead to decreased precipitation and increased temperature. This climate change will have a significant impact in developing countries like India because of their low adaptation capacity. The agriculture sector is primarily vulnerable and may create risk to the rural population (IPCC, 2007). As it has been estimated by the World Bank that, if climate change continues unhindered, then average temperatures in India is likely to reach as high as 29.1° C by the end of the century (up from 25.1 °C currently). Increase in temperature of the earth may lead to decrease in the length of growing season and yield of most crops (Saseendran *et al.,* 2008; Lal *et al.*, 2020; Sharma *et al.*, 2020; Sagar *et al.*, 2019; Parth *et al.*, 2019; Sagar *et al.*, 2019; Rao, 2019; Sharma and Rao, 2019; Dharbale *et al.*, 2019; Nyath *et al.*, 2018; Singh *et al.*, 2018). The anticipated negative impact of global warming on the climate of India is large; influence livestock population, agriculture and related allied sectors and ecosystem. A wide range of studies have substantiated that agroforestry systems have unique opportunity to augment the carbon stocks in the terrestrial biosphere (IPCC, 2000; Albrecht and Kandji, 2003). It has been estimated that 63 million ha of land areas are suitable for agroforestry and making this system a quantitatively important carbon stock (Kandji *et al.,* 2012).

This article reviews the understanding of consequence of climate change on Indian agriculture, various environmental parameters, livestock's population and health parameter etc. to highlight some important aspects in particular. As the agriculture and animal production system which is vulnerable to climate change is itself a large contributor to potential global warming through emission of CO_2, methane and nitrous oxide. The paper also presents a comprehensive review of the effect of climate change and GHG emissions in Indian scenario.

Is Climate Change Really Happening?: What are the indicators? Climate Change is the long-term average of the weather in a given place. While the weather can change in minutes or hours, a change in climate is something that develops over longer periods of decades to centuries. Climate is defined not only by average temperature and precipitation but also by the type, frequency, duration, and intensity of weather events such as heat waves, cold spells, storms, floods, and droughts (Source: https://www.epa.gov/climate-indicators). Global Climate Change indicators The Earth's climate is

AQUAPONICS: AN INNOVATIVE SUSTAINABLE FOOD PRODUCTION FARMING SYSTEM

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By 2050, the world population is estimated to increase to 9 billion. The expansive numbers of people are expecting to rely on agricultural sector including farming, fisheries, woodcrafts, and livestock. Natural calamities and crisis affect millions of people who depend on the primary sector. Indian farmers are exposed to many challenges resulting from low agricultural growth, sustainability concerns, and land degradation, as a large area of farmland has become infertile due to the overuse of fertilizers and pesticides. Conventional farming methods because of large usage of fertilizers for growing crops degraded the quality of the soil and local water sources. It is high time to overcome these challenges through innovative farming methods. For reducing poverty and attaining food security, expansion of agriculture sector is the most efficacious means. The technological and scientific advancement in the field of agriculture has opened a new era for the design and development of modern devices for plant health monitoring.

In order to meet human demand for aquatic products, total global aquatic production increased by 27.5% in 2010–2018, during which aquaculture and capture output increased by 29.8% and 10.4%, respectively (FAO, 2018). Aquaponics farming is a solution to overcome some of these challenges to an extent if the farmers are able to maintain the system with proper care and technical support. Aquaponics is an integrated system combination of aquaculture together with growing vegetables and crops without the use of fertilizers. Water circulates between the components of the system (fish tank, biofilter, hydroponic system), during which the feces of the fish become fertilizers for the plants (Nichols and Savidov, 2012).

Aquaponic systems have the potential to avoid some of the major resource inefficiencies present in conventional agriculture; however, achieving the resource efficiency as mentioned above, has been largely unquantified in scientific publications. Based on several past reviews, successful aquaponic operations must consider the impacts of system design (Palm *et al*., 2018), system water pH control (Tyson *et al*., 2011), aeration and filtration technologies (Danaher *et al*., 2013), acceptable nutrient ranges (Delaide *et al*., 2016), pairing of plant and fish species, microbial populations, nitrogen levels, quantity and type of feed (Endut *et al*., 2010), pest management and effective marketing. These factors are the main concern of those managing the system.

Thus aquaponics has emerged as a low-risk, high-profit farming method that requires only little maintenance and expenditure once it's set up and it also happens to be purely organic, chemical free, sustainable, no tilling the soil, no compost, no manure spreading, no tractor and no breaking back and sore joints, no cracked skin or needless exhaustion, no working to the bone for no reward, no trouble feeding the family. This is a globally accepted technology and adapted to a greater extent. Aquaponics has already made waves in the USA as well as other parts of the developed world.

Definition and Concept of Aquaponics: The term "aquaponics" is derived from the "aqua" in aquaculture and "ponics" in hydroponics (Marklin *et al*., 2013). Aquaponics is defined as the combination of hydroponics and recirculating aquaculture system which also plays a major role in minimizing the negative environmental impacts resulted from intensive fish farming and crop production. While aquaculture constitutes the breeding, rearing, and harvesting of fishes and other aquatic organisms in a controlled environment, hydroponics is a method of growing plants without soil by using mineral nutrient solutions in a water solvent. Aquaponics is an integrated sustainable method of farming by bringing aquaculture and hydroponics together in a single re-circulating system(Fig. 1).This process is the same closed-loop symbiotic combination as occurrs in nature, such as in a river or lake basin, where plants and fish live together in which fish wasteserves as nutrients for the plants, which in turn clean the water for the fish. In this type of integration, nutrients excreted by the fish through microbial activity (Zou *et al*., 2016) and the nitrifying bacteria in the biofilter

Chapter 4
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Morpho-physiological and Molecular Characterization of Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] Germplam Lines for Drought Tolerance

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ABSTRACT

Objectives: The present investigation was commenced to analyze presence of possible genetic diversity among different pearl millet germplasm lines by means of diverse drought linked morpho-physiological traits along with SSR molecular markers.
Study Design: In the present investigation, 96 pearl millet germplasm lines were screened against drought using different morphological and physiological traits along with SSR markers.
Place and Duration of the Study: The present study was conducted at College of Agriculture, Gwalior, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, M.P., India during July 2019 to December, 2020.
Methodology: The study was conducted to record different morphological and physiological traits related to drought tolerance and susceptibility. Thirty-five microsatellite markers were also used in laboratory to analyze the variability among pearl millet genotypes under study.
Results: Pearl millet genotypes were grouped according to their morpho-physiological characteristics. Among 35 SSR markers, twenty-two were successfully amplified across all germplasm lines and seven SSR markers were found to be polymorphic and fifteen markers were monomorphic. All seven polymorphic SSR markers were used consequently for amplification of all the 96 germplasm lines. The range of PIC value was 0.0939 to 0.2980 with an average of 0.2274. The highest PIC value was recorded for the markers Xibmsp26 and Xibmsp29 (0.2980) followed by Xibmsp03 (0.2392), Xibmsp29 (0.2392), Xibmsp06 (0.2289) and Xibmsp07 (0.1948) while the lowest for the marker Xibmsp01 (0.0939). The range of major allele frequency value was 0.7604 to 0.9479 with an average of 0.8363. The range of genetic diversity value was 0.0987 to 0.3644 with an average of 0.2665.
Conclusions: According to the morpho-physiological data a total of 22 pearl millet genotypes were found to be grouped distantly from rest of the genotypes. These genotypes may be drought tolerance as they are linked with drought tolerant morpho-physiological traits however, rests of the genotypes were found to be susceptible against drought.

Keywords: Pearl millet; drought tolerance; genetic diversity; polymorphism; molecular markers.

1. INTRODUCTION

Pearl millet is a C_4, annual and diploid species. It belongs to family poaceae. The present legitimately believed name of pearl millet is *Pennisetum glaucum* (L.) R. Br. [1]. It is supposed to have originated from West Africa [2,3] from where it spread into India and other countries. It is cultivated in the arid tropical region and semi-arid areas of Asia and Africa [4]. It is a primary food for most of the countries

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Chapter 8
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Role of Biochemical and Antioxidant Enzymes Activities in Drought Tolerance in Soybean: A Recent Study

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DOI: 10.9734/bpi/ctas/v3/2117C

ABSTRACT

Soybean genotypes were divided into two groups based on biochemical profiling, anti-oxidant enzyme activities and protein profiling. Drought tolerance features were found in three genotypes *viz*., JS97-52, RVS-14, and JS95-60, based on different biochemical and antioxidant enzyme activities analysis among 53 diverse genotypes. The results obtained could aid in the improvement of soybean genotypes through the production of drought-tolerant genotypes using both conventional and molecular breeding approaches. These findings also provided a foundation for additional research employing advanced biotechnological technologies to investigate the drought tolerance mechanism in soybean crops.

Keywords: Antioxidant enzymes; Biochemical parameters; Drought; Protein profiling; Sustainable agriculture

1. INTRODUCTION

Changes in the environment are to blame for the emergence of new issues. Climate change is one of them, and it has a significant impact on agriculture. In most parts of the world, there is a high need for water for crop irrigation in order to meet grain production targets. More than 40% of people from 54 nations will face a major problem in the coming days as a result of the drought [1]. A crop species or genotype that is tolerant of low rainfall intensity, unpredictable distribution, and high temperatures would be critical for ensuring a long-term food supply for the world's ever-growing population. It is believed that by carefully crafting biotechnological ways to build a cultivar for such a suboptimal environment, food security in inhospitable regions will be maintained.

Soybean is also acknowledged as a ‘miracle crop’ due to over 40% protein and 20% oil [2-8]. It needs an adequate water supply for the duration of its growth and development course to accomplish better yields [9]. The plants of soybean have been found to be affected by drought at every stage of life [10-15]. Significant reductions in the levels of chlorophyll a, b, and total chlorophyll have been observed due to drought in soybean crop [16]. Plants develop various mechanisms to fight different stresses [17] and these mechanisms may be due to alteration in biochemical pathways. Numerous biochemical parameters have been exploited to recognize tolerant genotype (s) to drought [18-20]. Knowledge of the biochemical mechanisms for drought tolerance in vegetable-type soybeans is very limited. Plants have evolved a number of biochemical and physiological mechanisms to improve their tolerance to abiotic stress. These may include the employment of various antioxidative mechanisms that are enzymatic or non-enzymatic in nature [21-24].

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Chapter 4
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Plant Tissue Culture Techniques for Conservation of Biodiversity of Some Plants Appropriate for Propgation in Degraded and Temperate Areas

Manoj Kumar Tripathi [a*], Sushma Tiwari [a], Niraj Tripathi [b], Gyanendra Tiwari [c], Deepa Bhatt [a], Megha Vibhute [d], Neha Gupta [a], Nishi Mishra [a], Prerana Parihar [a], Purnima Singh [a], Akash Sharma [a], Ashok Ahuja [a] and Sharad Tiwari [e]

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ABSTRACT

Plant Biotechnology is being employed as a device for conservation of natural habitats and their sustainable utilization for ecological balance, technologies for cultivation of plants in diverse cropping systems and on the problematic soil, improvement of state-of-art technologies for extraction, characterization and utilization of necessary bioactive components, generation of scientific and clinical information to support the health entitlements of botanical medicines, elicitation and improving the production of known and novel metabolites using metabolic engineering technology, DNA barcoding : identification and characterization of plant material, design and discovery of newer molecules for human and plant health, development of post-harvest management including establishment of effective partnerships between different stakeholders. Plant tissue culture can be used to rapidly multiply virus-free planting material in plants suitable for degraded lands and temperate areas by developing micropropagation protocols. Micropropogation is a time and space efficient technique that produces more viral disease-free and elite propagules. Germplasm storage and conservation is possible through the use of *in vitro* gene bank technology, in which vegetatively propagated plants can be conserved in cryogene banks, and recalcitrant seeds, embryos, and pollens can be stored in liquid nitrogen for long periods of time. This chapter discusses micropropagation protocols developed in our lab for various plants suitable for cultivation in undulated lands and temperate regions, as well as detection and production of natural compounds found in plants and ex situ conservation methods. Biotechnology and biodiversity of high value plants can be harnessed together as developmental challenge as well as an economic opportunity in future.

Keywords: Biodiversity; degraded land; plant cell; tissue & organ; culture; medicinal plants; metabolic engineering; bioactive compounds.

1. INTRODUCTION

Plant Biotechnology is being used as a tool for conservation of natural habitats and their sustainable utilization for ecological balance, technologies for cultivation of plants in different cropping systems and on the problematic soil, development of state-of-art technologies for extraction, characterization and utilization of essential bioactive components, generating scientific and clinical data to support the health claims of botanical drugs, elicitation and enhancing the production of known and novel metabolites using metabolic engineering technology, DNA bar coding: identification and characterization of plant material, design and discovery of newer molecules for human and plant

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Chapter 12
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In vitro Production of Secondary Metabolites Reserpine and Ajmalicine in *Rauvolfia Serpentina* (L.) Benth.

Gyanendra Tiwari[1], M. K. Tripathi[2*], Sushma Tiwari[2], Niraj Tripathi[3], Devi Singh Uikey[4] and R. P. Patel[5]

DOI: 10.9734/bpi/caprd/v4/2136C

ABSTRACT

Rauvolfia serpentina is an erect evergreen, woody perennial shrub and usually recognized as Sarpgandha Main institutes of sarpgandha roots are reserpine, rescinnamine, deserpidine and yohimbine and the root part of the plant is employed in several Ayurvedic polyherbal formations *viz.,* sarpgandha vati. When efficient and reproducible plant regeneration systems are available, in vitro culture is an important experimental tool in medicinal and aromatic crops. Experiments were carried out to quantify secondary metabolite production in *Rauvolfia serpentina* from filtrate of callus and cell suspension cultures. Reserpine and ajmalicine were found infiltrate of both one-month-old callus and cell suspension cultures. The culture medium MSD.5IB (MS+1.0 mgl^{-1} 2,4-D + 0.5 mgl^{-1} IBA) recovers the most reserpine content in both callus and cell suspension cultures after one month. The amount of reserpine in a liquid medium decreased dramatically as the concentration of 2,4-D in the medium increased. When the concentration of 2,4-D was increased, the concentration of Ajmalicine in both callus and cell suspension cultures decreased linearly. These products may be further produced in commercial scale in bioreactor by using raw biomolecules for commercial purposes.

Keywords: Rauvolfia serpentina; callus and cell suspension cultures; reserpine and ajmalicine.

ABBREVIATIONS

MS : Murashige and Skoog medium
Wh : White's medium
B_5 : Gamborg's medium
BA : 6-benzylaminopurine
TDZ : Thidiazuron
Kn : Kinetin
NAA : α-Naphthalene acetic acid
2,4-D : 2, 4-dichlorophenoxyacetic acid
IBA : Indole-3-butyric acid

1. INTRODUCTION

Rauvolfia serpentina is an erect evergreen, woody perennial shrub and usually recognized as Sarpgandha, Snake root plant, Chota Chand, Chandrika *etc.* It is belonging to family Apocynaceae. It

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Chapter 7
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Plant Genomic DNA Isolation: An Important Technology for Marker Assisted Selection

Sushma Tiwari [a*], M. K. Tripathi [a], R. S. Tomar [b] and Ashok Ahuja [a]

DOI: 10.9734/bpi/rppsr/v4/15255D

ABSTRACT

Plant biotechnology is necessary to maximize the probability of success in crop improvement programs. One area of biotechnology is DNA marker technology, derived from research in molecular genetics and genomics, offers great promise for plant breeding. Marker assisted selection in plant breeding, increase efficiency and precision. Mapping and marker assisted selection of targeted trait require high quality of DNA from a large number of plants in short time. However, many protocols have been developed and reported for extraction of plant DNA with the primary aim of development of a relatively quick, inexpensive and consistent to extract high quality DNA. The general principle of all these DNA extraction protocols remains the same involving disruption of the cell wall, cell membrane and nuclear membrane to release the highly intact DNA into solution ensuring removal of the contaminating biomolecules such as the proteins, polysaccharides, lipids, phenols and other secondary metabolites by enzymatic or chemical methods. High quality DNA is prime requirement for marker assisted selection applications in crop improvement as well as sequencing-based applications. Current article compiled Plant Genomic DNA isolation and quantification protocols for different crops.

Keywords: Agarose gel electrophoresis; MAS; plant genomic DNA isolation; purification; spectrophotometer; quantification.

1. INTRODUCTION

Plant Genomic DNA isolation is one of the prime requirements for marker assisted selection for precise breeding programmes [1,2]. The plant DNA isolation and purification procedures can be grouped into three categories, viz., (1) Cetyl Trimethyl Ammonium Bromide (CTAB) method [3,4], (2) Rapid DNA extraction method [5], and (3) DNA isolation by commercial kits such as DNeasy Mini and Maxi kits from QIAGEN, NucleoSpin Plant kits from Clontech, PureLink® Genomic Plant DNA Purification Kit from Life Technologies, PowerPlant® DNA Isolation Kit from MO BIO Laboratories, MasterPure™ Plant Leaf DNA Purification Kit from Epicentre, etc. These procedures usually consist of three steps: (1) rupture and lysis of cells to obtain cell extract (tissue maceration), using DNA extraction buffer (2) purification of DNA, and (3) quantification of DNA. Generally, for plant tissues, fresh leaves of 15 to 20 days are preferred (fresh, freeze-dried, or frozen in liquid nitrogen) and usually ruptured by mechanical force in pestle and motor or tissue lyzer. The main objective of various DNA isolation methods is development of relatively quick, inexpensive and consistent protocol to extract high quality DNA with better yield. Leaf samples contain large quantities of polyphenols, tannins and polysaccharides, so purification of DNA is equally important to get high quality DNA. The basic principle of DNA isolation is disruption of the cell wall, cell membrane and nuclear membrane to release the highly intact DNA into solution followed by precipitation of DNA and removal of the contaminating biomolecules such as the proteins, polysaccharides, lipids, phenols and other secondary metabolites by enzymatic or chemical methods. In present review, we have described two modified methods for plant genomic DNA isolation from leaf tissue.

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Chapter 9
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Recent Advancements on Callus and Cell Suspension Cultures: An Effectual Reserve for the Production of Pharmaceutically Significant Metabolites

Ashok Ahuja [a], Manoj Kumar Tripathi [a*], Sushma Tiwari [a], Niraj Tripathi [b], Gyanendra Tiwari [c], Nishi Mishra [a], Shashank Bhargav [a] and Sharad Tiwari [d]

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ABSTRACT

Secondary metabolites of pharmaceutically importance or phytopharmaceuticals comprise alkaloids, glycosides, flavonoids, volatile oils, tannins, resins *etc*. At present, most of these secondary metabolites are extracted from wild or cultivated plants since their chemical synthesis is either tremendously tough or economically impracticable. Production through callus and cell suspension cultures is a gorgeous substitute, nevertheless till yet this has had only restricted marketable accomplishment owing to less-existence of empathetic of how these metabolites are synthesized. The current book chapter has summarized some of the current progresses and investigations conducted by authors for the production of some of the useful bioactive secondary metabolites *viz.,* withanolides, bacosides, glychyrhizin, reserpine, ajmalicine, amarogentin, plumbagin and terpenoids from callus and cell suspension cultures of corresponding plant species. The similar have been deliberated vastly.

Keywords: Secondary metabolites; callus culture; cell suspension culture; medicinal plants; metabolic engineering; bioactive; withanolides; bacosides; glychyrhizin; terpenoids; reserpine, plumbagin; indole alkaloids; secoirridoids; xanthones.

1. STUDY OBJECTIVES

The present chapter was aimed to describe possible role of different plant growth regulators their concentrations, nature of explants and other culture conditions on establishment of callus and cell suspension cultures appropriate for production of secondary metabolites of pharmaceutical importance of imperative medicinal plants.

2. INTRODUCTION

Plants are ironic spring of bioactive compounds or phyto-pharmaceuticals employed in pharmaceutical industry. Some of the plant produced natural products including drugs for instance morphine, codeine, cocaine, quinine *etc*; anti-cancer catharanthus alkaloids, belladonna alkaloids, colchicines, phytostigminine, pilocarpine, reserpine and steroids like diosgenin, digoxin and digitoxin. Several of these pharmaceuticals are still in practice today and regularly no useful synthetic substitutes have been found that possess the same efficacy and pharmacological specificity [1-5]. Presently one fourth of all prearranged pharmaceuticals in industrialized nations cover amalgams that are unswervingly or tortuously, *via* semi-synthesis, derived from plants. Besides, 11% of the 252

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Chapter - 6

Dragon Fruit: A Super Food in India

Khushboo Tandon, P.K.S. Gurjar and R. Lekhi

Abstract

Dragon fruit (*Hylocereus undatus*) Family *Cactaceae*, Most Hylocereus species principally is originated in Mexico and Central and South America. It is a recently introduced super fruit in India, is considered to be a promising, remunerative fruit crop. It is a climbing vine cactus species which has received worldwide recognition first as ornamental plant and then as a fruit crop. Fruit has very attractive colour and mellow mouth melting pulp with black colour edible seed embedded in the pulp along with tremendous nutritive property which attracts the growers from different part of India to cultivate this fruit crop. It also contains phytonutrients, antioxidants, vitamin C, Protein, Carbohydrate, Vitamin B, Carotene and polyunsaturated fatty acids. Dragon fruit can be processed into a wide range of industrial products such as juice, sherbet, jam, syrup, ice cream, jelly, preserve, candy, pastries and Wine making. The tropical weather conditions are better for the dragon fruit cultivation. The dragon fruit plant gets the flowering in May to June month and fruits from Aug to Dec month.

Keywords: dragon fruit, nutritional properties, medicinal properties, fruit types etc.

Introduction

Dragon fruit (*Hylocereus undatus*) Family *Cactaceae*, Most Hylocereus species principally is originated in Mexico and Central and South America. It is a recently introduced super fruit in India, is considered to be a promising, remunerative fruit crop. It is a climbing vine cactus species which has received worldwide recognition first as ornamental plant and then as a fruit crop. Fruit has very attractive colour and mellow mouth melting pulp with black colour edible seed embedded in the pulp along with tremendous nutritive property which attracts the growers from different part of India to cultivate this fruit crop. The flower is so beautiful that it is nicknamed as 'Noble Women' or 'Queen of the Night'. The biggest advantage of this crop

Genomics Approaches for Restoration and Conservation of Agro-Biodiversity

14

R. S. Tomar, Prabha Singh, Sushma Tiwari, Manoj Kumar Tripathi, Sanjay Singh, K. Bhojaraja Naik, Chandan Kumar Singh, and Shailesh Kumar Singh

Abstract

Agro-biodiversity provides foods for living biota along with several things for easy living and survival on the planet. It is in various forms and goods like firewood; approximately two billion population globally utilize firewood as a source of energy for cooking and heating; fiber, like cotton, wool, silk, and flax; drugs, approximately 25% of drugs utilized come from plants; and for construction of household and utilization of timber wood as furniture, sports goods, and many. Nowadays it is an alarming threat because of the reduction in free space, smaller and fragmented habitats, and overexploitation by human for urbanization and fulfillment of their needs. This degradation and destruction have caused imbalance in the nature which has resulted in several calamities and disasters in the recent past. So it is important to protect and conserve the agro-biodiversity to

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Chapter - 8

Bioinformatics and Its Applications in Crop Improvement

Radha Gupta, Sushma Tiwari, M.K. Tripathi and Sajjan Kumar Pooniya

Abstract

Bioinformatics is a rapidly developing branch of science and is highly interdisciplinary, using concepts and techniques from informatics, mathematics, statistics, biology, chemistry, biochemistry, physics, and linguistics. Bioinformatics application is in information technology to manage biological data that helps in plant genomes study. Biological research that earlier used to start in laboratories, fields and plant clinics is now starts at the computational level using computers (In-silico) for analysis of the data, experiment planning and hypothesis development. Bioinformatics database and tools have various application in biological research enables storage, retrieval, analysis, annotation and visualization of results to promotes and better understanding of biological system. This will help in crop improvement and plant disease diagnosis to improve the quality of Plant.

Keywords: bioinformatics, genomics, agriculture, crop improvement and biotic stress

Introduction

Bioinformatics is defined as the study of information content and its flow in biological systems. It is an interdisciplinary branch of the science composed of biology, mathematics and computer science. According to the National Centre for Biotechnology Information (NCBI), "bioinformatics is the research development or application of computational tools and approaches for expanding the use of biological, medical, plant data base for acquire, store, organize, archive, analyze or visualize such data". Although bioinformatics is a new field of science but it is making progress in every field of biotechnology. Bioinformatics common activities includes, mapping, aligning different DNA, protein sequences, creating and viewing 3-D models of protein structures (Nilges and Linge, 2009). The purpose of bioinformatics is to understand the genetic and molecular basis of all biological processes in plants that are relevant to the specie. Bioinformatics

Chapter - 4

Foliar Diseases of Cluster Bean: A Consortium Approach for Disease Management to Improve Productivity

Dr. Rajni Singh Sasode and Dr. Pramod Kumar Fatehpuria

Abstract

Arid legume in India comprises four annual legumes *viz.*, Cluster bean or guar, Moth bean, Cowpea and Horse gram. These crops could not considered as major crops due to their low acreage at the national level. These crops are drought hardy can grow in soils with poor fertility and have deep mat type root system which is of great adaptive significance. Therefore these legumes are specifically important for sustaining production under arid and semi-arid ecosystem. However, these crops are important at the regional level especially, in the traditional farming system. These minor pulses may not substantially influence the productivity figures of pulses as a whole at the country level, the same may; however spectacularly contribute through specific climate zones and ecological niches. The pulses are known for their unique and specific adaptation towards fragile ecosystem where they encounter with degree of adversities composed of moisture scarcity, extremes of temperature and poor agronomic inputs with less care. Besides having versatile uses with low cultivation cost, these crops from important component of complex cropping systems, varying from one climatic zone to other. Suited to nutritionally poor and texturally degraded soils, pulses are recognized as essential segment of traditionally and indigenous and technologies with assured production in such area. The poor productivity of Cluster bean is of major concern. Several biotic and abiotic reasons can be assigned for stagnation in poor productivity of these legumes. Since, arid legumes are grown basically without plant protection and agronomic inputs. In recent year concerted efforts at various levels have led to the development of amenable technological advancements which are quite useful in raising the productivity of crops. In context of diseases the fungal foliar diseases among these legumes play an important role in reducing production and productivity of the crops. Fungal leaf spots are caused by a large number of

Nutrient Omission Plot Technique and its role in determining the nutrients rate and limiting nutrient in SSNM

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Introduction

The role of fertilizers in attaining the green revolution during 1960's in India cannot be overlooked which made the country a surplus producer of food grains. But over dependency on high analysis fertilizers and their continuous indiscriminate use,led in consistence decrease in factor productivity and nutrient use efficiency of major nutrients, which is now become a matter of serious concern to increase the agricultural productivity in the country. In many parts of India, land useintensification with inadequate and suboptimal nutrientinputs has led to accelerated nutrient removal resulting in nutrient deficiencies to plants and poor crop yield levels. These nutritional disorders are commonly manifested with visual symptoms and resulted in decrease in the growth and production of any crop. These problems are increasingly addressed by the application of fertilizers containing primarily N, P and K, though still used at inadequate rates with very large variations to all crops.

On another hand, due to seasonal and temporal variation in climate and indigenous soil nutrient supplies, the crop response to fertilizer application is also not always easy to predict. The spatial variability for soil nutrient supplying exists across the farmer's field so it is necessary to estimate that variability for efficient nutrient uptake and to increase crop productivity. Both climate and soil indigenous nutrient supplying capacity leads to large differences in optimal rates for fertilizer recommendations for different sites, season and years. The blanket recommendations of fertilizer with fixed rates and timings for large crop growing areas may lead farmers to over-fertilize in one and under-fertilize in other area. Now the fertilizers recommendation approach in the country needs a paradigm shift towards rationalized approach to supply the nutrient demand of a crop or rather a cropping system while maintaining the soil fertility. An alternative to blanket guidance for nitrogen (N), phosphorus (P), and potassium (K) fertilizers, SiteSpecific Nutrient Management (SSNM) aims to optimize the supply of soil nutrients over time and space to match the requirements of crops through five key principles (Balasubramanian *et al*., 1999; Dobermann *et al*., 2002). The field experiments are designed in such a way that with adoption of suitable crop

Chapter - 12

Biotic Stress Management in Vegetable Crop Production

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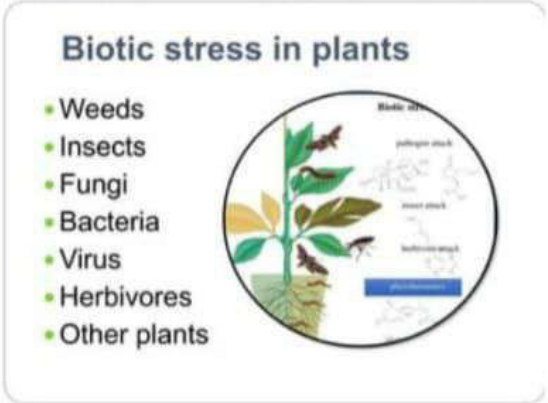
Introduction

Biotic stress is an adverse condition in which plant cannot sustain its normal growth due to the interaction with deleterious microorganisms (fungi, bacteria, viruses, viroids, phytoplasma, and nematodes), pest and weed or any living factor Balodi *et al.*, (2017). According to Wang *et al.* (2013), the biotic stresses are responsible for approximately, 28.2%, 37.4%, 31.2%, 40.3%, 26.3%, and 28.8% yield losses in wheat, rice, maize, potatoes, soybeans, and cotton crops, respectively. After infection with microorganisms, reactive oxygen species (ROS) increases and plants use the defense systems to scavenge these free radicals Atkinson and Urwin, (2012).



Sources: ALASKA (2008)

Entrepreneur Skills Development Through Commercial Production And Value Addition Of Grapes

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ABSTRACT

Establishing strong collaboration with national and international institutes in multidisciplinary approach or network or consortia mode would help in developing technologies and resolve the issues in a holistic manner. Human Resource Development enhancing quality of human resource is a pre-requisite for implementing and upgrading research programmes, developing technologies, evolving institutional arrangements to face challenges and harness opportunities.

Imparting education on all the aspects of Viticulture and Enology through full time graduate degree, PG Diploma, Certificate courses may help in developing specialists at all the levels so that grape cultivation and processing will be done in systematic manner with trained man power.

INTRODUCTION

Grape is one of the sweet, juicy and healthiest fruit available on the earth. Penalty minerals and vitamins are available in the grape required for human body growth. Grape is called as 'King of fruit' in 'Ayurveda' being a digestive property.

Grape cultivation is originated in Central Asia Region (from Black Sea and Caucasian Sea), after that, it spread to Europe and eastward to Iran and Afghanistan. In India Grape was introduced in 1300 AD by trespassers from Iran and Afghanistan.

India is among the first ten countries in the world in the production of grape. The leading producers of grape are Italy, France, Spain, USA, Turkey, China and Argentina. This crop occupies fifth position amongst fruit crops in India with a production of 2920.0 thousand tonnes from an area of 38.91 thousand ha. in 2018-19. (Horticultural Statistics at A Glance 2018)

The area under grape is 1.2 % of the total area of fruit crops in the country. Production is 2.8% of total fruits produced in the country. About 80% of the production comes from Maharashtra followed by Karnataka and Tamil Nadu. In