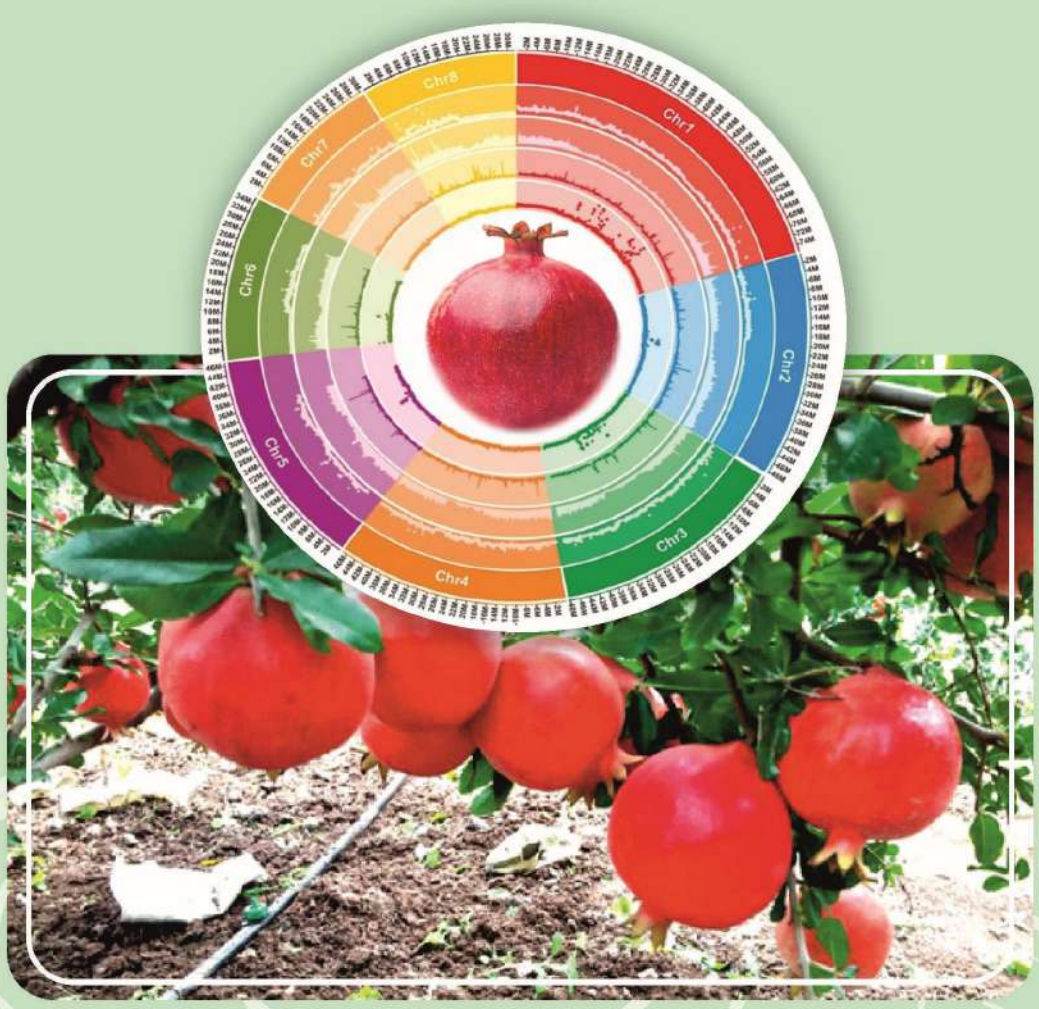
वार्षिक रिपोर्ट
ANNUAL REPORT
2022



भा.कृ.अनु.प. – राष्ट्रीय अनार अनुसंधान केंद्र
ICAR – National Research Centre on Pomegranate

एनएच - 65, सोलापुर-पुणे राजमार्ग, केगांव, सोलापुर-413255, महाराष्ट्र
NH-65, Solapur-Pune Highway, Kegaon, Solapur-413255, Maharashtra

NRCP ANNUAL REPORT 2022

ICAR-NRCP
ANNUAL REPORT 2022

ICAR- National Research Centre on Pomegranate
NH-65, Solapur –Pune Highway, Kegaon,
Solapur- 413 255, Maharashtra

Printed 2023

Editor
Rajiv A Marathe
Director

Editorial Team
K. Dhinesh Babu, Principal Scientist (Hort. -Fruit Science)
Prakash G. Patil, Senior Scientist (Plant Biotechnology)
Chandrakant Awachare, Scientist (Hort. - Fruit Science)
Dr. P. Roopa Sowjanya, Scientist (Genetics & Plant Breeding)

Summary in Hindi & Technical Support
Bhausaheb Naikwadi, Senior Technical Assistant

Correct Citation: Babu, K.D., Patil, P.G., Awachare C. and Sowjanya P. Roopa, 2023. ICAR-NRCP Annual Report 2022, National Research Centre on Pomegranate, Solapur 413 255 Maharashtra.

ICAR-NRCP website: nrcpomegranate.icar.gov.in
E-mail: nrcpomegranate@gmail.com

Published by the Director, ICAR-NRC on Pomegranate, Solapur-413255 (MS)

CONTENTS

Preface

ICAR-National Research Centre on Pomegranate, Solapur, has completed 17 years of journey on September 25, 2022. The Centre has accomplished its objectives with visible outcomes during the period and is proud to be the driving force behind the sprawling pomegranate sector in India. The pomegranate sector has recorded constant increase in area, production and productivity since last 8 years. In 2021-22, the pomegranate was cultivated over 2.76 lakh ha, production of 31.48 lakh MT with productivity of 11.41 t/ha and the export was 99.04 thousand MT.

This year can be considered a milestone for the institute, as ICAR awarded a team of scientists of NRCP, Solapur with the "Vasant Rao Naik Award for Outstanding Research and Application in Developed Farming Systems - 2021.". The ICAR-NRCP has released the Chromosome Scale Genome Assembly of Indian pomegranate cv. Bhagawa for press and media on 24th September under Chairmanship of the Dr. A.K. Singh, DDG (HS) and the same has been released at a public event on 25th September, on the occasion of 18th foundation day of ICAR-National Research Centre on Pomegranate or NRCP. This year scientists successfully completed whole genome sequencing of *Xap.* But during this year pomegranate production faced a significant challenge of the Shot Hole Borer infestation. To develop management strategies initially completed the molecular characterization and DNA sequencing of the Shot Hole Borer, and identified fungi associated with SHB viz., *Fusarium* and *colletrotricum gleosporiodies*. Finally developed management practices for the shot hole borer. During this period institute has got two externally funded projects from DST and BARC-BRNS. In this year, the institute has developed a highly nutritious pomegranate-karonda mixed jam. Added 84 new germplasms from Himachal Pradesh to our gene bank and five germplasms which exhibited salinity tolerance than the Bhagwa variety were identified. On a positive note, our research efforts culminated in the form of 21 research papers, 12 book chapters, 3 books and 29 popular articles. Our scientists have also received numerous awards for their contributions to pomegranate research.

ICAR-NRCP has significantly contributed in improving pomegranate scenario in India through its technologies on combating major diseases, improving fruit yield and quality, providing quality planting material, identifying suitable pomegranate growing areas in India, developing sound package of practices, acting as repository of germplasm for breeding new varieties, giving value addition technologies for complete utilization of fruit, dissemination, commercialization and transfer of technologies, imparting on-site and in-house trainings to stakeholders, etc. The Centre has implemented Government of India schemes, and introduced pomegranate cultivation in different states through Tribal Sub Plan, (TSP), Mera Gaon Mera Gaurav (MGMG) and Scheduled Caste Sub Plan (SCSP) by demonstrations, inputs, Soil Health Cards and technical guidance..

I wish to place on record my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for his encouragement. I am obliged to Dr. A.K. Singh, DDG (HS) for his moral support and guidance, which encourages us to move forward with confidence. The cooperation and support rendered by Dr. BK Pandey, ADG (HS) I/c and Dr. Vikramaditya Pandey, ADG (HS) I/c all the staff members of SMD (HS) to this Centre is thankfully acknowledged. I am grateful to Hon'ble Chairman and members of RAC for guidance and keen interest shaping the research activities of the institute. The Centre would not have achieved its milestones without constant support and cooperation of all scientific, administrative, technical and supporting staff as well as senior research fellows, young professionals in various research projects. I am grateful to all for their unflinching support and express my sincere thanks for the help rendered in betterment of this Centre.

Dr. R.A. Marathe
Director, ICAR-NRCP

Introduction

Horticulture has moved from rural confines to commercial venture. Scenario of horticulture crops in India has become very encouraging in recent times. Horticulture production in 2001-02 was only 145.8 million tones, which was much lower than food grain production (212.9 million tonnes). In 2009-10 to 2011-12 both were at par. Later horticulture production remained higher than food grain production with continuous increase recording 342.33 million tonnes in 2021-22, whereas food grain production was only 285.71 million tonnes (http://agricoop.nic.in). Today percentage share of horticulture output in agriculture has become 33%. Globally India is second largest producer of fruits and vegetables and first in Mango, Banana, lime, lemon, pomegranate, papaya and okra/ladies finger.

The pomegranate crop is considered as strategic crop in India to mitigate the future challenges like global warming, drought, alleviating the poverty by creating livelihood and improving the framers income. Therefore, in order to tap the vast potential of this crop by increasing pomegranate production, export and there by economic growth of India, Indian Council of Agricultural Research established ICAR-National Research Centre on Pomegranate during 2005 at Kegaon, Solapur (Maharashtra) a premier institute mainly for carrying out both basic and strategic research on pomegranate.

About two decades back consumer awareness towards innumerable health benefits of pomegranate increased market demand, resulting in constant increase in area and production of this crop. Alluring monetary returns from this horticulture crop were recorded, especially in India. Analysis of pomegranate statistics for last 12 years shows that, average increase in area was 157.94 %, production 323.69 % and productivity 64.41%. Looking into the impressive past scenario and keeping in mind the climate change and promising technologies available, it is expected that in the coming years the pomegranate can become one of the most important horticultural crops of India.

As per estimated global pomegranate acreage and production figures available on different internet sites, India is the largest producer with around 48% share globally. India in 2021-22, occupies an area of 2.76 lakh hectares with production of 31.48 lakh tonnes. The other major countries after India are China, Iran and Turkey. Rest of the pomegranate growing countries like USA, Tunisia, Morocco, Spain, Israel, Greece, Italy, South Africa etc. have lower area and production. The global pomegranate scenario clearly indicates that India has the advantage to come up with promising pomegranate technologies for the benefit of Indian population. Today estimated more than 2.5 lakh families are earning livelihood from this crop in arid and semi-arid regions of India.

Envisioning the economic importance of pomegranate for the farmers in arid and semi-arid regions, the ICAR-NRCP addressed these hurdles on priority and gave solutions to major challenges. Noteworthy technologies for promotion of pomegranate include:

(i) A well established, 'Field Gene bank' with 307 germplasm lines including indigenous and exotic lines established at ICAR-NRCP, Solapur which serves collection of genes for diverse characters.

(ii) Bio-hardened micro-propagation technology for propagation of disease free planting material.

(iii) Promising, cost effective, eco-friendly integrated nutrient, water, disease & insect pest management schedule with the use of bio-formulations and preventive strategies, resulting in quality fruit production.

(iv) Novel bio-formulation for potassium fertilizer supplement, with *Penicillium pinophilum,* that reduces 70% requirement of potassium to pomegranate, saves ~Rs.40,000/ha on fertilizers cost and increases yield by 25%.

(v) Processing technologies for total utilization of pomegranate for diversification of utilization pattern, and higher returns. These are pomegranate juice and ready to serve drink from low market value fruits; minimally processed pomegranate arils with shelf life of 14 days; high pharmaceutical value seed oil from dried seeds of cv. Bhagawa (28% w/w oil) and Ganesh (26.43 % w/w oil); hi-fibre cookies from de-oiled seed cake of pomegranate; sparkling pomegranate wine from pomegranate juice.

(vi) Bio-fortified pomegranate variety, 'Solapur Lal' developed through breeding matures in 160-165 days, has 25-35% higher yield over cv. Bhagawa and is nutritionally rich with more iron, zinc, ascorbic acid and anthocyanin contents over the ruling cv. Bhagawa. This bio-fortified variety is a boon to combat nutritional deficiencies in human beings and with TSS around 17.6 is a boon for processing industries too.

(vii) The Centre in collaboration with NBSS&LUP, Nagpur has accomplished mapping of pomegranate growing areas based on soil type and climatic conditions. This will help promote pomegranate cultivation in areas suitable for its cultivation but not yet growing pomegranate, for promoting crop diversification and improving economy of the farmer.

The NRCP has popularized its promising technologies through licensing, consultancy extension activities, distribution of NRCP publications, digital mobile app 'Solapur Anar', demonstrations on framers field, providing on campus and off campus trainings to framers and entrepreneurs and TV shows.

Due to highest BC ratio of pomegranate, this ancient health fruit with available technologies can be considered as an ideal crop for diversification under climate resilience and developing rural economy with the technologies available, cluster approach and government intervention. Government support for encouraging community farming and putting up processing units for value addition of unmarketable produce during natural calamities and poor market value will go a long way in improving economic status of farmers. Pomegranate cultivation in arid and semi-arid regions and tribal areas will not only be beneficial in monitory terms but its consumption will ensure nutritional security of the rural and tribal population, hence it should be promoted as an important crop for diversification in agriculture/horticulture in these areas.

ICAR-NRC on Pomegranate has developed infrastructure with state-of-art facilities for conducting basic, strategic and applied research and take it to the beneficiaries through extension activities, publications in popular languages, digital apps in multi-languages to fulfill the vision of Honorable Primer Minister of India of Digital India, Doubling Farmer's Income and Atmanirbhar Bharat.

Mandate:

- Basic, strategic and applied research on genetic resource management, crop improvement, production and protection technology for enhanced and sustained productivity of pomegranate.
- Transfer of technology and capacity building of stakeholders for enhancing and sustaining productivity of pomegranate.

Mission:

- To establish an international repository of genetic resources, develop suitable technologies for pomegranate production and to improve economic status of farmers in different regions.

Vision:

- To transform the ICAR-National Research Centre on Pomegranate to an International Centre for Pomegranate Research.

कार्यकारी सारांश

अनार इस फसल ने भारत के अनियमित वर्षा वाले शुष्क और अर्ध-शुष्क क्षेत्रों में किसानों की आजीविका सुरक्षा में सुधार के लिए अपना महत्व दिखाया है। आईसीएआर-राष्ट्रीय अनार अनुसंधान केंद्र, सोलापुर, अनार उत्पादकों के सामने आने वाले विभिन्न शोध योग्य मुद्दों को हल करने और इस लोकप्रिय फसल की चुनौतियों का सामना करने में महत्वपूर्ण भूमिका निभा रहा है। सन 2021-22 में अनार की खेती 2.76 लाख हेक्टेयर क्षेत्र पर की जा रही है तथा उत्पादन 31.48 लाख मीट्रिक टन का और 99,040 मीट्रिक टन का निर्यात हुआ।

रिपोर्ट के तहत वर्ष के दौरान, केंद्र ने कई संस्थागत परियोजनाओं, बाह्य वित्त पोषित परियोजनाओं, दो अंतर-संस्थागत सहयोगात्मक परियोजनाओं, एक अनुसूचित जाति उप-योजना (एससीएसपी) और एक जनजातीय उप-योजना (टीएसपी) योजना को संभाला है। रिपोर्ट के तहत अवधि के दौरान पंद्रह संस्थागत परियोजनाओं में से एक परियोजना सफलतापूर्वक पूरी हो गई है। प्रमुख उपलब्धियों का सारांश नीचे दिया गया है।

जननद्रव्य संसाधन:

- आईसीएआर-एनआरसीपी, सोलापुर के 307 अनार जर्मप्लाज्म (140 आईसी +167 ईसी) में से, बैक्टीरियल ब्लाइट रोग के खिलाफ 15 परिग्रहणों की जांच से पता चला कि एक जर्मप्लाज्म (ईसी-676992) बैक्टीरियल ब्ला इट रोग के खिलाफ गंभीरता ग्रेड 2 के साथ मध्यम प्रतिरोधी है।
- 2022 के दौरान, हिमाचल प्रदेश, भारत और इज़राइल से 84 नए अनार जर्मप्लाज्म का संकलन किया गया , जिनमें से 42 संग्रह सफलतापूर्वक स्थापित हुये और उनका रखरखाव किए गए। प्रतिरोधी स्रोतों की पहचान करने के लिए विभिन्न जैविक और अजैविक तनावों के लिए इनका आगे मूल्यांकन किया जाएगा।
- किसान किस्म "शरद किंग" का ऑन-साइट डस परीक्षण 14 जुलाई, 2022 को औरंगाबाद, महाराष्ट्र में किया गया था। परीक्षण की गई किस्म (शरद किंग) को पंखुड़ी की लंबाई (बड़ी), पंखुड़ी की चौड़ाई (बड़ी), जैसे लक्षणों के लिए अलग पाया गया। संदर्भ किस्म 'भगवा' (मध्यम, की तुलना में फल का आकार (गोल), एरिल लंबाई (छोटा), फल परिपक्वता (मध्यम) पाइ गयी।

फसल सुधार:

- बीज कठोरता विशेषता से जुड़े पांच उम्मीदवार miRNA-SSR मार्करों की पहचान की गई: सिलिको विश्लेषण के माध्यम से, हमने 761 संभावित अग्रदूत miRNA अनुक्रमों की खोज करके 132 miRNA-SSR मार्करों को डिज़ाइन किया है जो अनार में बीज परिपक्वता के दौरान व्यक्त किए जाते हैं।
- **विकसित गुणसूत्र विशिष्ट संभावित इंट्रॉन बहुरूपता (पीआईपी) मार्कर विकसित किए गए –**
- जीन व्युत्पन्न इंट्रॉन लेंथ मार्कर विकसित करने के लिए, हमने ट्यूनीशिया जीनोम के 36,524 एनोटेटेड जीन का सर्वेक्षण किया। एराबिडोप्सिस जीन की तुलना में इंट्रॉन लंबाई भिन्नता वाले 3,445 (13.4%) जीन की पहचान की गई और 8,812 संभावित इंट्रॉन पॉलीमोर्फिज्म (पीआईपी) प्राइमर डिजाइन किए गए।

फ़सल उत्पादन:

- बीस सेंटिमेटर लंबी , 4 नोडल वाली दृढ़ लकड़ी कटिंग को कोकोपीट + पर्लाइट + वर्मीक्यूलाइट 18 (2:1:1, वी/वी) पर रोपे जाने पर तथा जिंक सल्फेट (1%) तथा इंडोल-3-ब्यूटिरिक एसिड (500 पीपीएम) के संयोजन से उपचारित दृढ़ लकड़ी की कटिंग ने उच्चतम कटिंग सफलता (73.33%) दर्ज की।
- व्यावसायिक किस्म भगवा की तुलना में लवणता के प्रति IC-318733, Acc.-2, पटना-5 और IC-318712 जर्मप्लाज्मा को सहनशीलता पाया गया।
- टीसू कल्चर पौधे बनाने हेतु 0.5 मिलीग्राम/लीटर बीएपी + 0.25 मिलीग्राम/लीटर एनएए + 50 मिलीग्राम/लीटर एडेनिन सल्फेट के साथ संशोधित एमएस माध्यम ने 3.38 संख्या में साइड शूट और 4.75 जीआई के साथ

उच्चतम औसत शूट वृद्धि (6.95 सेमी) का उत्पादन किया, लेकिन साइड शूट की अधिकतम संख्या (3.82) एक ही माध्यम पर लेकिन उन्नत एडेनिन सल्फेट (100 मिलीग्राम/लीटर) के साथ पंजीकृत किए गए थे।

- पोल्ट्री कूड़े, रॉक फॉस्फेट, के-फेल्डस्पार, कंपोस्टिंग कल्चर और पी और के सॉल्यूबिलाइजर के साथ प्रेस मड की खाद बनाने से न केवल खाद में पोषक तत्वों की मात्रा बढ़ी, बल्कि खाद की गुणवत्ता में भी काफी सुधार हुआ।
- विभिन्न डी-ऑयल केक के बीच, सबसे अधिक मात्रा में पोषक तत्व यानी एन, पी और के को सबक्रिटिकल वॉटर हाइड्रोलिसिस उपचार के माध्यम से कुसुम केक से तरल जैविक उर्वरक के रूप में निकाला जा सकता है।
- जैविक पोषक तत्वों की खुराक के विभिन्न संयोजनों में, उच्चतम उपलब्ध एन सामग्री रासायनिक उर्वरकों के अनुप्रयोग और रासायनिक उर्वरकों के साथ एफवाईएम लगाने के किसानों के अभ्यास के साथ दर्ज की गई थी। उच्चतम उपलब्ध पी सामग्री फार्मयार्ड खाद, एन 2-फिक्सिंग बायोफर्टिलाइज़र और पी एंड के पूरक बायोमिनरल उर्वरक के संयोजन के साथ दर्ज की गई थी, जबकि उच्चतम उपलब्ध के और एस सामग्री रासायनिक उर्वरक के अनुप्रयोग के साथ दर्ज की गई थी। जैविक स्रोतों के माध्यम से पोषक तत्वों की पूर्ति के सभी उपचारों के साथ डीटीपीए निकालने योग्य Fe, Mn, Zn और Cu में महत्वपूर्ण कमी दर्ज की गई।
- सभी जैविक उपचारों से डिहाइड्रोजनेज, एसिड और क्षारीय फॉस्फेट गतिविधियों में उल्लेखनीय वृद्धि हुई और जीएम, एन2-फिक्सिंग बायोफर्टिलाइज़र और पी एंड के पूरक बायोमिनरल उर्वरक (टी 7) के संयोजन के साथ उच्चतम डिहाइड्रोजनेज, एसिड और क्षारीय फॉस्फेट गतिविधियां दर्ज की गईं, जबकि सबसे कम डिहाइड्रोजनेज गतिविधि दर्ज की गई। रासायनिक उर्वरकों के प्रयोग से देखा गया।

फसल सुरक्षा:

- अनार के बगीचों को प्रभावित करने वाले कीटों का आकलन करने के लिए महाराष्ट्र के सोलापुर जिले में एक सर्वेक्षण किया गया था। पहचाने गए प्राथमिक कीट शॉट होल बोरर (एसएचबी), थ्रिप्स और स्टेम बोरर थे। एसएचबी सोलापुर जिले में अनार के बागानों के लिए एक महत्वपूर्ण खतरे के रूप में उभरा गया।
- शॉट होल बोरर किड के लिए एक मानकीकृत इन-विट्रो रियरिंग प्रोटोकॉल विकसित किया गया था। अनार की छाल के बुरादे के साथ संशोधित अर्धसिंथेटिक माध्यम ने एसएचबी के पालन के लिए सर्वोत्तम परिणाम दिखाए।
- शॉट होल बोरर और संबंधित कवक का आणविक लक्षण वर्णन प्रजाति-विशिष्ट प्राइमरों और डीएनए अनुक्रमण का उपयोग करके किया गया था। एसएचबी आइसोलेट्स की पहचान यूवालेसिया फॉर्निकैटस के रूप में पुष्टि की गई थी।
- एसएचबी से जुड़े विभिन्न कवक की पहचान की गई, जिनमें अनकल्चर्ड फ्यूसेरियम और कोलेटोट्राइकम ग्लियोस्पोरियोइड्स शामिल हैं।
- केओलिन का एंटिट्रांसपरान्ट हेतु छिड़काव करनेसे बैक्टीरियल ब्लाइट रोग मे कमी पाई गयी साथ ही आट्राजिन एवं सिलीसिलिक अम्ल भी उपयोगी पाये गए
- बैक्टीरियल ब्लाइट रोगकारक जीवाणु झानथोंथोमोनस अक्सोनोपोडिस का सम्पूर्ण जीनोम सिकवेनसिंग किया गया

फल प्रसंस्करण :

- मफिन (कप केक्स) बनाने हेतु 8% अनार के छिलके के पाउडर का उपयोग किया गया ।
- अनार-करौंदा मिश्रित फल जैम को अनार के साथ-साथ अत्यधिक कम उपयोग किए गए करोंदा फल के पोषण संबंधी लाभों के उपयोग के उद्देश्य से विकसित किया गया था।
- खरबूजे के साथ मिश्रित अनार स्क्वैश विकसित किया गया। प्राप्त कुल संवेदी स्कोर के आधार पर, 75% अनार के रस और 25% खरबूजे के रस के साथ तैयार किया गया नमूना समग्र रूप से स्वीकार्य पाया गया।

अन्य गतिविधिया:

- केंद्र ने महाराष्ट्र, राजस्थान, छत्तीसगढ़, मध्य प्रदेश राज्यों में एससीएसपी, टीएसपी और मेरा गांव मेरा गौरव के माध्यम से प्रदर्शन, इनपुट की आपूर्ति, मृदा स्वास्थ्य कार्ड प्रदान करने, प्रशिक्षण और तकनीकी मार्गदर्शन प्रदान करके लगभग 915 किसानों को लाभान्वित करते हुए अनार की खेती को बढ़ावा दिया है।

- आईसीएआर-एनआरसीपी ने उद्यमियों के लिए तीन प्रौद्योगिकियों का व्यावसायीकरण किया और पांच प्रदर्शनियों में अपनी गतिविधि प्रदर्शित की और किसानों, छात्रों और अन्य हितधारकों सहित 1790 से अधिक आगंतुकों ने जानकारी के लिए केंद्र का दौरा किया।
- आईसीएआर-एनआरसीपी के सभी कर्मचारियों ने स्वच्छ भारत अभियान, अंतर्राष्ट्रीय महिला दिवस, किसान दिवस आदि के तहत गतिविधियों में सक्रिय रूप से भाग लिया।
- केंद्र ने अनार की खेती में शामिल किसानों और विभिन्न हितधारकों के लिए कार्यशालाएं और प्रशिक्षण कार्यक्रम भी आयोजित किए। इसके अलावा, विभिन्न हितधारकों तक आईसीएआर-एनआरसीपी प्रौद्योगिकियों का प्रसार करने के लिए विभिन्न संगठनों के सहयोग से विभिन्न इंटरैक्टिव बैठकें आयोजित की गईं।
- केंद्र ने सहकर्मी समीक्षा वाली पत्रिकाओं में 21 शोध पत्र प्रकाशित किए, जिनमें से नौ 10 से ऊपर NAAS रेटिंग वाले जर्नल में थे, 3 किताबें, 12 पुस्तक अध्याय, 29 लोकप्रिय लेख, इसके अलावा सम्मेलनों में 16 प्रस्तुतियाँ और 4 पोस्टर प्रस्तुतियाँ और 2 पेटेंट दिए गए। आईसीएआर-एनआरसीपी, सोलापुर को ड्राईलैंड फार्मिंग सिस्टम में उत्कृष्ट अनुसंधान और अनुप्रयोग के लिए वसंत राव नाइक पुरस्कार -2021 (कृषि अनुसंधान में उत्कृष्टता के लिए आईसीएआर-राष्ट्रीय पुरस्कार) मिला और वैज्ञानिकों को सर्वश्रेष्ठ मौखिक के अलावा पेशेवर सोसायटी जैसे पुरस्कार / फैलोशिप/ पोस्टर से भी पुरस्कार मिला है।

Executive Summary

The ICAR-National Research Centre on Pomegranate, Solapur has been playing pivotal role in solving various researchable issues faced by the pomegranate growers and meeting the challenges of this popular crop.

This year team of scientists from ICAR-NRCP, Solapur conferred with 'Vasant Rao Naik Award for Outstanding Research and Application in Dryland Farming Systems-2021.

During the year under report, the Centre has handled several Institutional Projects, Externally Funded Projects, two Inter-Institutional Collaborative Projects, one Schedule Castes Sub-Plan (SCSP) and one Tribal Sub-Plan (TSP) Scheme. Out of fifteen Institutional Projects, one project has been completed successfully during the period under report. The major achievements are summarized below.

Genetic Resources:

- Out of 307 pomegranate germplasm (140 IC +167 EC) maintained at ICAR-NRCP, Solapur, screening of 15 accessions against bacterial blight disease under challenge condition revealed One germplasm (EC-676992) as moderately resistant with BBD severity grade of 2.
- During 2022, 84 new pomegranate accessions were collected from Himachal Pradesh, India and Israel, Out of which, 42 accessions were successfully established and maintained for identification of resistant sources.
- On-Site DUS testing of farmer variety "Sharad King" having medium maturity period was carried at Aurangabad, Maharashtra in comparison to reference variety 'Bhagwa'.

Crop Improvement:

- Identified five candidate miRNA-SSR markers putatively linked to seed hardness trait: Through *in silico* analysis, we designed 132 miRNA-SSR markers by exploring 761 potential precursor miRNA sequences which are reported to be expressed during seed maturation in pomegranate.
- Developed chromosome specific potential intron polymorphism (PIP) markers: In order to develop gene derived intron length markers, we surveyed 36,524 annotated genes of Tunisia genome. Identified 3,445 (13.4%) genes having intron length varitions in comparison to Arabidopsis genes and designed 8,812 potentially intron polymorphism (PIP) primers.

Crop production:

- The 20cm long HWC with 4 nodes planted on cocopeat + perlite + vermiculite 18 (2:1:1, v/v) and treated with combination of Zinc sulphate (1%) with Indole-3-butyric acid (500 ppm) for 30 minutes registered the highest cutting success.
- Germplasms viz. IC-318733, Acc.2, Patna-5 and IC-318712 were found considerable tolerance against salinity as compared to the commercial variety Bhagwa.
- The modified MS medium with 0.5 mg/l BAP + 0.25 mg/l NAA + 50 mg/l adenine sulphate produced the highest average shoot growth (6.95 cm) with 3.38 number of side shoots and 4.75 GI but the maximum number of side shoots (3.82) were registered on the same medium but with enhanced adenine sulphate (100 mg/l).

- Composting of press mud with poultry litter, rock phosphate, K-feldspar, composting culture and P and K solubilizer enriched nutrient content and quality of compost.
- Among different de-oiled cakes, the highest amount of nutrients viz.,. N, P and K can be extracted in the form of liquid organic fertilizer from safflower cake through subcritical water hydrolysis treatment.
- The highest available P content was recorded with combination of farmyard manure, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer, while the highest available K and S content was recorded with the application of chemical fertilizer.
- All the organic treatments and combination of GM, N_2-fixing biofertilizer, and P & K supplementing biomineral fertilizer, significantly increased dehydrogenase, acid and alkaline phosphatase activities as compared to chemical fertilizers.

Crop Protection:

- In recent time, shot hole borer (SHB) emerged as a significant threat to pomegranate orchards in the Solapur district followed by thrips and stem borer.
- Protocol for in-vitro rearing of SHB using modified media variants was standardized.
- Molecular characterization and DNA sequencing studies revealed the identity of SHB isolates as *Euwallacea fornicatus.*
- Different fungi associated with SHB were identified, including uncultured *Fusarium* and *Colletotrichum gloeosporioides*.
- Plants treated with kaoline anti-transpirants recorded minimum bacterial blight disease incidence followed by atrazine and salicylic acid
- Whole genome sequence of bacterial blight causing most prevalent and virulent isolates of *Xanthomonas axonopodis* pv. *punicae* (Xap-118) *was carried out.*
- Volatile organic compounds (VOCs) profiling of bacterial endophytes and fungal bioagents using GC-MS
- Antagonistic activity of fungal bioagents against root knot nematode were studied

Post-Harvest Technology:

- The protocol for preparation of muffins incorporated with 8% pomegranate peel powder (PPP) was standardized.
- Protocol developed for preparation of pomegranate-karonda mixed fruit jam.
- Methodology standardized for preparation of pomegranate squash blended with muskmelon.

Others activities

- The Centre has taken up promotion of pomegranate cultivation in the states of Maharashtra, Rajasthan, Chhattisgarh, Madhya Pradesh through SCSP, TSP and Mera Gaon Mera Gaurav through demonstration, supplying inputs, providing Soil Health Card, imparting trainings and technical guidance benefitting around 915 farmers.
- ICAR-NRCP commercialized three technologies to entrepreneurs and displayed its activity in five exhibitions and more than 1790 visitors including farmers, students and other stakeholders visited the center for information.

- Various institutional activities were undertaken under Swachch Bharat Abhiyan, International Women's Day, Farmers' Day etc.
- The Centre also organized workshops and training programmes for farmers and various stakeholders involved in pomegranate cultivation. Apart from this, various interactive meetings were conducted in collaboration with different organizations to disseminate the ICAR-NRCP technologies to different stake holders.
- The Centre has published 21 research papers in peer reviewed journals (10 in > 10 NAAS rating), 3 books, 12 book chapters, 29 popular articles, besides 16 presentations in conferences and 4 poster presentations and 2 patent granted.
- Scientists of the centre got recognitions from professional Societies viz., Awards/ Fellowships, besides best oral / poster presentation awards.

Research Programmes & Projects

INSTITUTE RESEARCH PROJECTS ONGOING

S. No.	Project title	PI	Co-PIs	Duration DoS-DoE
1.	Breeding for bacterial blight resistance in pomegranate	Dr. Shilpa P.	Dr. Jyotsana Sharma Dr. K. Dhinesh Babu Dr. Prakash G Patil Dr. NV Singh Dr. P Roopa Sowjanya	01/08/2019-31/07/2024
2.	Draft genome sequencing of Pomegranate (*Punica granatum* L.) cv. Bhagwa	Dr. Roopa Sowjanya P.	Dr. Shilpa P. Dr. N.V. Singh, Dr. Prakash G Patil	21/02/2017-20/01/2023
3.	Development of genetic resources resistant to wilt complex in pomegranate	Dr. P. Roopa Sowjanya	Dr. NV Singh Dr. Manjunatha, N Dr. Somnath Pokhare Dr. Shilpa Parashuram Dr. R.A. Marathe	01/09/2022-31/8/2027
4.	Genetic Mapping of Bacterial Blight and Fruit Quality Traits in Pomegranate	Dr. P. G. Patil	Dr. J. Sharma Dr. Shilpa P. Dr. N. V. Singh Dr. K. Dhinesh Babu	01/01/2018-31/12/2022
5.	Combating stresses and improving quality in pomegranate (*Punica granatum* L.) by exploiting rootstocks	Dr. N.V. Singh	Dr. P. Roopa Sowjanya, Dr. Prakash G Patil Dr. Manjunatha N., Dr. K. Dhinesh Babu Dr. Somnath Pokhare, Dr. Chandrakant Awachare, Dr. R.A. Marathe	20/08/2020-19/08/2025
6.	Crop regulation practices for improving productivity of pomegranate	Dr. K. Dhinesh Babu	Dr, N.V. Singh Dr A. Maity Dr J. Sharma	01/04/2018-31/12/2023
7.	Package of practices for organic cultivation of pomegranate	Dr. A. Maity	Dr. J. Sharma Dr. Gaikwad N.N. Dr. Mallikarjun, H.	01/08/2018-31/07/2024
8.	Post-harvest management and value addition in pomegranate for Entrepreneurship development	Dr. Gaikwad N.N.	Dr. Namrata Giri Dr. K. Dhinesh Babu, Dr. Ashis Maity,	01/07/2019-30/06/2024
9.	Development of Functional food products and waste utilization from pomegranate	Dr. Namrata A Giri	Dr. Nilesh N. Gaikwad Dr. Manjunatha N. Dr. Pinky Raigond	20/08/2020-31/07/2025

S. No.	Project title	PI	Co-PIs	Duration DoS-DoE
10.	Development of technologies for sustainable management of important insect pest of pomegranate	Dr. Mallikarjun	Dr. Manjunatha N Dr. Somnath S. Pokhare Dr. R.A. Marathe	01/09/2020-31/08/2025
11.	Studies on wilt complex in Pomegranate	Dr. Somnath Pokhare	Dr. Manjunatha.N Dr.Mallikarjun M.H. Dr.R A Marathe	01/01/2021-31/12/2026
12.	Epidemiology and sustainable management of economically important phylloplane diseases of pomegranate	Dr. Manjunatha N.	Dr. Jyotsana Sharma, Dr. Somnath S. Pokhare, Dr. Mallikarjun M H, Dr. Prakash G Patil, Dr. A Maity and Dr. R.A. Marathe	01/01/2021-31/12/2026
13.	Flagship project on Integrated approach to eradicate bacterial blight	Dr. Jyotsana Sharma	Dr. A.Maity Dr. N.V.Singh Dr. Shilpa. P Dr. K. Dhinesh Babu Dr. P.G.Patil Dr. A.Kumar, (IARI) Dr. Manjunatha N Dr. R.K.Mestha (UHSB)	01/10/2014-31/12/2023
14.	Biotic stress induced biochemical and epigenetic changes associated with major insect pest and diseases in diverse pomegranate (Punica granatum L.) genotypes.	Mr. Rahul Damale	Dr. N. V Singh Dr. K. Dhinesh Babu Dr. Shilpa Parshuram Dr. Manjunath N. Dr. Mallikarjun Harsur Dr. R.A. Marathe	01/06/2021-31-05/2026
15.	Canopy architecture management and high density planting in pomegranate	Mr. Chandrakant Awachare	Dr. N.V. Singh Dr. R.A. Marathe Dr. K. Dhinesh Babu Dr. Pinky Raigond	01/01/2022-31/12/2025
16.	Fertigation Scheduling of major nutrient with reference to crop-soil environment in pomegranate cv.Bhagwa	Dr. P.S.Shirgure	Dr. K.D. Babu Dr. Manjunath N Dr. Mallikarjun H	01/09/2022-31/08/2026

INSTITUTE RESEARCH PROJECTS COMPLETED

S. No.	Project title	PI	Co-PIs	Status	Duration DoS-DoE
1.	Genetic Mapping of Bacterial Blight and Fruit Quality Traits in Pomegranate	Dr. P. G. Patil	Dr. J. Sharma Dr. Shilpa P. Dr. N. V. Singh Dr. K. D. Babu	Completed	01/01/2018-31/12/2022

INTER-INSTITUTIONAL COLLABORATIVE PROJECTS ONGOING

S. No.	Project title	Collaborative Institute	PI	Co-PIs	Duration DoS-DoE
1.	Delineation of potential areas for pomegranate cultivation in India using remote sensing and GIS techniques	ICAR-NBSS&LUP Nagpur	-	Dr. J. Sharma Dr. A. Maity	(2014 -15) to ongoing
2.	Unraveling the mechanism and developing mitigation strategies for aril browning and fruit cracking in pomegranate	ICAR-NIASM, Baramati	Dr. Pinky Raigond	Dr. N.V. Singh, Dr. Shilpa Parashuram, Dr. K. Dhinesh Babu, Dr. Ashis Maity and Dr. R.A. Marathe, Mr. Rahul Damale, Dr. Namrata Giri	(01/02/2019-31/12/2024)
3.	Valorization of fruit and vegetable wastes for aquafeed	ICAR - Central Institute of Fisheries Education, Mumbai, Maharashtra	Dr. Shamna N.	Parimal Sardar, Ashutosh D. Deo, Manish Jayant, Subodh Gupta, Md. Aklakur, Babitha Rani A.M, Manjusha L, Jeena K, Namrata A. Giri	(2022-2025)

TRIBAL SUB-PLAN ONGOING

S. No.	Project title	Chairman	Committee Members
1.	Schedule Tribe Component	Chairman Dr. Mallikarjun Harsur	Member Secretary: Mr. Rahul Devidas Damale Member: Dr. Shilpa P.

TRIBAL SUB-PLAN COMPLETED

S. No.	Project title	Chairman	Committee Members
1.	Promotion of pomegranate cultivation in tribal areas of M.P. and Chhattisgarh in collaboration with SRIJAN, India	Dr. N.V. Singh	-

S. No.	Project title	Chairman	Committee Members
2.	Tribal Sub-Plan of ICAR-NRCP, Solapur	Dr. Somnath S. Pokhare	Dr. Namrata Giri & Mr. Rahul Damale, Dr. Nilesh Gaikwad

SCHEDULED CASTES SUB-PLAN

S. No.	Project title	Chairman	Committee Members
1.	Promotion of pomegranate cultivation among SC farmers in Tikamgarh, M.P. and Kalaburgi, Karnataka	Dr. N.V. Singh (till June 2022)	Dr. Shilpa Parashuram and Dr. Roopa Sowjanya
2.	Supporting SC farmers of Kalaburgi, Karnataka through training and agri-input distribution	Dr. N.V. Singh (till June 2022)	Dr. Shilpa P. Dr. Roopa Sowjanya P. Mr. Yuvraj Shinde Mr. Mahadev Gogaon
3.	Supporting SC farmers of Kalaburgi, Karnataka through training and agri-input distribution	Dr. Pinky Raigond' below this (June 2022 onwards)	Dr. Shilpa P. Dr. Chandrakant Awachare Dr. Mallikarjun Mr. Mahadev Gogaon

EXTERNALLY FUNDED PROJECTS ONGOING

S. No	Funding agency	Project	PI	Co-PIs	Duration DoS-DoE & Amount (Lakh)
1.	ICAR	ICAR-All India Coordinated Research Project on Arid Zone Fruits	Dr. K. Dhinesh Babu	Dr. N.V. Singh Dr. Mallikarjun	01/04/2012
2.	PPV&FRA, New Delhi	Establishment of DUS centre at ICAR-NRCP, Solapur	Dr. Shilpa P.	Dr. P .Roopa Sowjanya	13/10/2011 to still continuing
3.	RKVY, DAC, GoI	Horticulture Crop Pest Surveillance and Advisory Project for Mango, Pomegranate & Banana	Dr. Jyotsana Sharma	Dr. Mallikarjun	01/04/2015 to ongoing
4.	DST - SERB, GOI	Genome wide association mapping in Pomegranate to identify novel genes	Dr. P .Roopa Sowjanya	Dr. NV Singh, Dr. Manjunatha N, Dr. Shilpa Parashuram	24/08/2022 - 23/08/2025
5.	DAE – BRNS, GOI	Induced Mutagenesis in pomegranate for biotic stress resistance	Dr. P. Roopa Sowjanya	Dr. Suvendu Madal, BARC (Program Collaborator)	01/06/2022-31/03/2025
6.	ICAR	National Agriculture innovation Fund	Dr. Nilesh N. Gaikwad	-	01/04/2008-continuing (8.30)

CONTRACTUAL RESEARCH PROJECTS ONGOING

S. No	Funding agency	Project	PI	Co-PIs	Duration DoS-DoE & Amount (Lakh)
1.	UPL Pvt Ltd.	Bio-efficacy evaluation of fungicides AVANCER GLOW (Azoxystrobin 8.3% + Mancozeb 66.7% WG) and CUPROFIX DISPERSS (Copper sulphate 47.15%+Mancozeb 30% WG) against disease complex of pomegranate	Dr Manjunatha N	Dr. Jyotsana Sharma, Dr. Somnath S. Pokhare, Mr. Vijay Lokhande	01/06/ 2021 to 31/08/ 2023
2.	Bayer Crop Science Limited	Efficacy and crop safety evaluation of Glyphosate IPA salt 41% w/wsl in pomegranate	Dr. N.V. Singh	Dr. R. A. Marathe, Director Mr. Mahadev Gogaon	01/08/2021-31/07/2023
3.	Fertis India Pvt Ltd	Bio-efficacy of Ecolaid freedom microbicide on bacterial blight of pomegranate	Dr Manjunatha N	Dr. Jyotsana Sharma, Dr R.A. Marathe, Mr. Vijay Lokhande	01/06/2021 to 31/08/ 2023
4.	DuPont-Corteva Ltd	Efficacy of Q8U80 500SC for the management of root knot nematode on Pomegranate	Dr. Somnath S. Pokhare	Dr. Mallikarjun H. & Dr. Manjunatha N.	29/12/2020-30/06/2023
5.	Bayer Crop Science Pvt. Ltd.	Evaluation of Spirotetramat 150 g/L OD for bio-efficacy against thrips in pomegranate	Dr. Mallikarjun M.H	Dr. K. Dhinesh Babu Dr. R. A. Marathe, Director	01/10/2022-30/09/2023 (22.84 Lakh)
6.	RCF Nano Urea (NU)	Title: Evaluation of RCF Nano Urea (NU) using fertigation and foliar techniques on growth, yield and fruit quality of pomegranate	PD: Dr. R. A. Marathe, Director PI: Dr. P.S. Shirgure	Co-PI: Dr. K.Dhinesh Babu	(Oct 2022 to Sept 2024) Budget 29.42

CONTRACTUAL RESEARCH PROJECTS COMPLETED

S. No	Funding agency	Project	PI	Co-PIs	Duration DoS-DoE
1.	M/s. Biostadt India Ltd	To study the effect of biozyme Fruit Plus L on yield and quality parameters	Dr. N.V. Singh	-	1/12/2020 to 30/09/2021
2.	Sirius Minerals India Pvt. Ltd.	Evaluating Poly-4 as multi-nutrients fertil-izer in pomegranate for yield and quality	Dr. Ashis Maity	Dr. Nilesh Gaikwad	01/08/2021-28/02/2023

Research Achievements

1. Crop Improvement

1.1 PROJECT: IDENTIFICATION OF PROMISING HYBRIDS FOR TABLE AND PROCESSING PURPOSE

Evaluation of 9 NRCP hybrids during eighth year of planting led to the identification of one promising pomegranate hybrid NRCP H-14 for table purpose.

Evaluation of sweet type NRCP hybrids for yield and quality parameters

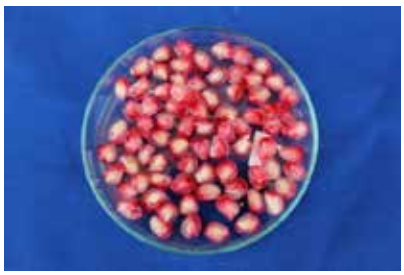
Hybrid	No. of Fruits/ Tree	Fruit Weight (g)	Fruit Yield (kg/Tree)	100 Aril Weight	Rind thickness	TSS (°B)	Acidity (%)
NRCP H-2	101.4	285.4	28.8	29.6	3.16	16.4	0.52
NRCP H-5	115.2	278.5	29.2	30.6	2.80	16.0	0.45
NRCP H-6	135.0	276.0	37.3	40.0	3.25	17.6	0.40
NRCP H-8	108.6	288.2	31.1	36.4	3.72	17.8	0.72
NRCP H-10	120.4	275.2	33.0	30.5	2.78	16.3	0.45
NRCP H-14	125.2	280.4	35.1	32.7	2.76	17.8	0.41
NRCP H-19	103.2	265.8	27.3	30.4	2.70	15.2	0.60
NRCP H-22	118.4	275.5	32.4	35.8	3.20	16.3	0.46
NRCP H-24	126.2	276.5	34.8	36.9	3.22	16.9	0.40
Bhagawa (Check var.)	90.4	284.0	25.7	35.6	3.20	15.6	0.45

The salient character of NRCP H-14 is mentioned below.

The salient features of pomegranate hybrid NRCP H-14 as compared to Bhagawa

Parameter	NRCP H-14	Bhagawa
Maturity (days)	165.0	180.2
No. of fruits/plant	125.2	90.4
Fruit weight (g)	280.4	284.0
Fruit yield (kg/plant)	35.1	25.7
100 Aril weight (g)	32.7	35.6
TSS (°Brix)	17.8	15.7
Titrable acidity (%)	0.41	0.43
Vitamin C (mg/100g)	19.0	14.0
Anthocyanin (mg/100g)	127.6	352.4





NRCP H-14

Pomegranate hybrid NRCP H-14

Evaluation of 16 NRCP hybrids during eighth year of planting led to the identification of NRCP H-4 for anardana purpose.

Evaluation of sour type NRCP hybrids for yield and quality parameters

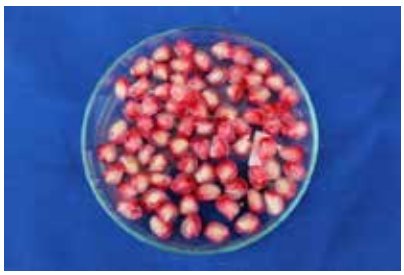
Hybrid	No. of Fruits / Tree	Fruit Weight (g)	Fruit Yield (kg/ Tree)	100 Aril Weight	Rind thickness	TSS (°B)	Acidity (%)
NRCP H-1	105.2	280.2	29.4	34.8	3.90	17.5	3.58
NRCP H-3	145.2	262.5	38.1	33.2	3.30	17.2	3.12
NRCP H-4	120.4	278.2	33.5	31.6	2.96	15.9	5.80
NRCP H-7	112.4	258.4	28.9	41.3	2.98	16.8	1.10
NRCP H-9	115.2	270.4	31.1	36.7	3.81	16.0	2.70
NRCP H-11	105.0	273.4	28.7	30.9	3.11	15.6	4.30
NRCP H-12	114.2	276.0	31.5	41.0	3.10	16.8	4.80
NRCP H-13	109.0	274.3	29.9	41.5	3.55	17.9	2.10
NRCP H-15	110.0	281.4	35.1	36.8	2.84	15.8	3.58
NRCP H-16	120.6	273.2	32.8	35.8	3.13	15.9	2.36
NRCP H-17	116.0	262.4	30.4	37.0	2.96	16.6	2.30
NRCP H-18	111.8	288.1	32.0	42.0	2.84	17.4	2.88
NRCP H-20	104.4	270.2	28.1	33.2	3.36	16.4	1.60
NRCP H-21	122.2	269.4	32.8	33.6	3.12	16.4	3.36
NRCP H-23	130.0	268.2	34.8	33.4	3.14	16.6	3.44
NRCP H-25	127.0	279.0	35.4	34.2	3.16	16.7	3.50
Amlidana (Check var.)	68.6	232.3	15.9	36.8	2.80	15.8	4.28

The salient characters of pomegranate hybrid NRCP H-4 as compared to Amlidana

Parameter	NRCP H-4	Amlidana
Maturity (days)	140.4	145.2
No. of fruits/plant	120.4	68.6
Fruit weight (g)	278.2	232.3

Parameter	NRCP H-4	Amlidana
Fruit yield (kg/plant)	33.5	15.9
100 aril weight (g)	31.6	36.8
TSS (^{0}Brix)	16.0	15.8
Titrable acidity (%)	5.80	4.28
Vitamin C (mg/100g)	18.9	14.6
Anthocyanin (mg/100g)	65.8	68.5





NRCP H-4

Pomegranate hybrid NRCP H-4

Identification and characterization of early maturing genotypes for escaping BBD in pomegranate

Second year evaluation of identified new "Bhagawa" clonal variant was carried out. Statistical analysis of two years mean data using two sample T-test showed significant difference for aril %, rind thickness (mm), aril width (mm), fruit juiciness % (V/W), fruit colour (a*, b*) and fruit maturity (days after anthesis) characters as compared to check. Among these, the most distinct characters are rind thickness and fruit maturity. In the identified variant, the fruit rind is thinner (2.05mm) and fruit matures in about 138-148 days in comparison to check variety 'Bhagawa' which is having medium thick rind (3.95mm) and matures in about 177-187 days. This variant is also having attractive fruit weight (266g); 100 aril weight (31.36g); aril length (11.19mm); aril width (7.22mm) and fruit juiciness (45.48%) in comparison to Bhagawa (280g; 30.71g; 10.60mm; 6.42mm and 34.65%).

Mean fruit characteristic features of identified variant and check variety 'Bhagawa'

Characters	New Variant					Bhagawa					
	Mean	Range	SD	SEm	CV%	Mean	Range	SD	SEm	CV%	T - Statistic
Fruit weight (g)	266.6	231.0-310.0	27.2	11.1	10.2	280.5	238.9-334.0	39.4	16.1	14.0	-0.71
Fruit length (mm)	78.2	70.7-84.8	6.32	2.58	8.08	82.0	75.58-89.4	5.96	2.43	7.26	-1.08
Fruit diameter (mm)	79.7	75.2-88.9	4.78	1.95	6.00	81.4	75.07-91.6	6.62	2.70	8.14	-0.51
Crown length (mm)	19.0	17.5-21.8	1.60	0.65	8.40	20.4	18.39-25.2	2.46	1.00	12.0	-1.20
No of arils/fruit	565.7	447.2-727.0	93.6	38.2	16.5	575.9	440.76-662.4	82.9	33.9	14.4	-0.20
Aril %	64.0	62.0-65.7	1.54	0.63	2.40	53.7	47.62-59.0	4.51	1.84	8.39	**5.32****
100 Arial weight (g)	31.4	27.6-34.1	2.51	1.03	8.01	30.7	23.54-37.7	6.91	2.82	22.5	0.22
Rind thickness (mm)	2.0	1.58-2.43	0.30	0.12	14.5	3.95	3.20-5.11	0.67	0.27	16.9	**-6.38****
TSS (^{0}Brix)	14.9	14.0-16.0	0.67	0.27	4.52	15.0	14.5-15.5	0.36	0.15	2.42	-0.36

Characters	New Variant					Bhagawa					
	Mean	Range	SD	SEm	CV%	Mean	Range	SD	SEm	CV%	T - Statistic
Acidity %	0.34	0.27-0.37	0.04	0.02	12.9	0.36	0.24-0.50	0.12	0.05	32.4	-0.56
Aril length (mm)	11.2	9.88-11.8	0.67	0.27	6.00	10.6	9.79-11.4	0.81	0.33	7.60	1.38
Aril width (mm)	7.20	6.92-7.67	0.25	0.10	3.46	6.42	5.86-7.40	0.59	0.24	9.13	**3.07***
Fruit juiciness % (V/W)	45.5	37.6-48.5	4.02	1.64	8.85	34.6	31.6-36.6	1.78	0.73	5.15	**6.03****
Fruit colour L*	55.7	52.0-58.9	3.10	1.27	5.57	50.2	43.3-57.0	5.56	2.27	11.0	2.09
Fruit colour a*	34.3	31.8-37.3	1.96	0.80	5.72	39.0	35.0-43.0	3.07	1.25	7.88	**-3.17***
Fruit colour b*	31.9	29.5-35.1	2.42	0.99	7.59	24.8	21.6-26.7	1.82	0.74	7.35	**5.72****
Aril colour L*	36.7	26.1-49.4	10.8	4.43	29.5	31.0	19.7-43.1	11.5	4.71	37.2	0.89
Aril colour a*	22.6	14.3-27.7	5.20	2.12	23.0	28.1	23.3-32.8	3.82	1.56	13.6	-2.08
Aril colour b*	15.7	11.7-21.2	4.13	1.69	26.2	14.7	10.3-18.5	4.04	1.65	27.4	0.42
Seed weight (g)	1.51	1.38-1.60	0.10	0.04	6.38	1.56	1.46-1.70	0.11	0.04	6.91	-0.88
Seed length (mm)	6.99	6.89-7.06	0.06	0.03	0.92	7.05	6.70-7.35	0.25	0.10	3.53	-0.59
Seed width (mm)	2.77	2.67-2.93	0.10	0.04	3.68	2.68	2.55-2.87	0.12	0.05	4.33	1.51
Seed texture (N)	38.0	33.9-44.9	3.96	1.62	10.4	36.7	30.9-40.6	4.26	1.74	11.6	0.57
Fruit maturity (days after anthesis)	143.0	138.0-148.0	4.47	1.83	3.13	181.3	177.0-187.0	4.59	1.87	2.53	**-14.6****

New Variant

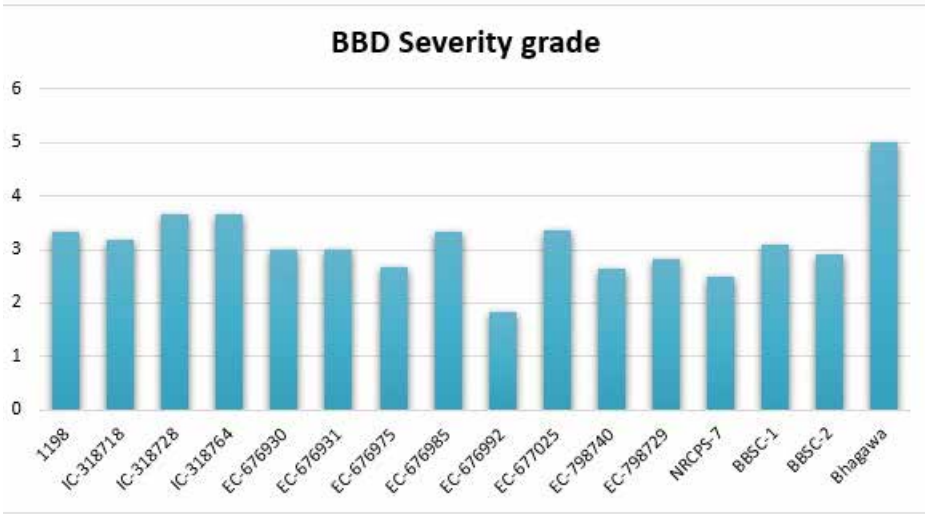
Bhagawa

Distinctness between the selected new variant and check variety "Bhagawa" for rind thickness character

1.2 PROJECT: BREEDING FOR BACTERIAL BLIGHT RESISTANCE IN POMEGRANATE (*Punica granatum* L.)

Screening of exotic and indigenous germplasm accessions against bacterial blight disease (BBD)

Fifteen accessions including four wild, eight exotic and three breeding lines were screened against BBD to know their genetic reaction to bacterial blight disease (XAP-90, 118 culture @ 10^8 pfu/ml; OD: 0.154) under challenge inoculation and compared with the susceptible check variety "Bhagawa". One germplasm (EC-676992) was found moderately resistant (SG: ≤2) and 7 genotypes (EC-798740; EC-676975; EC-798729; EC-676931; EC-676930; NRCS-7 and BBSC-2, SG: ≤3) as moderately susceptible in comparison to standard check variety 'Bhagawa' (SG: 5).

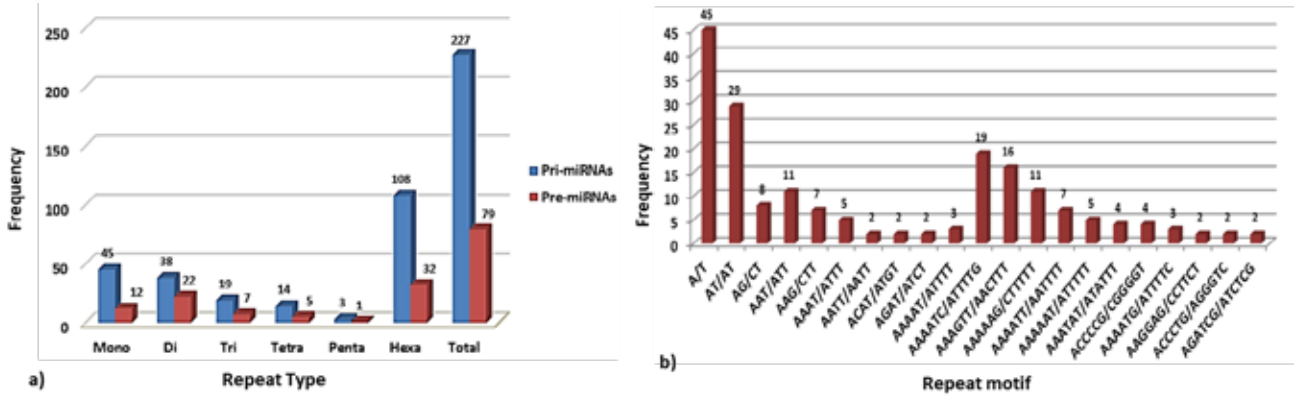


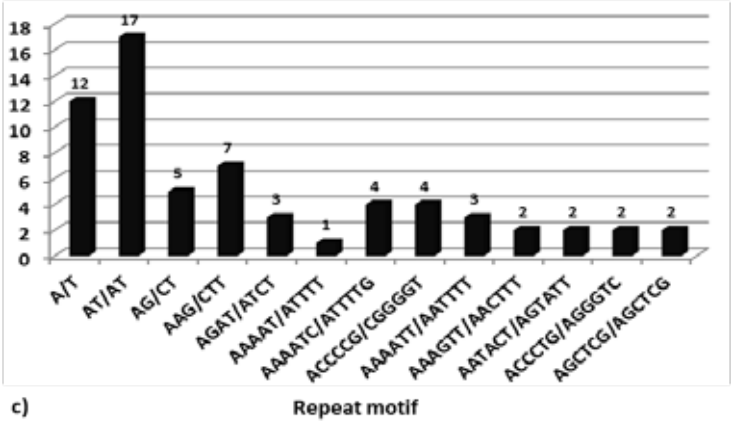
Screening of exotic and indigenous germplasm accessions against BBD

1.3 PROJECT: GENETIC MAPPING OF BACTERIAL BLIGHT AND FRUIT QUALITY TRAITS IN POMEGRANATE

Identification of five candidate miRNA-SSR markers putatively linked to seed hardness trait

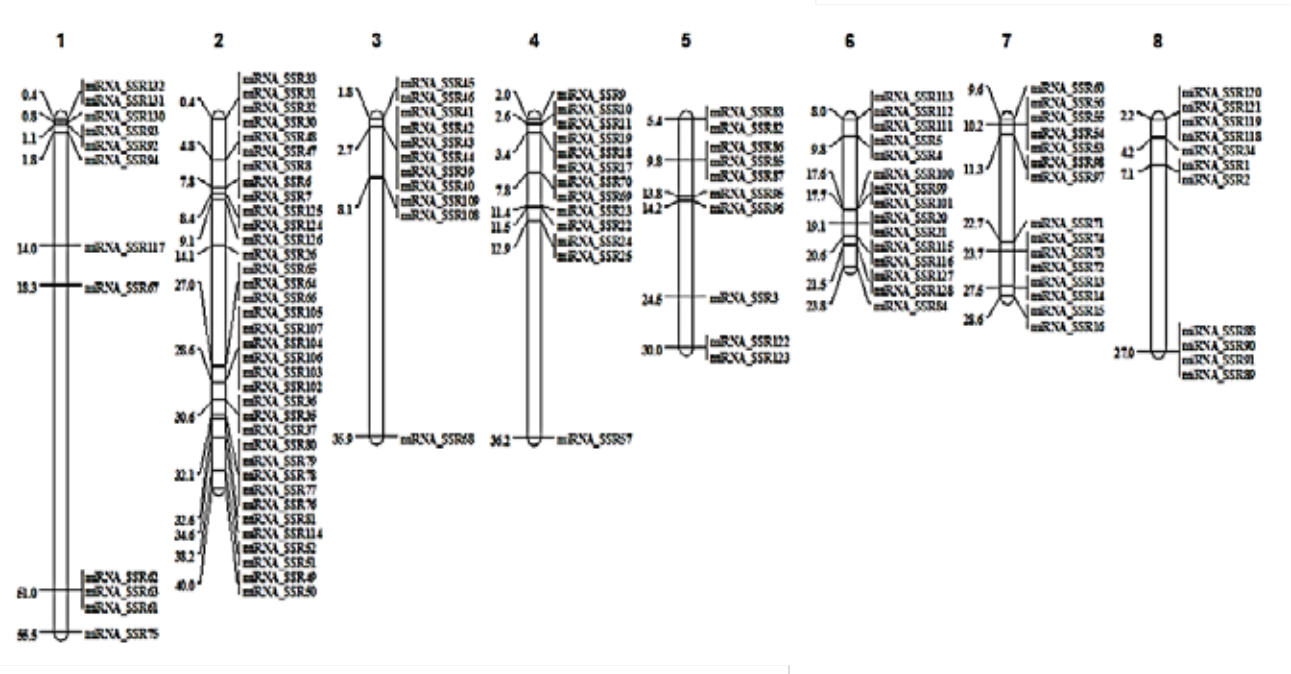
Total 761 potential precursor miRNA sequences which are reported to be expressed during seed maturation in pomegranate were retrieved. SSR mining and BLASTx of analysis of these sequences resulted in identification of 69 non-coding unique sequences for pre-miRNA sequences, which were then searched for BLASTn homology against Dabenzi genome. Sixty three true pri-miRNA contigs encoding 213 pre-miRNAs were predicted. Analysis of the resulting sequences enabled discovery of SSRs within pri-miRNA (227) and pre-miRNA sequences (79). Concerning the abundance of SSR motifs, hexa-nucleotides were the most pronounced (47.58%), followed by mono- (19.82%) and di-nucleotides (16.74%) in pri-miRNAs. Similar SSR distribution pattern was observed in pre-miRNAs. With respect to repeat motif, pri-miRNAs revealed more abundance of A/T (100%) repeats followed by AT/AT (76.31%), which is also witnessed in pre-miRNA sequences.





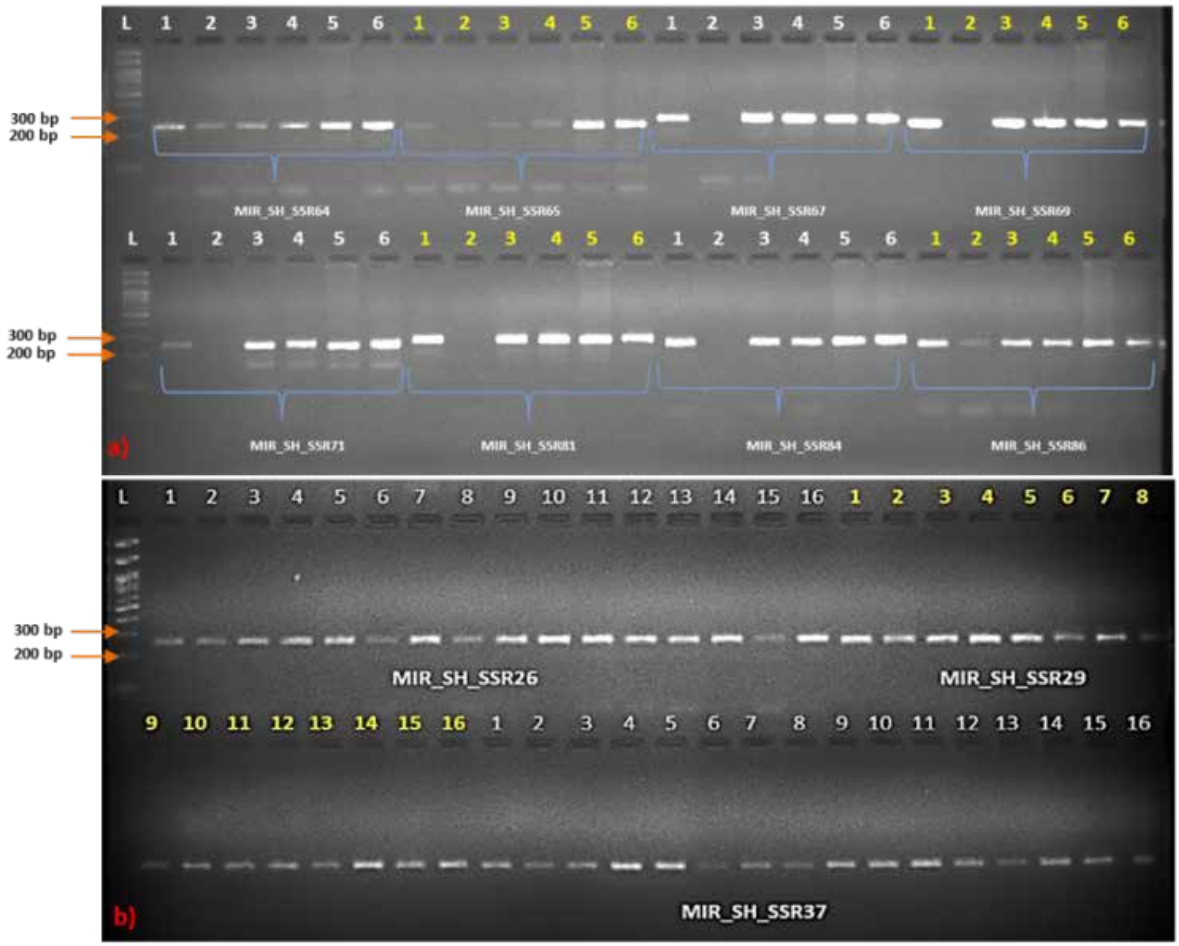
Frequency distribution for SSR repeats in pri- and pre- miRNA sequences of pomegranate genome cv. Dabenzi

A total of 132 miRNA-SSRs were designed for seed type trait from 63 true pri-miRNAs, of which 46 were specific to pre-miRNAs. To assess amplification efficiency, specificity and chromosome locations of the miRNA-SSRs, we performed ePCR or e-mapping of SSRs on the eight chromosomes of Tunisia genome. As a result, 123 of 132 SSRs were successfully got validated across eight chromosomes, producing alleles of single, two, three or more than three alleles in the Tunisia genome. Physical locations of miRNA-SSRs were visualized on eight chromosomes. A total of 123 markers were mapped onto individual chromosomes of Tunisia, of which Chm_2 (36 markers), Chm_6 (15) and Chm_7 (15) had the higher number of SSRs, followed by Chm_4 (13), Chm_1 (12), Chm_3 (11), Chm_8 (11) and Chm_5 (10) respectively.



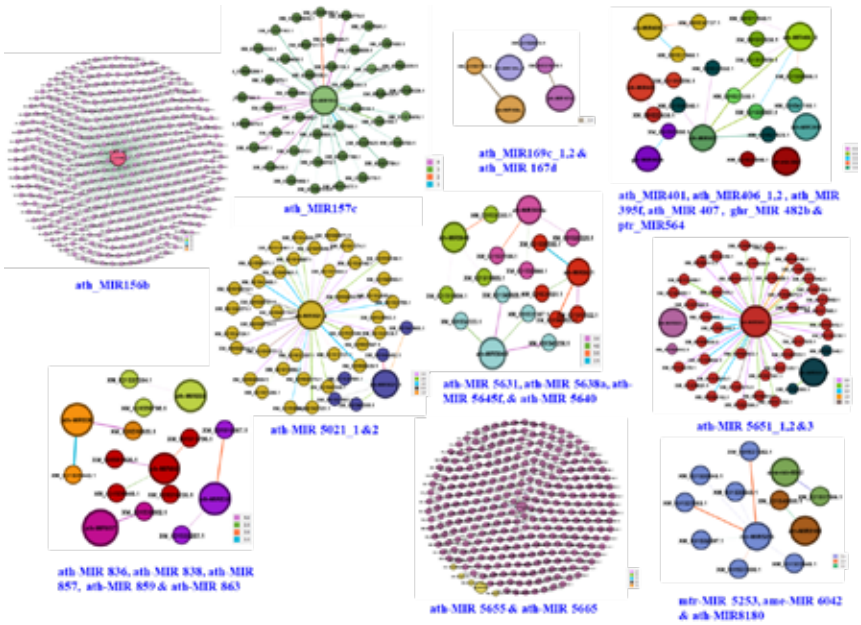
Chromosome specific localization of miRNA-SSRs markers on Tunisia genome

Further, 80 SSRs producing specific amplicons were ePCR-confirmed on multiple genomes *i.e.* Dabenzi, Taishanhong, AG2017 and Tunisia, yielding a set of 63 polymorphic SSRs (polymorphism information content ≥0.5). Of these, 32 miRNA-SSRs revealed higher polymorphism level (89.29%) when assayed on six pomegranate genotypes.



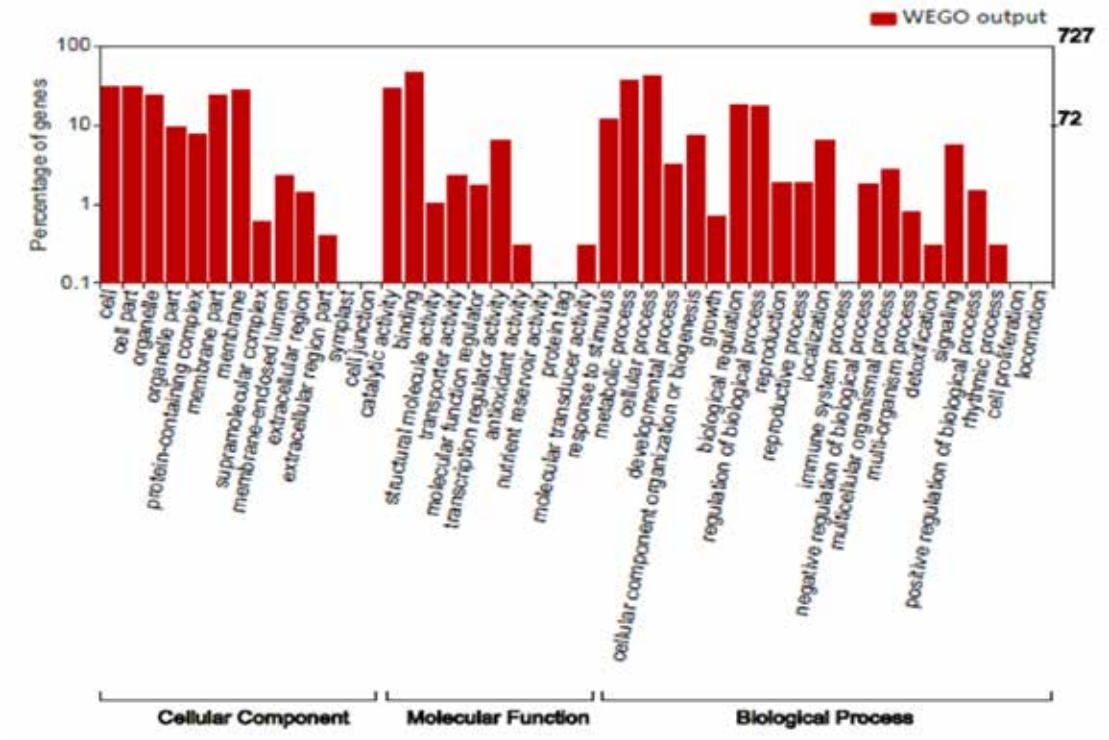
Allelic variations among 16 pomegranate genotypes based on miRNA-SSRs

To assign functional roles to the identified miRNA-SSRs, we carried out target analysis for 44 mature-miRNAs using 21,877 unique gene models from Tunisia genome. This resulted in identification of a total of 2,306 targets, of which 1,935 were found unique targets and 371 as common targets. The predicted targets belonged to 24 miRNA families, with -MIR156b having the highest targets (655), followed by ath-MIR5655 (592), MIR5021_1 and 2 (522), ath-MIR5651_3 (394), ath-MIR157c (43) and ath-MIR5651_1 (39). Further, based on lowest target score (≤4) and highest minimum free energy (Mfe) ratio of hybridization (≥0.7), 2,306 targets were narrowed down to a set of 727 candidate genes, which were negatively regulated by 24 miRNA families. Ten independent networks were obtained for 24 miRNA families targeting 727 candidate genes with lowest target score and highest Mfe.



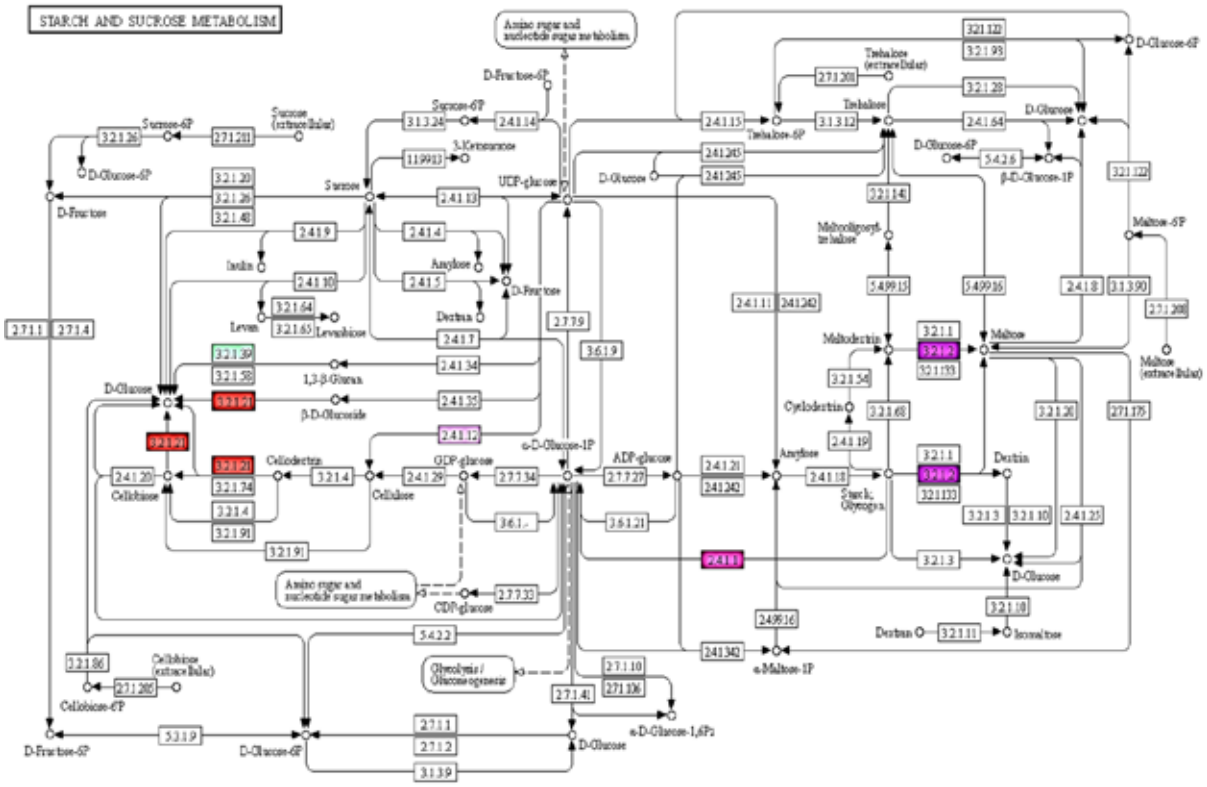
Gene regulatory network for 24 miRNA families based on target analysis

We performed Gene Ontology for 727 top genes targeted by miRNAs to find the potential contributions of these genes during seed development and maturation. The target genes were grouped into three classes: biological process (20 GO terms), molecular function (11 GO terms), and cellular component (13 GO terms).



Distribution of GO terms in the Cellular component, Molecular function and Biological Process category

The KEGG pathway enrichment analysis revealed 95 of 727 targets code for 101 enzymes involved in 58 pathways, with the highest representation from Starch and sucrose metabolism, Glycerophospholipid metabolism, Glycerolipid metabolism, Amino sugar and nucleotide sugar metabolism, Pentose and glucuronate interconversions and so forth. Among these pathways maximum of seven enzymes were part of starch and sucrose metabolism and four enzymes involved in Amino sugar and nucleotide sugar metabolism which is depicted above i.e. ec:3.2.1.39 -endo-1,3- beta-D-glucosidase, ec:2.7.7.27-adenylyltransferase, ec:3.2.1.26-invertase, ec:2.4.1.12 - synthase (UDP-forming), ec:3.2.1.21- gentiobiase, ec:3.2.1.2-saccharogen amylase, ec:2.4.1.1- phosphorylase, ec:1.1.1.22-6-dehydrogenase, ec:3.2.1.55-end alpha-L-arabinofuranosidase,ec:2.4.1.43-4-alphagalacturonosyltransferase suggesting possible role in seed maturation.



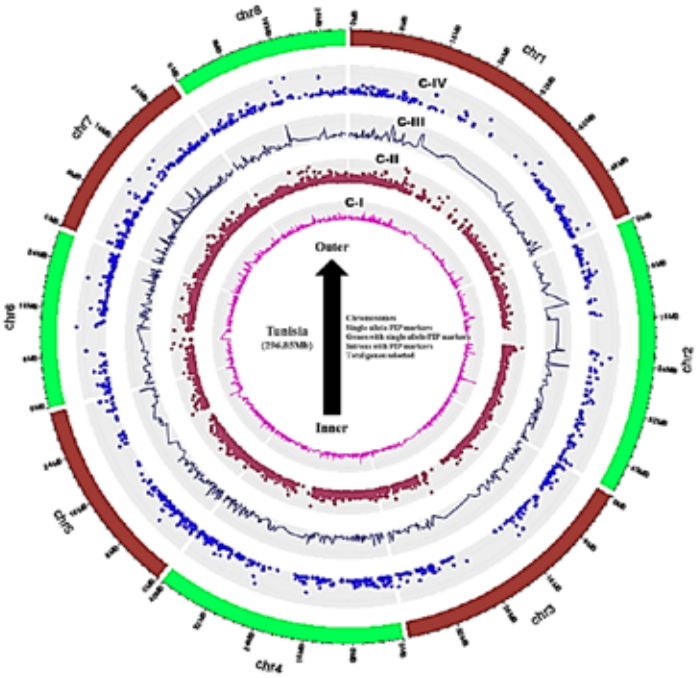
KEGG pathway showing enzymes targeted by miRNAs involved in starch and sucrose, amino sugar and nucleotide metabolism for seed development

Through *in silico* analysis we confirmed that these 24 miRNA families involved in complex regulation of seed maturation since these showed strongest interactions with MYB, auxin response factors, WRKY and NAC, AP2/ERF and B3 domain-containing transcription factors and enzymes mainly involved in cellulose, lignin and sugar metabolism etc. These analysis finally resulted in identification of five informative miRNA-SSRs *i.e.* miRNA_SH_SSR69, miRNA_SH_ SSR36, miRNA_SH_SSR103, miRNA_SH_SSR35 and miRNA_SH_SSR53, which are influencing expression of multiple genes serving as transcription factors, enzymes and transporters involved in seed development and maturation to impart seed type trait (hard/soft).

Large scale development of chromosome specific potential intron polymorphism (PIP) markers for trait mapping

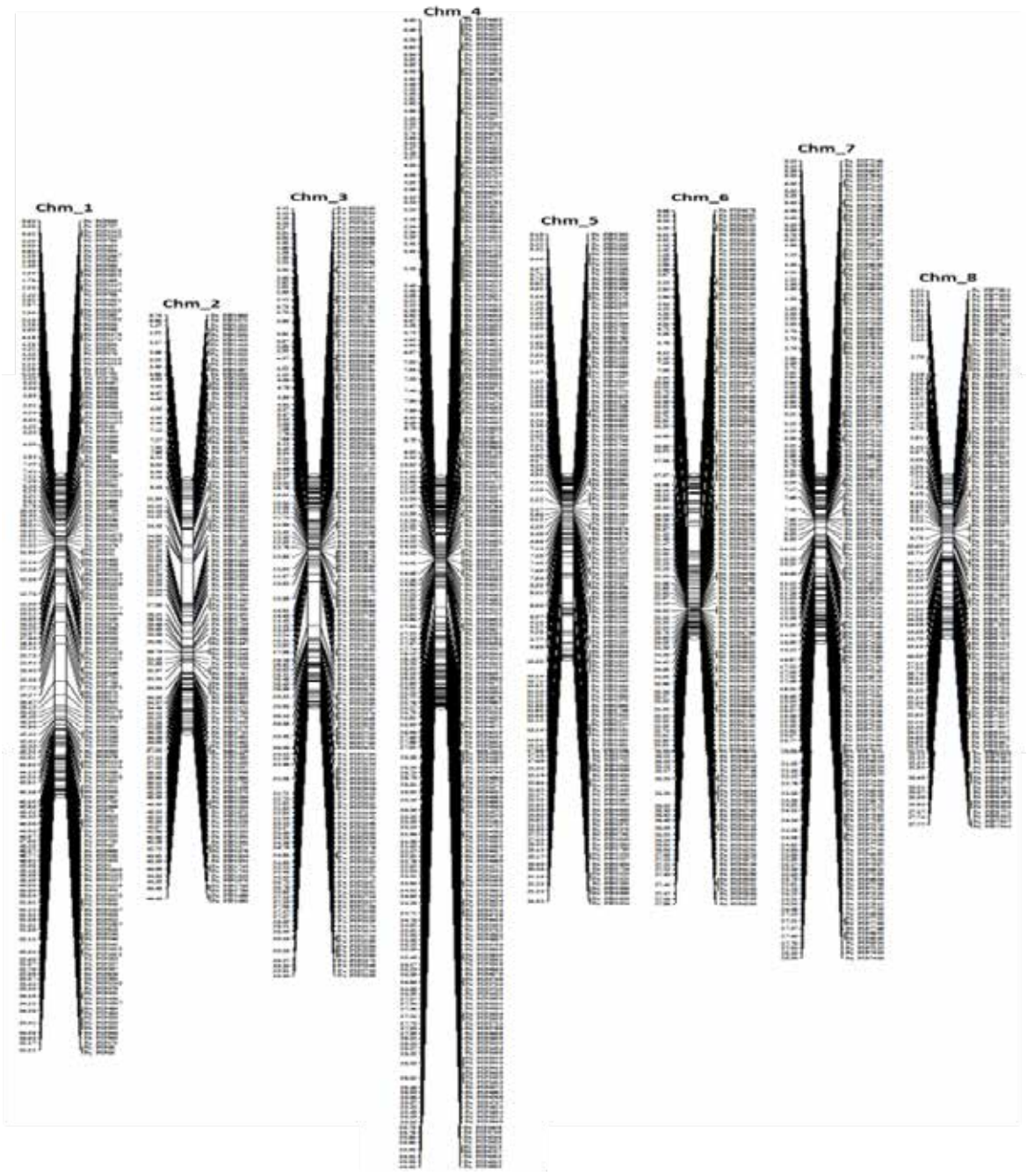
We performed a genome-wide survey of intron length (IL) markers in the 36,524 annotated genes of the Tunisia genome by using Arabidopsis as a reference genome in the PIP database. As a result, 8,812 PIP markers were designed that are specific to 3,445 (13.40%) gene models that span 8 Tunisia chromosomes. The marker density ranged from 22.84 per Mb (Chm_ 1) to 36.60 per Mb (Chm_4 & 6) with an average of 30.76 per Mb. The highest average marker density (36.60/Mb) was recorded for chromosomes 4 and 6, followed by 35.54/Mb and 34.55/Mb for chromosomes 7 and 8, and the lowest (22.84/Mb) was found in chromosome 1.

Further, ePCR mapping of 8,812 PIP markers on Tunisia chromosomes revealed that 7,425 (84.26%) markers were successfully got validated. Frequency distribution analysis of physically mapped PIP markers revealed that markers mapped on chromosome 4 (1,317 markers, 89.7%) were more frequent than those mapped on chromosome 2 (707, 67.05%). Out of 7,425 markers, 1,233 (16.60%) produced single-locus amplification in Tunisia chromosomes corresponding to 958 (27.80%) genes. Further, the overall distribution of PIP markers on 8 Tunisia chromosomes, their positions, intron numbers, and lengths within 3,445 to 958 chosen genes were reduced from the inside to the outer rings as depicted in Circos graph.



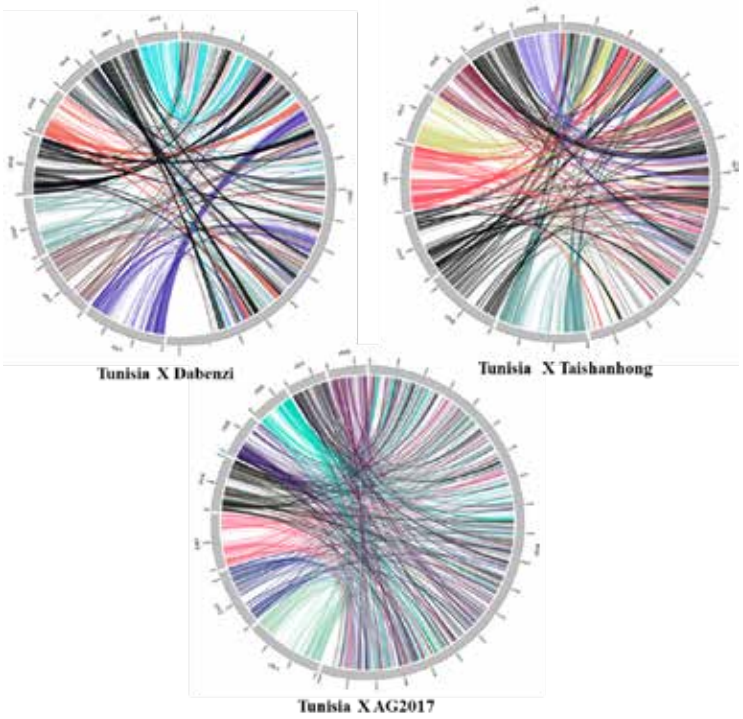
Circos graph depicting the physical location of genes, intron numbers and lengths targeted

On each chromosome, the physical start positions of 1,233 Pg_PIP markers were used to create a high-density PIP marker based physical map. The map revealed that Chm_4 had the highest number of markers (234), followed by Chm_1 (170), Chm_7 (163), and Chm_3 (157). Whereas Chm_8 had the lowest number of markers (110), followed by Chm_2 (120), Chm_5 (137), and Chm_6 (142).



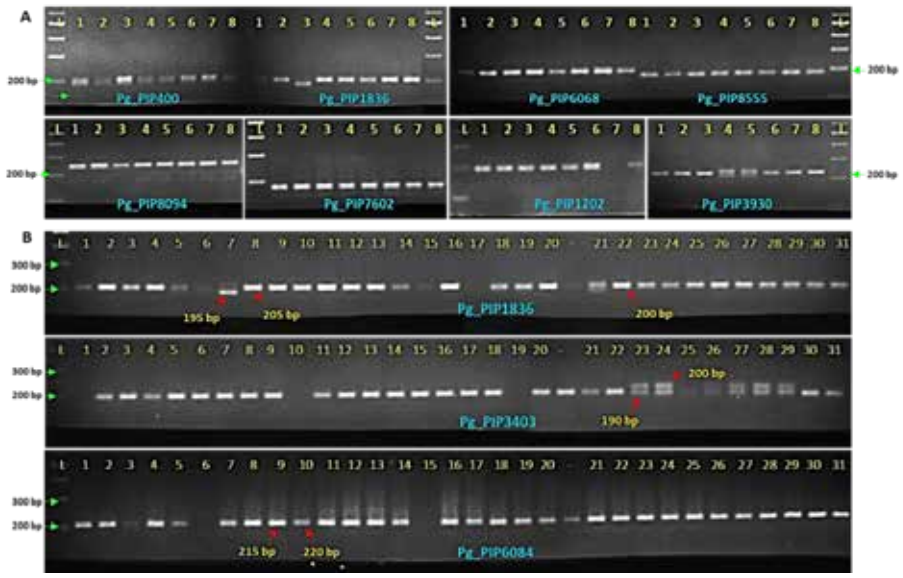
Physical linkage map based on 1233 PIP markers of Tunisia genome

We further showed the utility of the PIP marker-based physical map to facilitate comparative genome mapping in pomegranate. A total of 1,233 physically mapped markers were compared with the three different pomegranate draft genomes. We noticed 98.38% (1,213) to 98.86% (1,219) markers mapped to Dabenzi and Taishanhong genome assemblies, respectively, with lower than 94.97% in AG2017 (1,171) genome. This revealed a considerable proportion of sequence-based orthology and syntenic relationship due to the cross-transferability nature of ILP markers within genera or cross-genera as that of SSR markers. These results also substantiated conserved orthologous genes that are evenly distributed across pomegranate genomes.



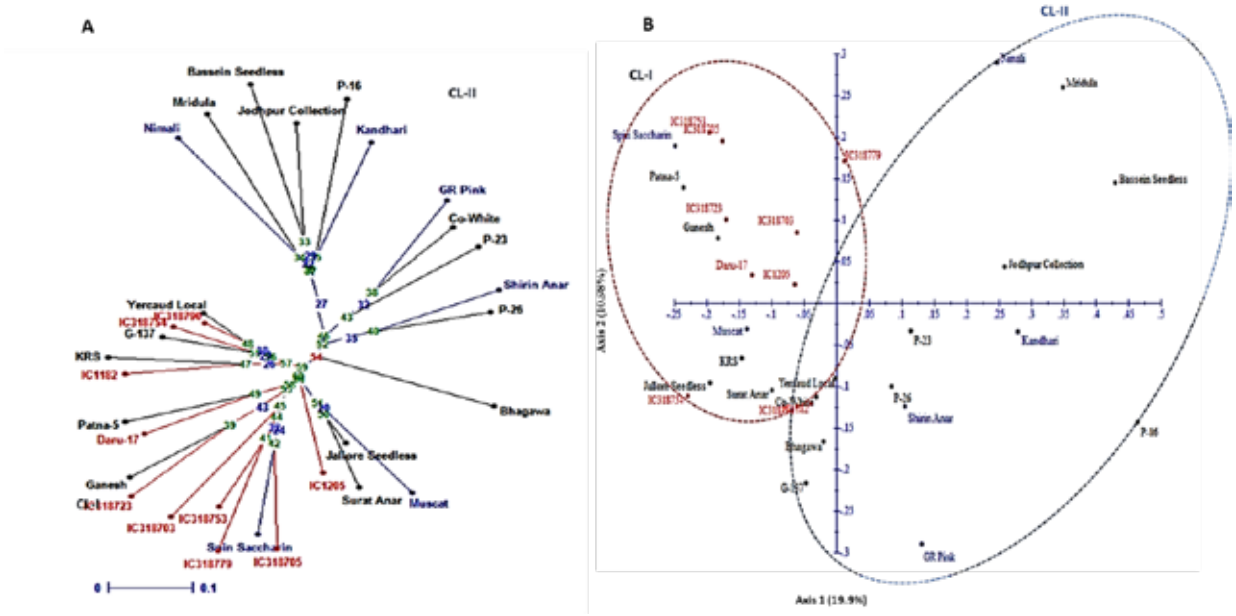
Syntenic relationships between Tunisia in comparison to Dabenzi and Taishanhong genomes based on 1233 PIP markers

For wet-lab validation, we synthesized a set of 100 PIP markers randomly distributed across chromosomes of Tunisia and screened on eight pomegranate genotypes. As a result, 99 (99%) PIP primers could produce gene-specific amplicons in test genotypes. Of these, 76 (76%) PIP markers revealed polymorphisms across eight pomegranate genotypes, 12 were monomorphic, and 11 markers showed amplifications in one to three genotypes but one marker did not show amplification. The representative gel profiles of pomegranate genotypes using selected PIP markers are shown below.



Allelic variations as revealed by PIP markers when assayed on pomegranate genotypes

We demonstrated the potential utility of the developed markers by analyzing the genetic diversity of 31 pomegranate genotypes using 24 PIP markers. The NJ tree based on 24 PIP markers divided 31 genotypes into two separated groups constituting wild and cultivated types. It was interesting to note that cluster 2 was found to be more diverse by including a few introduced exotic pomegranate accessions like Nimali (Srilanka), Kandhari (Afghanistan), GR Pink (Russia), and Shirin Anar (Russia). The PCA plot also grouped 31 genotypes into two major clusters as that of the NJ tree. The PCos 1 accounted for a higher proportion of the variance of 19.9%, separated wild from cultivated genotypes of pomegranate.

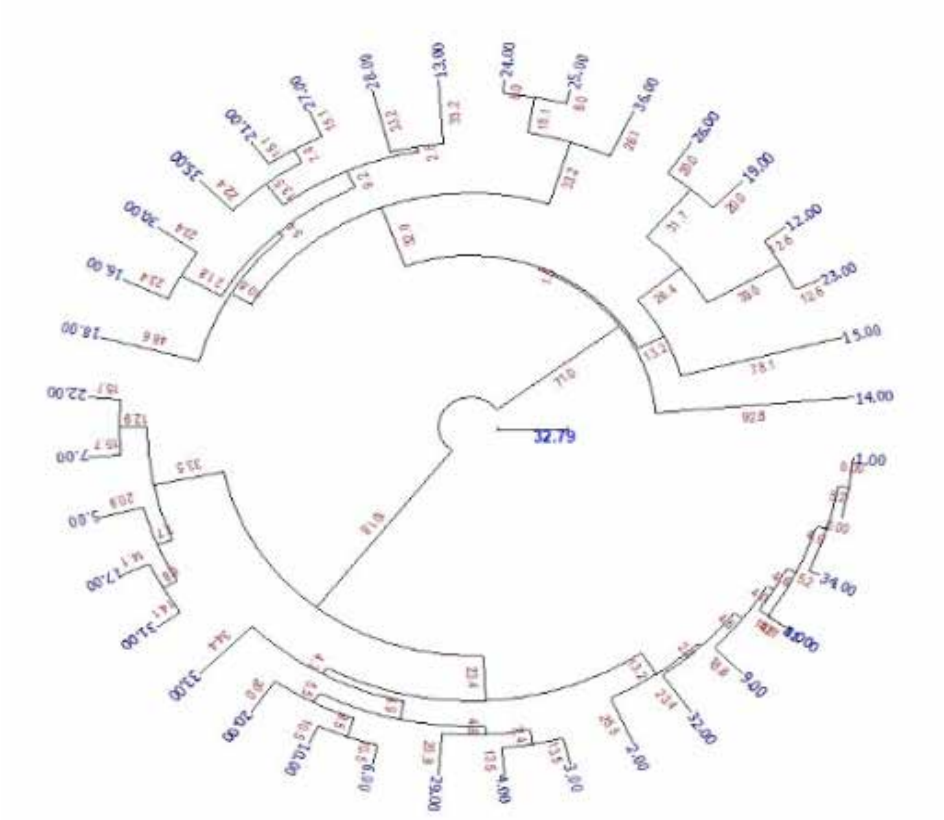


Genetic relationships among 31 pomegranate genotypes based on twenty four PIP markers: (A) Neighbor- joining tree and (B) Principal coordinate analysis

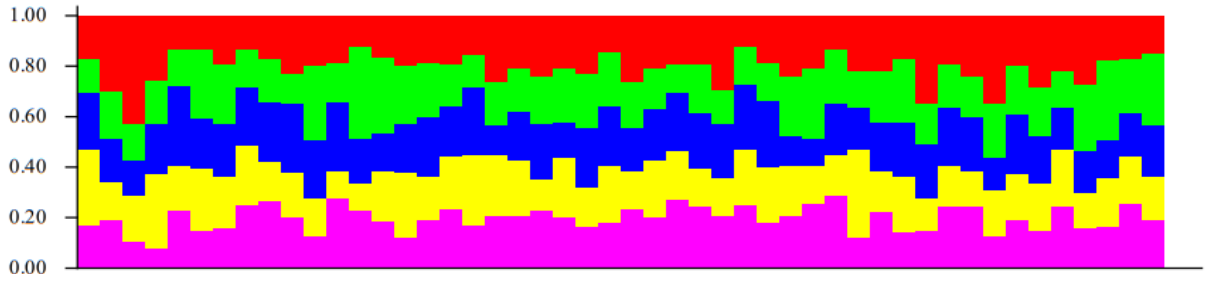
Through this work we reports for the first time large-scale development and validation of gene-based and chromosome-specific PIP markers, which would serve as a rich marker resource for genetic variation studies, functional gene discovery, and genomics-assisted breeding of pomegranate.

1.4 Project: Draft genome sequencing of Pomegranate (*Punica granatum* L.) Cv. Bhagawa

Phenotyping has been carried out for 48 pomegranate germplasm lines which constituted both indigenous and exotic collections. A sub set of 120 SSR markers were screened on these genotypes, of which 35 were found polymorphic. Analysis of Variance (ANOVA) for morphological data indicated statistical significance for genotypes chosen for the study. Analysis of Molecular variance (AMOVA) based on genotypic data also showed statistical significance. Hence, both phenotypic and genotypic data were subjected for marker trait association analysis using GAPPIT package of R software. Population structure analysis was carried out by using STRUCTURE software. From these analysis, we could able to identify few markers which are significantly associated with economically important fruit traits of pomegranate. Hence these markers can be used for pomegranate genetic improvement programmes.



Cluster analysis of 48 germplasm lines based on molecular data



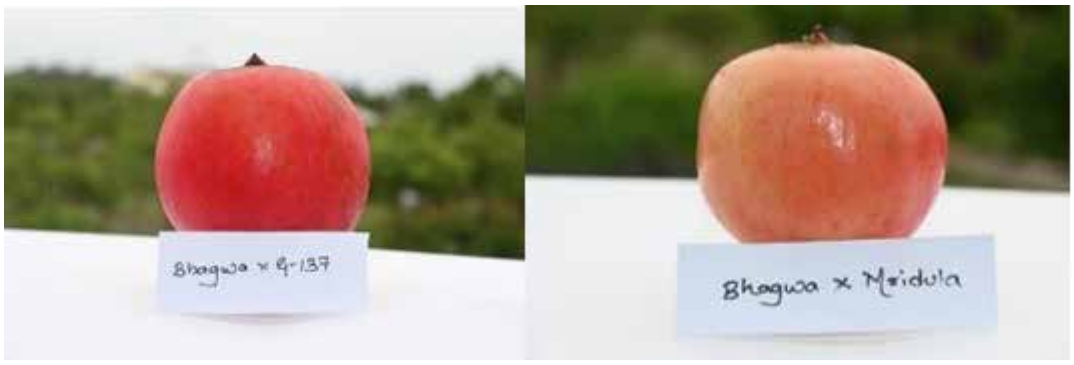
Population structure analysis of the given population based on morphological data (K=5)

Linkage map development

To develop linkage map one should have mapping population. On the mapping population screening of polymorphic marker will be carried and subjected for the linkage analysis. Therefore, linkage map development involves developing mapping population followed by parental screening for polymorphic markers and screening on F_1 population and subjected for statistical analysis.

In order to achieve this, parental polymorphism was carried out and identified 25 polymorphic markers between Bhagawa and 1196. These markers will be screened on F_1 population to construct linkage map. We also generated 16 new hybrid populations for developing the mapping populations to map important horticultural traits.

B5 - Crossing block and the fruiting setting in the crossed lines



F_1/Hybrid fruits of newly generated crosses

1.5 PROJECT: DEVELOPMENT OF GENETIC RESOURCES RESISTANT TO WILT COMPLEX IN POMEGRANATE

In order to identify resistant donors for wilt resistance, fifty pomegranate germplasm lines were multiplied to screen against ***Certocystis fimbrata, Meldiogyna incongnita*** and ***Fusarium sp.***

A new technique for propagation and heterosis fixing in Pomegranate

Soil free method of propagating and fixing heterosis can be achieved through hydroponics. Hydroponics is the technique of growing plants using a water based nutrient solution rather than soil. In general pomegranate propagation is carried out by hardwood cutting, air-layering and tissue culture. The media used for hardwood cutting and air layering is through soil substrate like cocopeat or a mixture of soil, FYM, sand, in case of tissue culture a special composed media consisting of nutrients, amino acids, vitamins, hormones is used in semi solid condition.

In this experiment the pomegranate cuttings in soil less conditions i.e. hydroponics was tested. A total of 15 cuttings of pomegranate with pencil sized thickness having 2 nodes and about 10 cm height, treated with IBA (2gm/litre) and placed in a thermocol sheet to act as holding material for the cuttings in liquid phase media. Total setup was kept in a desiccator to provide controlled

conditions. Leaf initiation was observed on 5th day and on 10th day we found callus formation in the bottom of the cutting, which further resulted in the formation of roots. In hardwood cuttings the number of days required for leaf initiation is 7-8 days. Rooting will be induced after 30 days of planting. Hence this technique will reduce the time of propagation. The large scale production/ multiplication through hydroponics is under standardization, once it gets standardized surely it will help the farming community in reducing the cost and time involved in propagation.

Propagation of pomegranate cuttings in the soil less condition

2. Plant Propagation

2.1 Project: Combating stresses and improving quality in pomegranate (*Punica granatum* L.) By exploiting rootstocks

Hard wood cutting success as influenced by potting mixture, ringing, growth regulators and other pre-treatments

Different experiments were executed to visualize the influence of potting mixture, ringing, growth regulators and other pre-treatments of cutting success in pomegranate. Eight to twelve mm in diameter, 20-25 cm long and about 6-8 months old hardwood cuttings were used during semi-dormant conditions for the execution of the experiments (February-March under Solapur Maharashtra conditions). In all the experiment, cuttings were maintained after planting under polyhouse conditions with 27±2 °C and 80 % RH with alternate day light irrigation with tap water.

For the potting experiment different potting mixtures were used. The cuttings planted on rooting media consisting of cocopeat + vermiculite + perlite (T5) took minimum 12.23 days to shoot emergence and showed highest cutting success (70.83 %), highest shoot and root biomass (3.69 g and 0.68g for shoot and root fresh weight, respectively), the maxiumum leaf chlorophyll content and photosynthesis (3.68 mg/g FW, 6.74 µmol CO2/m2/s, respectively). However, treatment comprised of cocopeat + red soil (T3) registered maximum sprouting (87.78%, but at par with T5, 85.00%). Independent of rooting media , the ringing and covering of stem one week before planting of cuttings registered significantly higher sprouting (81.43%) and cutting success (62.38 %) as compared to no ringing and covering. The highest final cutting success (80.00 %) was obtained with ringing and covering of stem and planting of cutting on cocopeat + vermiculite + perlite (T5). Interaction study between different growing media and cuttings success in pomegranate cultivar 'Super Bhagawa' revealed that among the different media and different media combinations, sand + cocopeat (1:1) showed the highest survival percentage (86.61%) followed by cocopeat (77.67%).

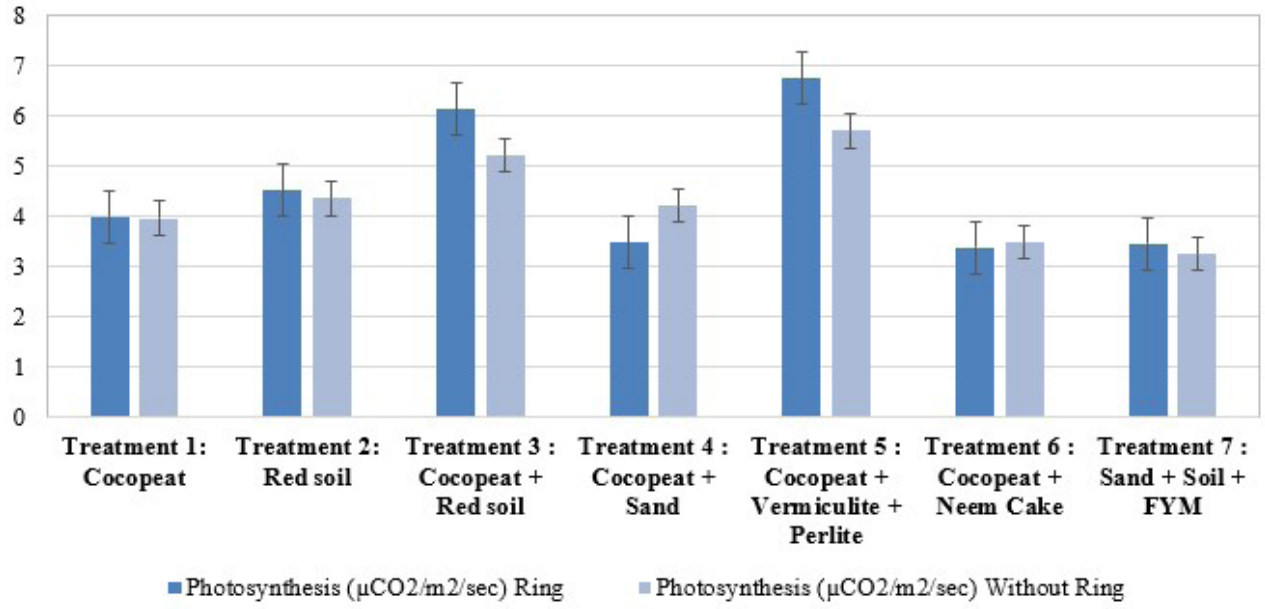
Effect of stem ringing and potting mixture on cutting success

Potting Mixture (PM)*	RC#	No RC	Avg	RC	No RC	Avg.	RC	No RC	Avg.
	NDSE*	NDSE		MSC@ (%)	MSC (%)	FCS& (%)	FCS (%)		
Cocopeat (T1)	15.3	14.9	15.1	90.0	45.6	67.9	70.0	28.9	49.4
Red soil (T2)	15.6	14.7	15.2	91.7	61.1	76.4	73.3	33.9	53.6
Cocopeat + Red soil (T3)	14.8	14.1	14.4	96.7	78.9	87.8	71.7	39.4	55.6
Cocopeat + Vermiculite + Perlite (T5)	11.2	13.2	12.2	96.7	73.3	85.0	80.0	61.7	70.8
Sand + Soil + FYM (T7)	17.9	16.6	17.2	55.0	35.6	45.3	38.3	23.3	30.8
Average	15.5	15.0		81.4	58.7		62.4	37.7	

Potting Mixture (PM)*		RC#	No RC	Avg	RC	No RC	Avg.	RC	No RC	Avg.
		NDSE*	NDSE		MSC@ (%)	MSC (%)	FCS& (%)	FCS (%)		
CD (p≤0.05)	PM	0.86			7.52			7.29		
	RC	1.62			14.0			13.6		
	PM x RC	2.29			19.9			19.3		

#Ringing and cutting, *Number of days to shoot emergence, @Maximum sprouting of cuttings, &Final cutting success

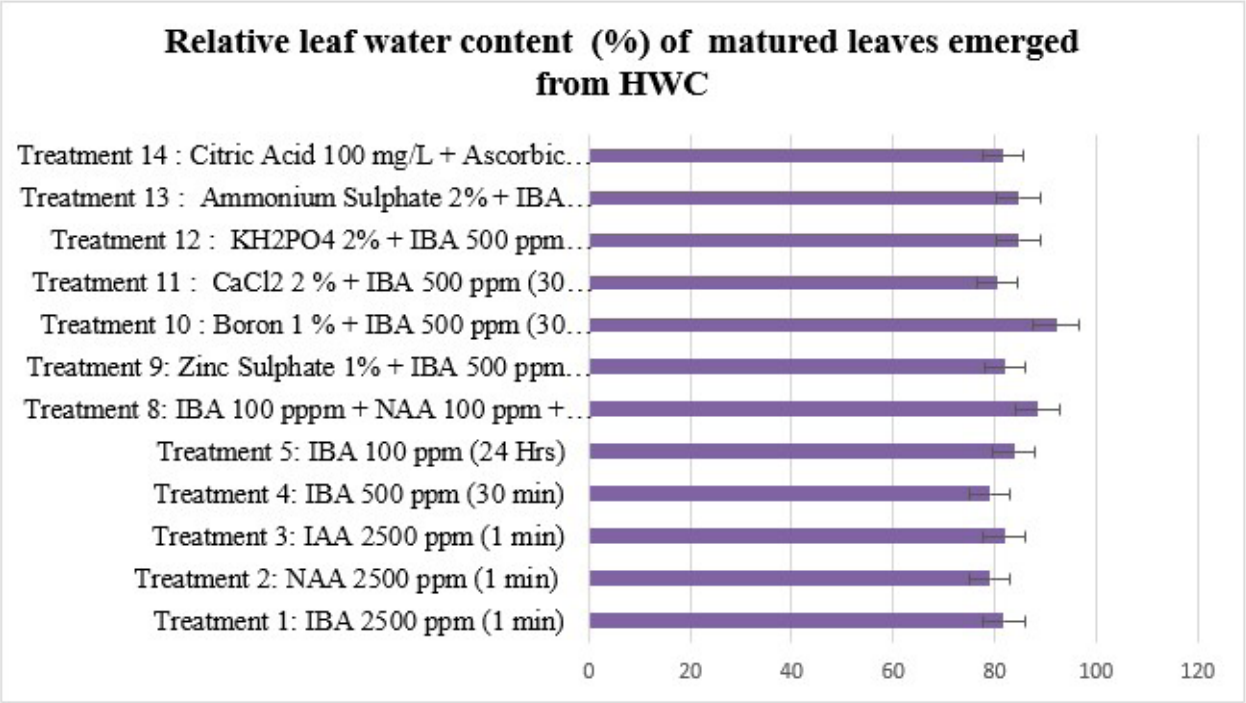
Effect of various pre-treatments on cutting success



Photosynthesis as influenced by the potting mixture

Treatment	Average number of days to shoot emergence	Maximum sprouting of cuttings (%)	Final cutting success (%)
Treatment 1: IBA 2500 ppm (1 min)	19.8	70.0	63.3
Treatment 4: IBA 500 ppm (30 min)	15.5	66.7	53.3
Treatment 5: IBA 100 ppm (24 hrs)	15.5	43.3	43.3
Treatment 9: Zinc Sulphate 1% + IBA 500 ppm (30 min)	**15.7**	**86.7**	**70.0**
Treatment 10: Boron 1 % + IBA 500 ppm (30 min)	15.6	86.7	60.0
Treatment 11: $CaCl_2$ 2 % + IBA 500 ppm (30 min)	16.9	76.7	60.0
Treatment 12: KH_2PO_4 2% + IBA 500 ppm (30 min)	18.6	76.7	60.0

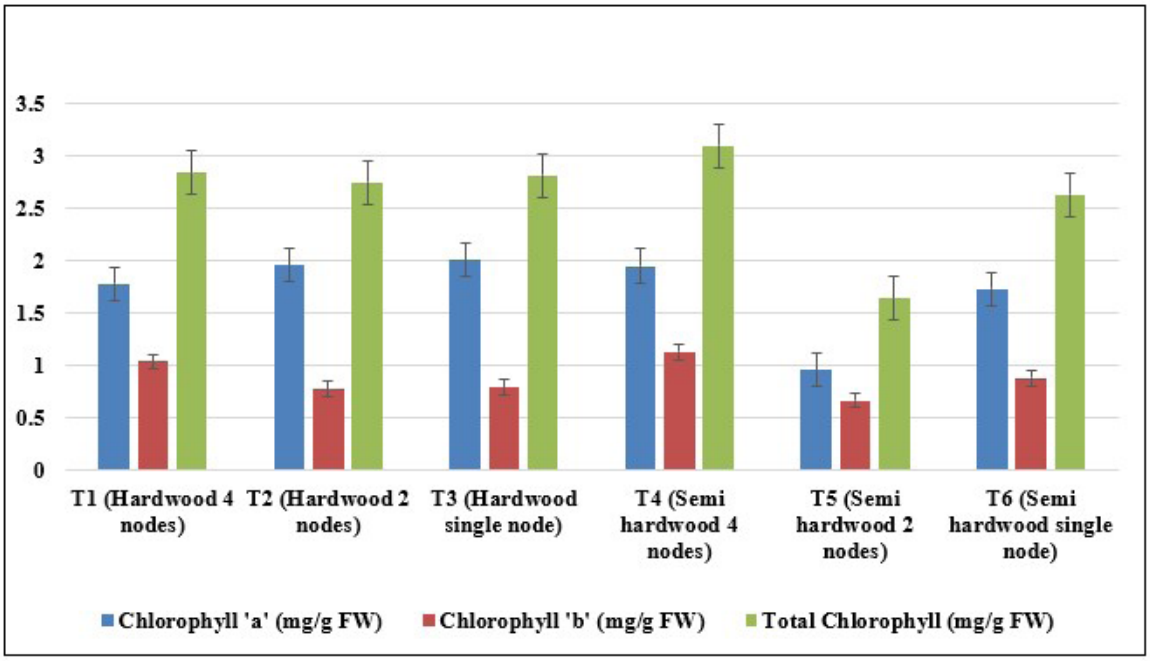
Treatment	Average number of days to shoot emergence	Maximum sprouting of cuttings (%)	Final cutting success (%)
Treatment 13: Ammonium Sulphate 2% + IBA 500 ppm (30 min)	17.5	76.7	66.7
Treatment 14: Citric Acid 100 mg/L + Ascorbic Acid 100 mg/L + IBA 500 ppm (30 min)	15.5	70.0	56.7
CD (p≤0.05)	3.16	16.3	20.3



Among various pre-treatments given to the hardwood cutting before the planting of cutting in the nursery bags, cuttings treated with combination of Zinc sulphate (1%) with Indole-3-butyric acid (IBA) (500 ppm) for 30 minutes registered highest cutting success (73.33%) and it was at par with the treatments T10, T14 and T1 but significantly better than rest of the treatments. As far as sprouting of cuttings are concerned Boric acid (1%) with IBA (500 ppm) for 30 minutes displayed the best results (84.44%) which was at par with treatments having ZnSO4 + IBA, $CaCl_2$ + IBA, KH_2PO_4 + IBA and only IBA but significantly superior to all other treatments . However, days to shoot emergence was earliest in cuttings treated with IAA (100 ppm) for 24 hrs and $CaCl_2$ (2 %) + IBA (500 ppm) for 30 min (14.73 and 14.99 days, respectively) and were at par with T14 (Citric Acid 100 ppm + Ascorbic Acid 100 ppm + IBA 500ppm for 30 min) but significantly earlier to other treatments. Total fresh and dry biomass of root and shoot was found to be the highest in cutting treated with ammonium sulphate (2%) + IBA (500ppm) for 30 min (T13- 4.53g and 1.32g for shoot and root fresh wt., respectively) which was at par with T8, T11 and T14 but significantly better to other treatments. The total leaf chlorophyll content was found to be the highest in T5 (4.01 mg/g FW), which was at par with T3, T11 and T9.

Length and maturity of wood influencing the cutting success, propagability of shoot and root, fresh and dry biomass

Length of Cutting	Average number of days to shoot emergence	Maximum Sprouting of Cuttings (%)	Final Cutting Success (%)	Shoot Fresh Wt. (g)	Root Fresh Wt. (g)	Shoot Dry Wt. (g)	Root Dry Wt. (g)
T1 (Hardwood 4 nodes-20 cm)	14.3	73.3	60.0	2.42	0.87	0.87	0.15
T2 (Hardwood 2 nodes-10 cm)	21.6	53.3	33.3	0.93	0.28	0.35	0.07
T3 (Hardwood single node-5 cm)	16.9	40.0	20.0	0.37	0.27	0.14	0.07
T4 (Semi hardwood 4 nodes-20 cm)	13.9	63.3	33.3	1.28	0.34	0.44	0.06
T5 (Semi hardwood 2 nodes-10 cm)	15.8	50.0	36.7	0.78	0.30	0.27	0.06
T6 (Semi hardwood single node)	14.7	33.3	33.3	0.14	0.01	0.04	0.01
CD (p≤0.05)	NS	23.4	19.7	0.52	0.20	0.24	0.05



Leaf chlorophyll content as influenced length and maturity of the wood

The length of the cutting and maturity of the wood are the two important considerations for enhacing cutting success. Among the various length of cuttings (4 nodal-20 cm, 2 nodal-10 cm and single nodal-5 cm), and wood maturity (hardwood, 8-12 mm diameter with > 6 months old and semi-hardwood, 4-6 mm in diameter with 4-6 months old) are tested here. The 4 nodes long harwood have registered the maximum cutting success (60.0%) and treatment 1 (4 nodal hard wood cuttings) 3 and 4 (4 nodal semi-hardwood cuttings) performed at par for leaf total

chlorophyll content (2.85 and 3.10 mg/g FW). But interestingly, RLWC (%) was higher in semi-hardwood cutting with two nodes and the result was at par with treatment 1 and 3.

Evaluation of pomegranate germplasm against salinity

The tolerance of germplasm against salinity as compared to the commercial variety Bhagawa was evaluated in a pot culture experiment. The irrigation with 200 mM (20.8 dsm^{-1}) NaCl solution (1:1) was given at every 3-4 days for 90 days. As a result the four genotypes *i.e.* IC-318733, Acc.-2, Patna-5 and IC-318712, showed considerable lower reduction of biomass under saline condition as compared to 'Bhagwa'. The genotype IC-318733 with very meager visual symptoms of leaf necrosis and dryness were observed under saline conditions. Whereas symptoms were quite pronounced in 'Bhagawa'. The enhanced proline concentration and epi-cuticular wax under influence of salinity were found in wild genotypes as compared to 'Bhagawa'. The total chlorophyll reduction under influence of salinity among the genotypes were 2.25% in Patna-5, 10.45% in IC-318733 and 12.67% in IC-318735, as compared to 33.50% in 'Solapur Lal' and 45.25% in 'Bhagwa'. Leaf stomatal density, length and width were also found to be influenced by salinity.

Response of pomegranate genotypes against salinity

Accession/ Variety	Shoot weight (g)		Root weight (g)	
	0 mM	200 mM	0 mM	200 mM
IC-318733	62.3	55.7 (moderate reduction by 10.66%)	38.6	34.2 (meager reduction by 11.2%)
ACC-6	67.6	62.6 (meager reduction by 7.48%)	41.9	36.3
Solapur Anardana	45.1	41.6 (meager reduction by 7.85%)	32.3	24.2
IC-318712	52.3	46.3 (moderate reduction by 11.47%)	27.8	21.9
EC-676960	42.3	29.4 (drastic reduction by 30.51%)	19.3	14.3 (drastic reduction by 25.9%)
Bhagawa	39.1	29.3 (drastic reduction by 25.10%)	21.2	16.1 (drastic reduction by 24.1%)
Solapur Lal	37.8	27.5 (drastic reduction by 26.76%)	24.3	18.3 (drastic reduction by 24.8%)
IC-318735	41.2	36.1	26.9	19.7
Patna-5	42.4	37.8 (moderate reduction by 10.7%)	20.2	17.5 (moderate reduction by 13.3%)
$CD_{0.05}$	8.4	7.5	7.01	6.00

Physiological and biochemical parameters of germplasm as influenced by imposed salinity treatment

Accession/ Variety	Proline content (µg / 100 g FW)		RWC (%)		MSI (%)		ECW (mg / cm^2)	
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
IC-318733	5.27	9.46 (increase by 79.5%)	67.6	63.6	89.4	79.6	0.29	0.38 (up by 31.0%)
ACC-6	5.45	6.87	75.3	50.1	62.9	50.1	0.24	0.27
Solapur Anardana	4.82	8.28	63.8	47.1	77.5	57.1	0.27	0.29
IC-318712	5.69	10.00 (increase by 73.64%)	68.6	45.2	77.5	65.2	0.25	0.28
Bhagawa	4.13	6.21 (meagre increase by 50.36%)	65.6	52.5	85.0	52.5	0.20	0.22 (up by only 10.00%)

Accession/ Variety	Proline content (µg / 100 g FW)		RWC (%)		MSI (%)		ECW (mg / cm²)	
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
Solapur Lal	3.96	6.51	68.4	58.2	68.5	48.2	0.32	0.35
IC-318735	5.03	7.28	68.6	65.2	81.7	65.2	0.17	0.19
Patna-5	4.58	10.89 (drastic increase by 138%)	67.4	62.2	93.8	86.4	0.18	0.24
CD 0.05	1.21	1.84	5.04	9.72	9.17	9.72	0.01	0.01

Visual leaf deformities in germplasm due to salinity treatment

Accession/ Variety	Plant height (m)	Foliar salt damage						
		Leaf abscission		Leaf necrosis		Leaf dryness		
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
IC-318733	2.35	2.17	**No abscission**	**Very low**	**Very low**	**Low**	**Very low**	**Very low**
ACC-6	2.61	2.26	No abscission	low	Low	Medium	Very low	High
Solapur Anaradana	2.66	2.17	No abscission	High	No necrosis	High	No dryness	Very high
IC-318712	2.63	2.19	No abscission	Low	Very low	Low	Medium	Medium
IC-318707	2.10	1.76	No abscission	Medium	Very low	High	Low	High
IC-318728	2.56	2.31	Low	High	Very low	High	Medium	Low
EC-676960	2.79	2.48	No abscission	Medium	Very low	High	Very Low	Low
Bhagawa	2.34	1.92	No abscission	High	No necrosis	High	No dryness	Very high
Solapur Lal	2.21	1.86	No abscission	Low	No necrosis	High	No dryness	Very high
IC-318735	2.68	2.35	No abscission	High	Low	Medium	Very low	Medium
Patna-5	1.87	1.68	**No abscission**	**Very low**	**No necrosis**	**Very low**	**Very low**	**Low**

Leaf chlorophyll content as influenced by salinity treatment

Accession/ Variety	Chlorophyll a (mg /g FW)		Chlorophyll b (mg /g FW)		Total Chlorophyll (mg /g FW)		Chlorophyll a/b (mg /g FW)	
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
IC-318733	1.23	0.97	0.50	0.41	1.73	1.37	2.47	2.43
ACC-6	1.06	0.90	0.47	0.42	1.54	1.31	2.24	2.18
Solapur Anaradana	1.23	0.81	0.57	0.47	1.80	1.29	2.17	1.72
IC-318712	1.29	0.87	0.45	0.34	1.74	1.21	2.84	2.63
Bhagawa	1.27	0.66	0.52	0.32	1.79	0.98	2.44	2.08
Solapur Lal	1.32	0.81	0.58	0.46	1.91	1.27	2.26	1.76
IC-318735	0.95	0.85	0.47	0.39	1.42	1.24	2.01	2.17
Patna-5	0.90	0.89	0.42	0.36	1.33	1.30	2.15	2.57
$CD_{0.05}$	0.08	0.07	0.07	NS	0.10	0.09	0.40	0.33

Leaf stomatal features as influenced by salinity treatment

Accession/ Variety	Stomatal density (cm^2)		Stomatal length (µm)		Stomatal width (µm)	
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
IC-318733	4.87	3.41	9.34	8.21	6.05	4.67
ACC-6	4.43	3.15	8.91	7.71	5.82	4.48
Solapur Anaradana	5.61	3.08	9.56	8.53	6.58	5.81
IC-318712	5.69	3.70	11.71	9.41	8.18	6.78
IC-318707	5.18	3.09	10.52	8.68	7.54	6.24
IC-318706	5.38	3.43	10.49	8.46	6.53	5.23
IC-318728	6.05	3.76	11.52	9.58	7.92	6.57
IC-676960	5.14	2.79	10.23	8.05	7.28	6.13
Bhagawa	5.74	**3.19**	11.47	9.47	7.84	6.72
Solapur Lal	4.37	2.84	9.18	7.15	5.21	3.99
IC-318735	5.84	3.79	11.68	10.08	8.06	6.85
Patna-5	5.13	**4.29**	10.29	9.56	8.01	6.76
$CD_{0.05}$	1.02	0.86	1.57	NS	1.38	1.47

In *vitro* shoot proliferation and rooting of 'Super Bhagawa'

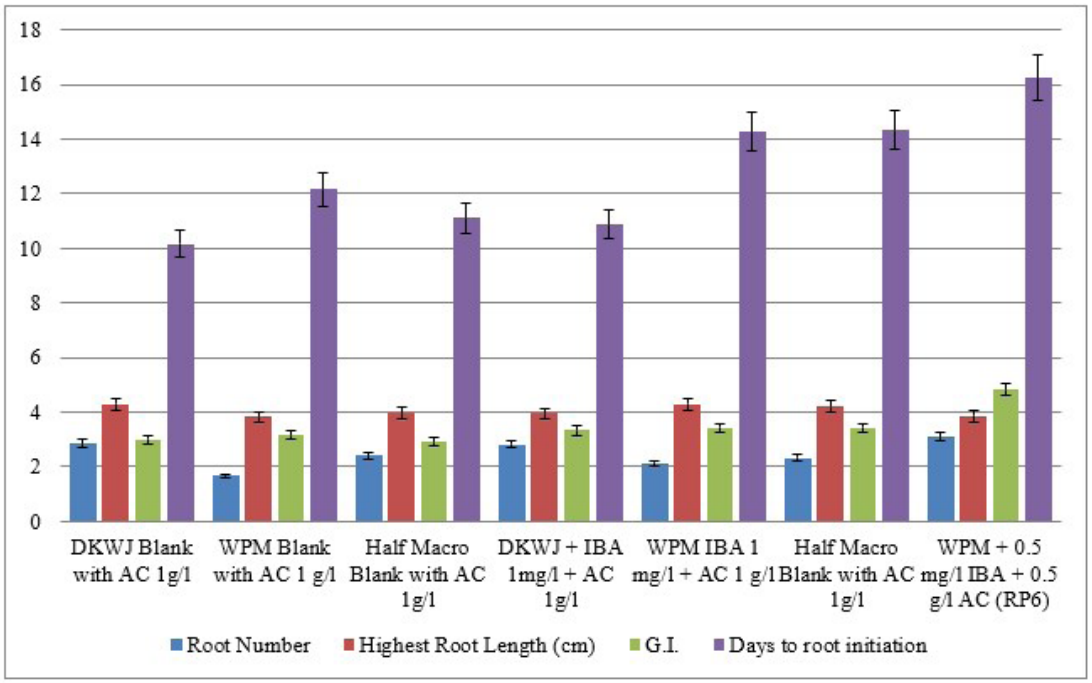
The modified MS medium with 0.5 mg/l BAP + 0.25 mg/l NAA + 50 mg/l Adenine sulphate produced the highest average shoot growth (6.95 cm) with 3.38 number of side shoots and 4.75 greenness index. But the maximum number of side shoots (3.82) were registered on the same medium with enhanced Adenine sulphate (100 mg/l).

In the present study three different basal media (having fixed concentration of activated charcoal-1g/l) with and without IBA were used to promote *in vitro* rooting of pomegranate micro-shoots. The previously identified rooting medium (RP-6 WPM+AC 500mg/l+ 0.5 mg/l IBA) was kept as a control. All the treatments registered better *in vitro* rooting as compared to control. This suggested that increasing activated charcoal from 500 mg to 1.0 g/l is beneficial for *in vitro* rooting. Interestingly, addition of IBA to the rooting medium did not improve the *in vitro* rooting of micro-shoots. DKW-Juglans basal medium and reduced strength MS medium (half macro salts) with 1.0 g/l activated charcoal and with or without IBA was found better.

In *vitro* shoot proliferation as influenced by BAP, NAA and Adenine sulphate

Treatment	BAP (mg/ml)	NAA (mg/ml)	Adenine sulphate	Treatment	Net Shoot growth (cm)	Number of side shoots	Greenness Index
Modified MS (Reduced NH_4NO_3 and enhanced $CuSO_4$, $CoCl_2$, $FeSO_4$-EDTA and Thiamine) + $AgNO_3$ + Ascorbic acid	0.3	0.15	50	**T1**	5.72	2.30	3.75
	0.3	0.15	100	**T2**	5.05	1.81	4.50
	0.5	0.25	50	**T3**	5.41	1.70	4.00
	0.5	0.25	100	**T4**	5.35	1.55	4.00
	1.0	0.50	50	**T5**	6.20	1.35	3.75
	1.0	0.50	100	**T6**	4.66	1.53	3.50
	0.3	0.15	50	**T7**	3.22	3.17	3.75

Treatment	BAP (mg/ ml)	NAA (mg/ ml)	Adenine sulphate	Treatment	Net Shoot growth (cm)	Number of side shoots	Greenness Index
	0.3	0.15	100	**T8**	4.13	2.65	3.75
	0.5	**0.25**	**50**	**T9**	**6.95**	3.38	**4.75**
	0.5	0.25	100	**T10**	3.77	**3.82**	3.50
	1.0	0.50	50	**T11**	3.74	1.43	4.00
	1.0	0.50	100	**T12**	3.47	3.14	3.50
CD (p=0.05)					NS	1.08	NS



***In vitro* rooting as influenced by basal media and growth regulator combinations**

3. Crop Production

3.1 Project: Crop regulation practices for improving productivity of pomegranate

Crop load optimization through thinning in pomegranate variety Solapur Lal

Pomegranate variety Solapur Lal is a hybrid variety with vigorous nature. Upon crop regulation, Solapur Lal produces profuse flowers and surplus fruits throughout the tertiary branches, resulting in medium sized fruits. In order to improve the fruit size, the excess fruits should be removed at the time of fruit set through fruit thinning. An experiment was conducted in Solapur Lal by adopting six thinning levels. The results revealed that light thinning of fruits resulted in optimum no. of fruits (114.2 fruits/tree), fruit size (275.20g/fruit) and optimum yield (31.43kg/tree), which is superior over the control. The export quality fruits were highest in light thinning over the others and were lowest in control.

Effect of fruit thinning on yield and quality of pomegranate var. Solapur lal :

Thinning Level	No. of fruits/tree	Mean fruit weight (g)	Yield (kg/ plant)	Yield (ton/ha)	TSS (°B)	Acidity (%)	Brix- Acid ratio
Control (without thinning) (> 135 fruits/tree)	141.5	251.9	35.6	26.4	17.2	0.46	37.4
Very light thinning (121 - 135 fruits/tree)	128.4	264.2	33.9	25.1	17.4	0.43	40.3
Light thinning (106-120 fruits/tree)	114.2	275.2	31.4	23.3	17.6	0.40	44.0
Medium thinning (91- 105 fruits/tree	97.6	277.0	27.0	20.0	17.6	0.40	44.0
Heavy thinning (76-90 fruits/tree)	85.1	280.1	23.8	17.6	17.7	0.40	44.1
Very heavy thinning (61-75 fruits/tree)	71.6	282.2	20.2	14.9	17.7	0.39	45.3

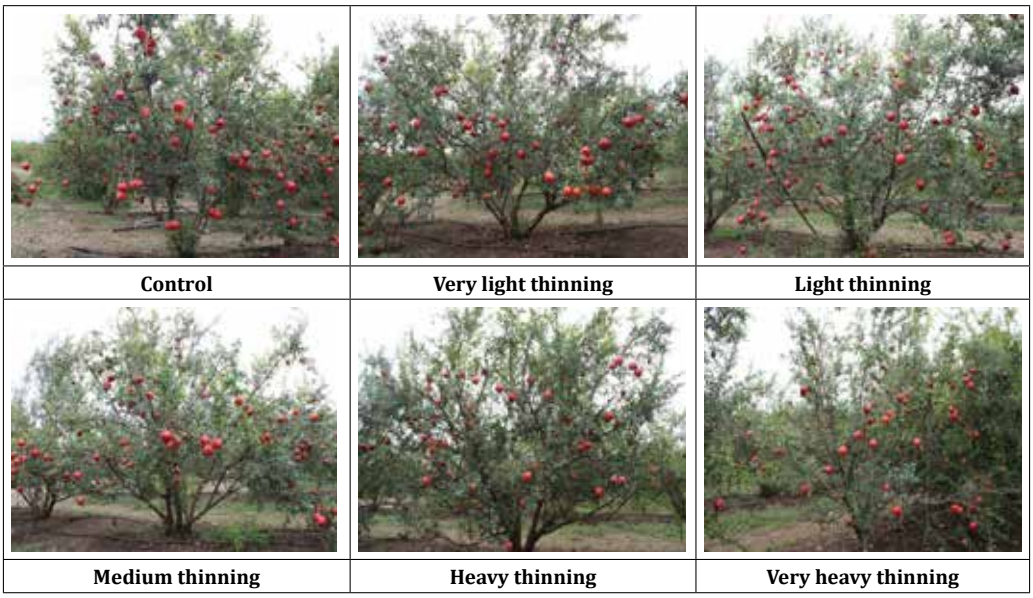


Fig 1. Crop load optimization through thinning in Solapur Lal

Effect of 2, 4 -D on flower / fruit drop

An experiment was conducted to control the flower drop in pomegranate variety Bhagawa during Hasth bahar. Growth regulator 2, 4-D at six concentrations (5, 10, 15, 20, 25 and 30ppm) was foliar sprayed at the onset of flowering and 10 days after an anthesis. The increase in concentration of 2, 4-D significantly reduced the flower drop. The 2, 4-D concentration @20ppm was found to be highly beneficial for management of fruit drop. Apart from this, 2, 4-D@ 20ppm also recorded the minimum fruit drop (19.8 flowers/tree), percent fruit drop (10.67%), and highest fruit set (59.12%) and number of fruits (97.90 fruits/tree) besides highest yield (26.59 kg /tree). Yield did not increased beyond this concentration.

Effect of 2, 4-D on flower drop and fruit set of pomegranate

Concentration of 2,4-D (ppm)	Total No. of bisexual flowers/tree	No. of bisexual flowers dropped/ tree	Percent dropped flowers (%)	No. of bisexual flowers retained	No. of fruits / plant	Fruit set (%)
5 ppm	192.8	37.0	19.2	155.8	81.6	52.4
10 ppm	193.5	32.7	16.9	160.8	86.4	53.6
15 ppm	190.8	27.0	14.1	163.8	91.8	56.1
20 ppm	185.7	19.8	10.7	166.0	97.9	59.1
25 ppm	183.3	20.1	11.0	163.1	96.3	59.1
30 ppm	183.3	20.8	11.4	162.5	93.3	57.4
Control (Unsprayed)	192.8	46.7	24.2	146.2	76.2	50.8

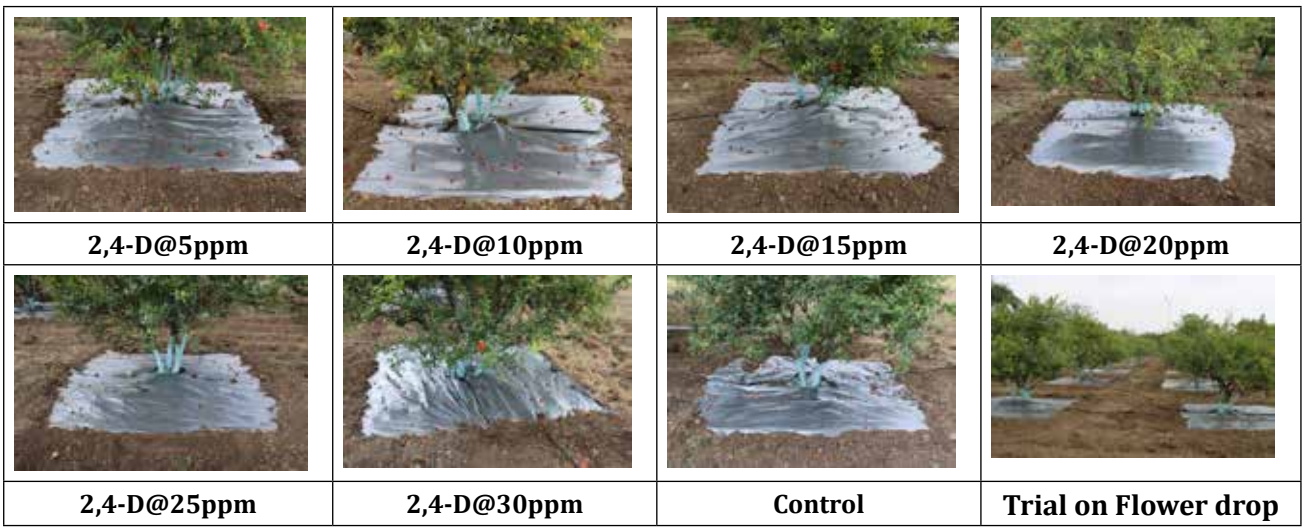


Fig 2. Effect of 2, 4-D on control of flower drop in pomegranate

Effect of 2, 4-D on fruit weight, yield and quality of pomegranate:

Concentration of 2,4-D (ppm)	No. of fruits/ Tree	Fruit weight (g)	Yield (kg/tree)	Yield (t/ha)	TSS (°B)	Titrable acidity (%)
5 ppm	81.6	262.8	21.4	15.9	15.5	0.48
10 ppm	86.4	266.0	23.0	17.0	15.6	0.47
15 ppm	91.8	269.3	24.7	18.3	15.7	0.47

Concentration of 2,4-D (ppm)	No. of fruits/ Tree	Fruit weight (g)	Yield (kg/tree)	Yield (t/ha)	TSS (°B)	Titrable acidity (%)
20 ppm	97.9	271.5	26.6	19.7	15.9	0.45
25 ppm	96.3	270.8	26.1	19.3	15.9	0.45
30 ppm	93.3	269.7	25.2	18.6	15.9	0.45
Control (Unsprayed)	76.2	252.4	19.2	14.2	15.3	0.49

3.2. Project: Package of Practices for Organic Cultivation of Pomegranate

Preparation of enriched compost from sugarcane press mud

Sugarcane press mud is a by-product of sugar industry and is widely available biomass in sugarcane growing regions. However, its nutrient content is low and is difficult to get decomposed. An effort was made to prepared enriched compost through addition of poultry litter, rock phosphate, K-feldspar and P and K solubilizer. Composition of different composts are as follows: T1: Press mud (80%) + Fresh cow dung (20%); T2: Press mud (50%) + Poultry litter (30%) + Fresh cow dung (20%); T3: Press mud (49.8%) + Poultry litter (30%) + Fresh cow dung (20%) + Composting culture (0.2%); T4: Press mud (45.8%) + Poultry litter (30%) + Fresh cow dung (20%) + Composting culture (0.2%) + Rock phosphate (2%) + K-feldspar (2%); T5: Press mud (45.6%) + Poultry litter (30%) + Fresh cow dung (20%) + Composting culture (0.2%) + Rock phosphate (2%) + K-feldspar (2%) + P and K solubilizer (0.2%).

Analysis of compost after 80 days of composting revealed that with the composting pH, organic matter, total organic C, germination index and cation exchange capacity increased substantially. While electrical conductivity (EC), water-soluble polyphenols, C and N ratio, and ash content decreased. This indicates that the composting process is proceeding towards end or completion. Further, it was observed that content of macro-elements like N, P and K and micro-elements like Fe, Mn, Zn and Cu got increased in different composts than the compost prepared from sugarcane press-mud. The highest increase in nutrient content was observed with T5 compost followed by T4 compost.

So, composting of press mud with poultry litter, rock phosphate, K-feldspar, composting culture and P and K solubilizer not only enriched nutrient content in the compost but also substantially improved the quality of compost as well.

Extraction of nutrient from waste biomass (de-oiled cake) using subcritical water hydrolysis treatment

Various de-oiled cakes contain substantial amount of nutrients. Composting is more commonly used for disposal of these solid biomass wastes. But it has some drawbacks including long residence time, odour release, pathogen development and application of compost is labour intensive. The nitrogen content in various de-oiled cakes is given below.

Total N content in different de-oiled cakes

Name of de-oiled cakes	Total N content (%)
Groundnut cake	5.85
Safflower cake	7.67
Cotton seed cake	3.58
Soybean cake	7.03

Among different de-oiled cakes used, safflower cake contains the highest amount of N (7.67%) followed by soybean cake (7.03%). The subcritical water hydrolysis treatment of various cakes revealed that from safflower cake the highest amount of nutrients *i.e.* N, P and K can be extracted in the form of liquid organic fertilizer. The final volume of extract is also higher than other feedstock. However, the final pH of the extract is higher and it needs to be lowered through using organic acid for making it suitable for application as liquid organic fertilizer.

Physico-chemical properties of liquid organic fertilizer obtained from different de-oiled cakes

Material	Initial vol. (ml)	Final vol. (ml)	Initial pH	Final pH	Total N ($g\ l^{-1}$)	Total P ($g\ l^{-1}$)	Total K ($g\ l^{-1}$)
Soybean cake	500	350	8.44	7.11	7.00	0.76	7.80
Safflower cake	500	456	12.0	9.37	10.5	0.80	9.80
Groundnut cake	500	415	10.4	7.82	6.10	0.46	7.20
Cotton seed cake	500	330	12.0	8.04	4.40	0.36	6.40

Liquid organic fertilizer produced by subcritical water hydrolysis with different alkaline reagent at different strength

Treatment condition	Initial pH	Final pH	Final volume (ml)	Total N ($g\ l^{-1}$)	Total P ($g\ l^{-1}$)	Total K ($g\ l^{-1}$)
0.1M NaOH	10.7	7.27	450	8.40	0.61	4.00
0.2 M NaOH	12.1	9.39	452	9.50	0.71	9.10
0.5 M NaOH	13.1	11.9	455	11.1	0.57	10.5
0.1 M KOH	8.57	6.57	400	4.70	0.43	3.70
0.2 M KOH	12.5	9.27	435	7.10	0.52	8.90
0.5 M KOH	12.9	9.65	430	10.2	0.67	11.3

Supplementing nutrient to pomegranate tree through various organic sources:

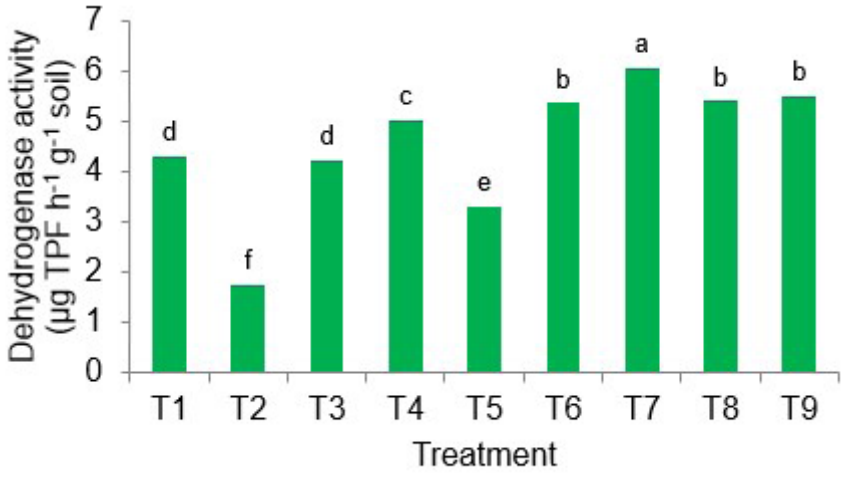
Effect of soil fertility at flowering

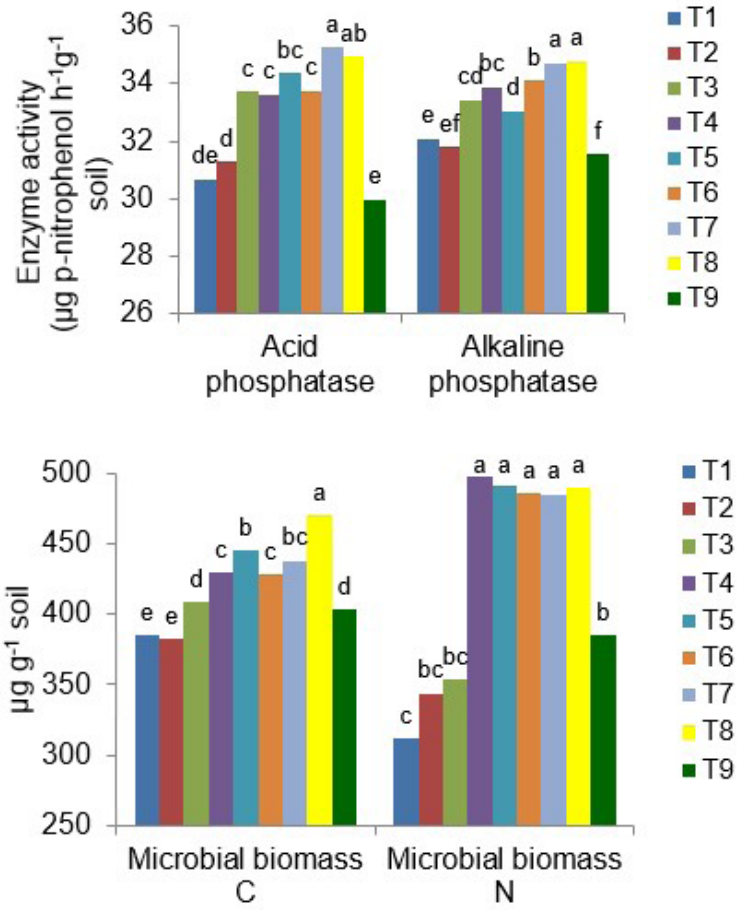
A field experiment was conducted to supplement nutrients through various organic sources *viz.*, farmyard manures (FYM), P and K supplementing biomineral fertilizer, N_2-fixing biofertilizer, and green manuring (GM). Soil samples were collected at flowering and the analysis results revealed that application of chemical fertilizer (T2), farmers practice of using FYM with chemical fertilizers (T9), combination of FYM and P and K supplementing biomineral fertilizer (T4), combination of GM, N_2-fixing biofertilizer, and P and K supplementing biomineral fertilizer (T7) and combination of FYM, N_2-fixing biofertilizer, GM, P and K supplementing biomineral fertilizer (T8) significantly increased available N content in soil at flowering. However, the highest available N content was recorded with the application of chemical fertilizers and farmers practice of applying FYM with chemical fertilizers. While all the organic treatments significantly increased available P and K content of soil. The highest available P content was recorded with combination of farmyard manure, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer. While the highest available K content was recorded with the application of chemical fertilizer. Significant increase in available S content was noticed with the application of chemical fertilizers (T2), combination of GM, P & K

supplementing biomineral fertilizer (T6) and combination of FYM, N_2-fixing biofertilizer, GM and P & K supplementing biomineral fertilizer (T8). The highest available S content was noted with the application of chemical fertilizer. Significant reduction in DTPA extractable Fe, Mn, Zn and Cu was recorded with all the treatments of supplementing nutrients through organic sources. No significant change in soil pH and EC was noticed. However, significant improvement in organic and labile C content of soil was recorded with all the treatments of supplementing nutrients through various organic sources. The highest organic and labile C content was recorded with combination of FYM, N_2-fixing biofertilizer, and P & K supplementing biomineral fertilizer (T5) and combination of FYM, N_2-fixing biofertilizer, GM and P & K supplementing biomineral fertilizer (T8) respectively. Even organic and labile C content were significantly higher with all the organic treatments than chemical fertilizers application (T2) and farmers practice of applying FYM with chemical fertilizers (T9).

Effect on soil biological parameters

Except FYM application (T3) and combination of FYM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer (T5), all the organic treatments significantly increased dehydrogenase activity and the highest dehydrogenase activity was recorded with combination of GM, N_2-fixing biofertilizer, and P & K supplementing biomineral fertilizer (T7). While least dehydrogenase activity was observed with the application of chemical fertilizers. Significant improvement in acid and alkaline phosphatase activity were observed with all the organic treatments and the highest acid and alkaline phosphatase activity was observed with the combination of GM, N_2-fixing biofertilizer, and P & K supplementing biomineral fertilizer (T7) and combination of FYM, N_2-fixing biofertilizer, GM and P & K supplementing biomineral fertilizer. Treatments of chemical fertilizers application and farmers practice of applying FYM with chemical fertilizers registered least acid and alkaline phosphatase activity. Similarly, all the organic treatments recorded significant improvement in the microbial biomass C and N content of soil. As like phosphatase activity, combination of FYM, N_2-fixing biofertilizer, GM and P & K supplementing biomineral fertilizer (T8) recorded the highest microbial biomass C and N content of soil. While chemical fertilizers treatment (T2) recorded the least microbial biomass C content of soil. The farmers practice of applying FYM with chemical fertilizers registered lower microbial biomass C & N content of soil than all the organic treatments except only FYM application (T3).





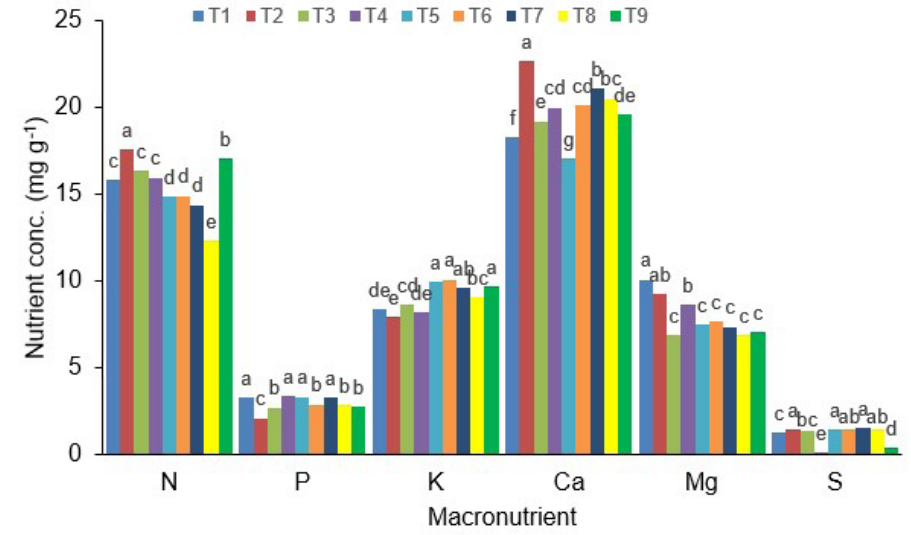
Effect of different organic nutrient supplement options on (a) dehydrogenase (b) acid and alkaline phosphatase enzyme activity (c) microbial biomass C and N content of soil at flowering: Where, T1: Control; T2: 100% of RFD through chemical fertilizer, N:P_2O_5:K_2O: : 625:250:250 g/tree; T3: Farm Yard manure (N-0.5%) , 60 kg/tree; T4: Farm yard manure @ 60 kg/tree + P and K supplementing biomineral fertilizer @ 150 g/tree; T5: Farm yard manure @ 40 kg/tree + N_2 fixing biofertilizer + P and K supplementing biomineral fertilizer @ 150 g/tree; T6: Green manuring + P and K supplementing biomineral fertilizer @ 150 g/tree; T7: Green manuring + N_2 fixing bio-fertilizer + P and K supplementing bio-mineral fertilizer @ 150 g/ tree; T8: Farm yard manure @ 40 kg/tree + N_2 fixing biofertilizer + Green manuring + P and K supplementing biomineral fertilizer @ 150 g/tree; T9: Farmers' practice i.e. 40 kg FYM +625 g N+ 250 g P_2O_5 +250 g K_2O/tree).

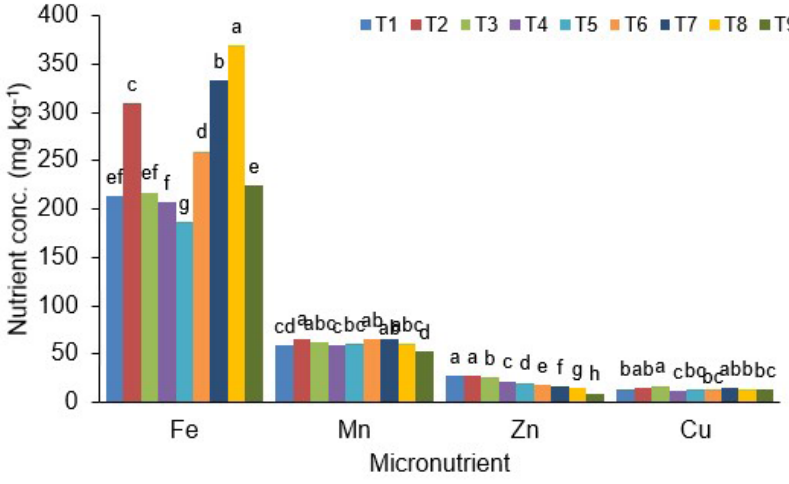
Effect on tree's nutritional status at flowering

Tree's nutritional status at flowering revealed that only chemical fertilizer application and farmers practice of applying FYM with chemical fertilizers significantly increased N concentration in leaves. While all the organic treatments recorded significantly lower N concentration in leaves. Some of the organic treatments *viz.,* T5, T6, T7 & T8 and farmers practice resulted significant increase in leaf K concentration. The highest K concentration was recorded with the combination of GM and P & K supplementing biomineral fertilizer (T6), combination of FYM, N_2-fixing biofertilizer, and P & K supplementing biomineral fertilizer (T5) and combination of GM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer (T7), which were at par with each other.

Except the combination of FYM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer (T5) all other organic treatments significantly increased Ca concentration in leaves. The highest Ca concentration was recorded with the application of chemical fertilizers followed by the combination treatment of GM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer. While, all the organic treatments resulted in lowering of Mg concentration in leaves. Except two organic treatments *viz.,* T3 and T4, all other organic treatments significantly increased S concentration in leaves.

Regarding micronutrients, combination of GM, P & K supplementing biomineral fertilizer (T6), combination of GM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer (T7) and combination of FYM, N_2-fixing biofertilizer, GM and P & K supplementing biomineral fertilizer (T8) and chemical fertilizer application (T2) resulted in significant increase in Fe concentration in leaves. The highest leaf Fe concentration was recorded with T8 organic treatment. Similarly, chemical fertilizer application and two organic treatments viz., T6 comprising of GM and P & K supplementing biomineral fertilizer and T7 comprising of GM, N_2-fixing biofertilizer and P & K supplementing biomineral fertilizer significantly increased Mn concentration in leaves. While, only FYM application (T3) significantly increased Cu concentration in leaves.





Effect of different organic nutrient supplements on trees' (a) macronutrients (b) micronutrients status at flowering (Where, T1: Control; T2: 100% of RFD through chemical fertilizer, N:P_2O_5:K_2O: : 625:250:250 g/tree; T3: Farm Yard manure (N-0.5%) , 60 kg/tree; T4: Farm yard manure @ 60 kg/tree + P and K supplementing biomineral fertilizer @ 150 g/tree; T5: Farm yard manure @ 40 kg/tree + N_2 fixing biofertilizer + P and K supplementing bio-mineral fertilizer @ 150 g/tree; T6: Green manuring + P and K supplementing biomineral fertilizer @ 150 g/tree; T7: Green manuring + N_2 fixing biofertilizer + P and K supplementing biomineral fertilizer @ 150 g/tree; T8: Farm yard manure @ 40 kg/tree + N_2 fixing biofertilizer + Green manuring + P and K supplementing biomineral fertilizer @ 150 g/tree; T9: Farmers practice i.e. 40 kg FYM +625 g N+ 250 g P_2O_5 +250 g K_2O/tree).

Effect on flowering behavior and fruit setting

All the organic treatments and farmers practice resulted significant increase in male, bisexual and total flowers count. While significantly lesser no. of male and bisexual flowers were recorded with chemical fertilizers application (T2). The highest bisexual and total flower count were recorded with the organic treatment comprising of GM, and P & K supplementing biomineral fertilizer (T6). While the highest no. of male flower was recorded with organic treatment comprising of FYM and P & K supplementing biomineral fertilizer (T4). Significantly higher no. of fruit set was also recorded with all the organic treatments. While no significant increase in fruit set was noticed with chemical fertilizer application (T2). The highest no. of fruit set was observed with the application of FYM @ 60 kg tree-1(T3) followed by combination of GM and P & K supplementing biomineral fertilizer (T6). FYM application treatment (T3) also recorded the highest percent bisexual flowers and fruit set.

3.3 PROJECT: CANOPY ARCHITECTURE MANAGEMENT AND HIGH DENSITY PLANTING IN POMEGRANATE

Planted air layered / rooted cuttings of Solapur Lal and Bhagwa as per envisaged technical program (4.5 x 3.0 m and 4.5 x 1.5 m) January, 2022. The plants are trained with single stem system and being maintained as per recommended pomegranate production and plant protection practices. Installed Y- Trellis system of canopy management in both Solapur Lal and Bhagwa. Pomegranate tree has a propensity to develop suckers on tree trunk and crown during the growing season. Therefore, a small experiment was conducted to check suckering by covering the stems with clear polythene film (20 micron). No suckers were noted on stem covered with clear polythene film however, in control plants it was observed after 9-12 days. No major differences were noted with respect to photosynthesis and total chlorophyll content in stems covered with with clean polythene film and control plants.

Stems covered with clear polythene film (20 micron) to control suckers

Variety	Stems covered with clean polythene film		Control	
	Photosynthesis (µmol $CO_2/m^2/sec$)	Total Chlorophyll Content (mg/g FW)	Photosynthesis (µmol $CO_2/m^2/sec$)	Total Chlorophyll Content (mg/g FW)
Solapur Lal	13.67 ± 2.68	2.48 ± 0.21	12.89 ± 2.58	2.28 ± 0.27
Bhagwa	9.87 ± 2.19	2.19 ± 0.17	8.22 ± 2.43	1.98 ± 0.21
Mean	11.77	2.34	10.55	2.13

3.4. PROJECT: UNRAVELING MECHANISM AND DEVELOPING MITIGATION STRATEGIES FOR ARIL BROWNING AND FRUIT CRACKING IN POMEGRANATE

Based on two years of field screening of 64 pomegranate germplasm accessions during Ambe bahar, 18 diverse germplasm accessions were selected for evaluation in the study. Eighteen accessions which showed cracking % of 0 %, 0-5 %, 5-10 %, 10-15 %, 15-20 %, 20-25 %, >25 % were evaluated for different morphological, biochemical and physiological characters.

Expression of traits like Betagalactosidase (11 accessions), Polyphenol oxidase (16 accessions), Polygalacturonase (16 accessions), Starch (10 accessions), Reducing sugars (10 accessions), Relative fruit weight (17 accessions), Fruit length (17 accessions), Fruit diameter (17 accessions), Peduncle length (17 genotypes), Peduncle diameter (17 genotypes), Relative water content (17 accessions), Membrane thermal stability (12 accessions), Chlorophyll content (16 accessions), Proline content (17 accessions), were recorded in the selected genotypes with three replications.

Betagalactosidase enzyme is involved in cell wall loosening. It ranged from 1.13 (Yercaud HRS) to 3.31 (318803) in uncracked rind of germplasm, and from 1.14 (Yercaud HRS) to 3.77 µmol/mg/h (Yercaud) in cracked rind of germplasm. It was reported to increase in the rind of 6 germplasm out of 11 germplasm evaluated. Polygalacturonase activity ranged from 2 to 34 µmol/g/min. It was reported to increase in cracked rind of two germplasm and decrease in germplasm 1203. Polyphenol oxidase activity ranged from 0.06 to 0.31 U/ml. Its activity decreased in 9 germplasm, whereas increased in 6 germplasm.

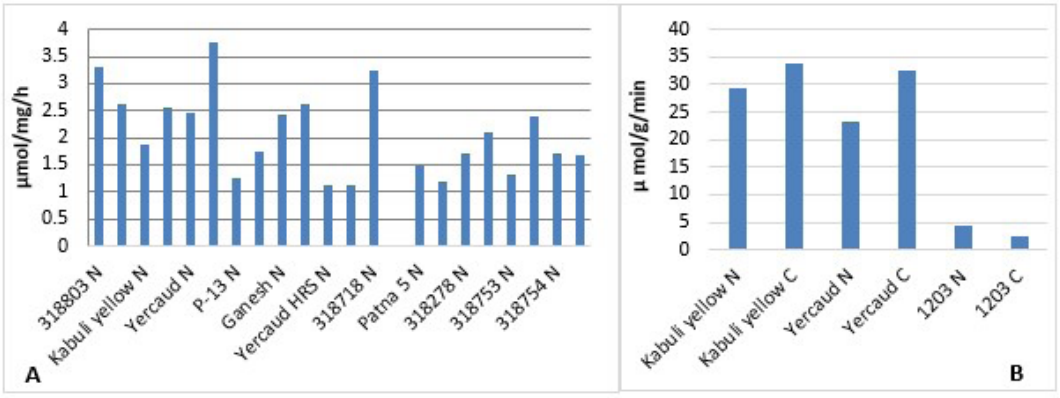


Fig.3 Changes in Beta galactosidase activity (A) and Polygalacturonase activity (B) in rind of normal and cracked pomegranate fruits

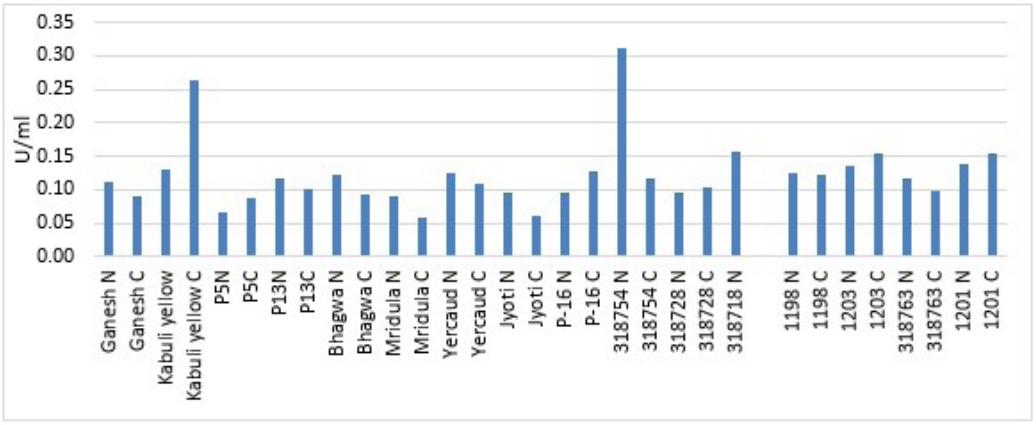


Fig 4. Changes in Polyphenol oxidase in rind of normal and cracked pomegranate fruits

Relative water content was more in uncraked rind as compared to cracked rind. Relative water content was maximum in uncracked rind of Yercaud HRS and 3188754, whereas least in germplasm 1198 and Kandhari. Rind membrane thermal stability was more in uncracked rind of all the tested germplasm compared to cracked rind. Germplasm 1198 exhibited maximum membrane thermal stability followed by Bhagawa and Patna 5, and it was least in Mridula.

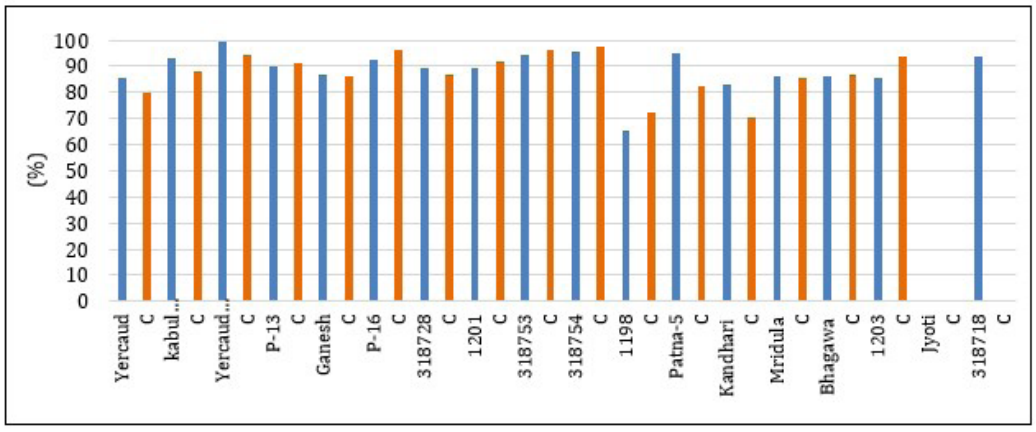


Fig 5. Relative water content of rind

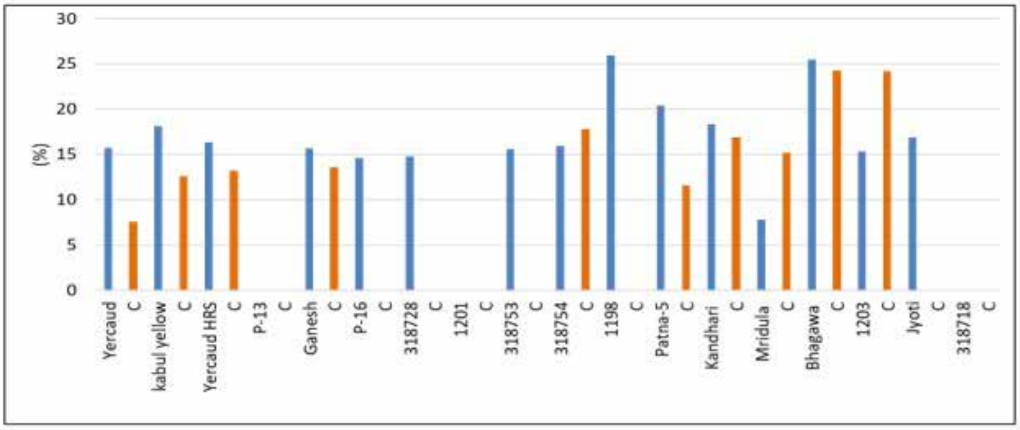


Fig 6. Membrane thermal stability of rind

Flower induction using plant growth hormones/signalling molecules

During Ambe bahar, plant growth hormones/signalling molecules were sprayed twice on plants of Bhagawa variety of pomegranate. Single dose/concentration of ten chemicals/ plant growth hormones *viz.,* Spermidine, Putrescine, 6BA, Ammonium sulphate, Potassium dihydrogen phosphate, NAA, Proline, Chitosan, Ascorbic acid and Paclobutrazol were sprayed twice at a gap of 15 days on newly expanded leaves of pomegranate plants in February. Three replications per treatment were used with two plants in each replication. Results are shown as average of 6 plants. The effect of these sprays on flowering pattern was recorded. The results showed that the male flower ranged from 393 (Paclobutrazol) to 667 (Ascorbic acid), female flowers ranged from 110 (Putrescine) to 218 (Proline) and intermediate from 8 (Chitosan) to 20 (Spermidine). Overall least flowering was reported in Paclobutrazol treated plants (612) and maximum in Proline (856) treated plants.

Influence of plant growth hormones/signalling molecules on flower number

Treatments	Male	Female	Intermediate	Total
Control	554	130	10	694
Spermidine (1.5 ppm)	577	201	20	798
Putrescine (44 ppm)	607	110	13	730
6BA (200 ppm)	527	210	15	751
Ammonium sulphate (0.5%/ 5000 ppm)	575	182	14	771
Potassium dihydrogen phosphate (0.5%/ 5000 ppm)	394	191	14	599
NAA (20 ppm)	413	197	12	622
Proline (100 ppm)	615	218	23	856
Chitosan (500 ppm)	565	126	8	698
Ascorbic acid (250 ppm)	667	156	14	837
Paclobutrazol (36 ppm)	393	206	13	612

Maximum increase in female flowering was reported by using Proline and increase was 40% as compared to control plants. 6 Benzyl adenine, Paclobutrazol and Spermidine also increased female flowers and increase was 38, 37 and 35% as compared to control.

Percent change in flowering due to treatments

Treatments	Female flower	Male flowers	Total flowers
Control			
Spermidine (1.5 ppm)	35	4	13
Putrescine (44 ppm)	-18	9	5
6BA (200 ppm)	38	-5	8
Ammonium sulphate (0.5%/ 5000 ppm)	28	4	10
Potassium dihydrogen phosphate (0.5%/ 5000 ppm)	32	-41	-16
NAA (20 ppm)	34	-34	-12
Proline (100 ppm)	40	10	19
Chitosan (500 ppm)	-3	2	1
Ascorbic acid (250 ppm)	17	17	17
Paclobutrazol (36 ppm)	37	-41	-13

Effect of treatments on Photosynthetic efficiency of pomegranate plants

Photosynthetic efficiency of plants treated with different chemicals/plant growth hormones ranged from 9.48 to 12.04 µmol CO_2 $m^{-2}s^{-1}$. Spermidine was most efficient in increasing rate of photosynthesis, followed by NAA and Ascorbic acid. Rate of photosynthesis increased by 14% with spermidine and 12% with NAA and ascorbic acid application as compared to control plants. Among the treatments rate of photosynthesis was least in Paclobutrazol treated plants. Proline and Potassium dihydrogen phosphate treatment also reduced rate of photosynthesis compared to control plants. Flowering showed positive correlation with photosynthesis (r = 0.47).

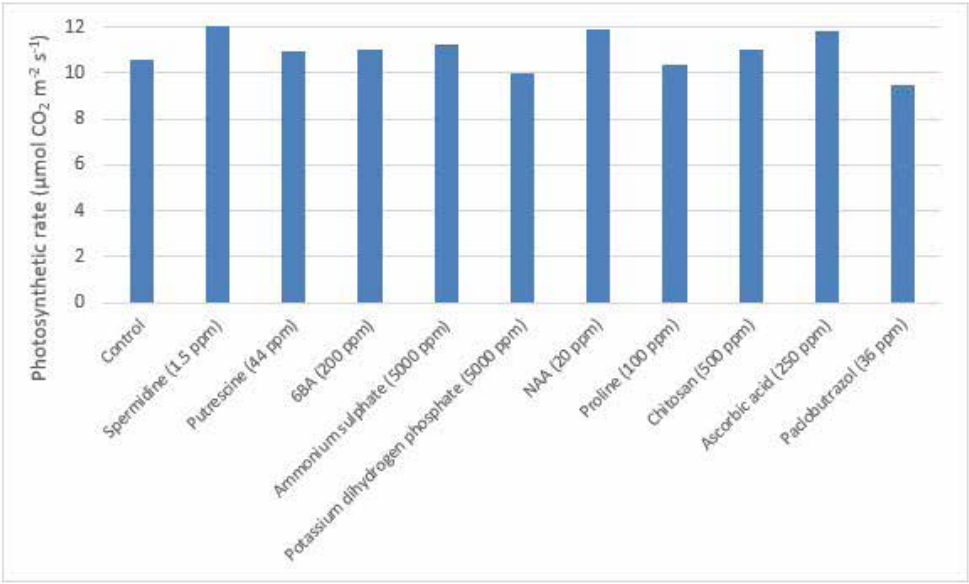


Fig 7. Changes in photosynthetic rate

Intercellular CO_2 concentration ranged from 158 to 192 µmol CO_2 mol^{-1}. It was maximum in Spermidine-treated plants and least in Paclobutrazol treated plants. Spermidine application increased the intercellular CO_2 concentration to 6%. Whereas, Paclobutrazol treatment decreased the concentration by 13% as compared to control plants. Transpiration rate ranged from 4.61 to 6.50 mmol H_2O $m^{-2}s^{-1}$. Transpiration rate was high in Spermidine treated plants and increase was 12% as compared to control. NAA treatment also showed high transpiration rate and increase was 8% as compared to control. Paclobutrazol treatment showed least rate of transpiration and it was 21% lower than control treatment. Likewise, water use efficiency (WUE) was maximum in Paclobutrazol treated plants that exhibited 13% more WUE than control plants, followed by Ammonium sulphate and Chitosan treatment.

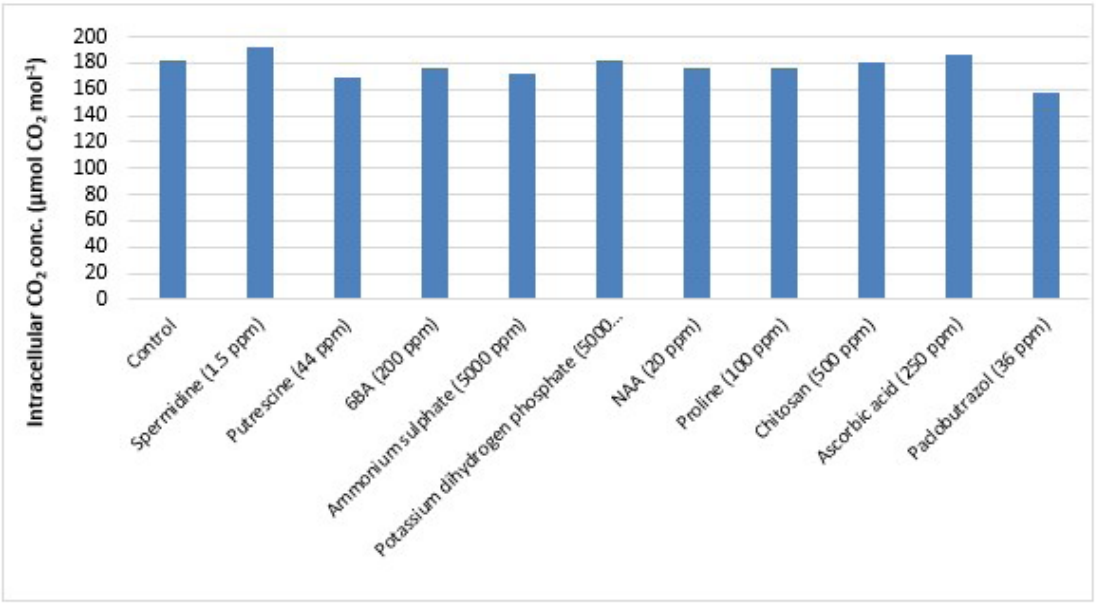


Fig 8. Changes in intracellular CO_2 concentration

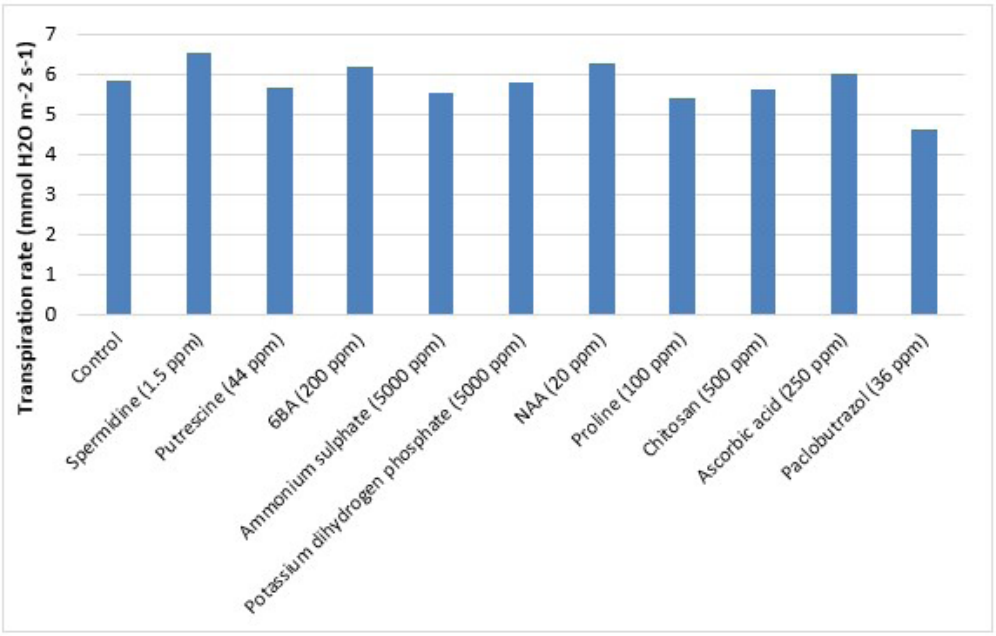


Fig 9. Changes in rate of transpiration

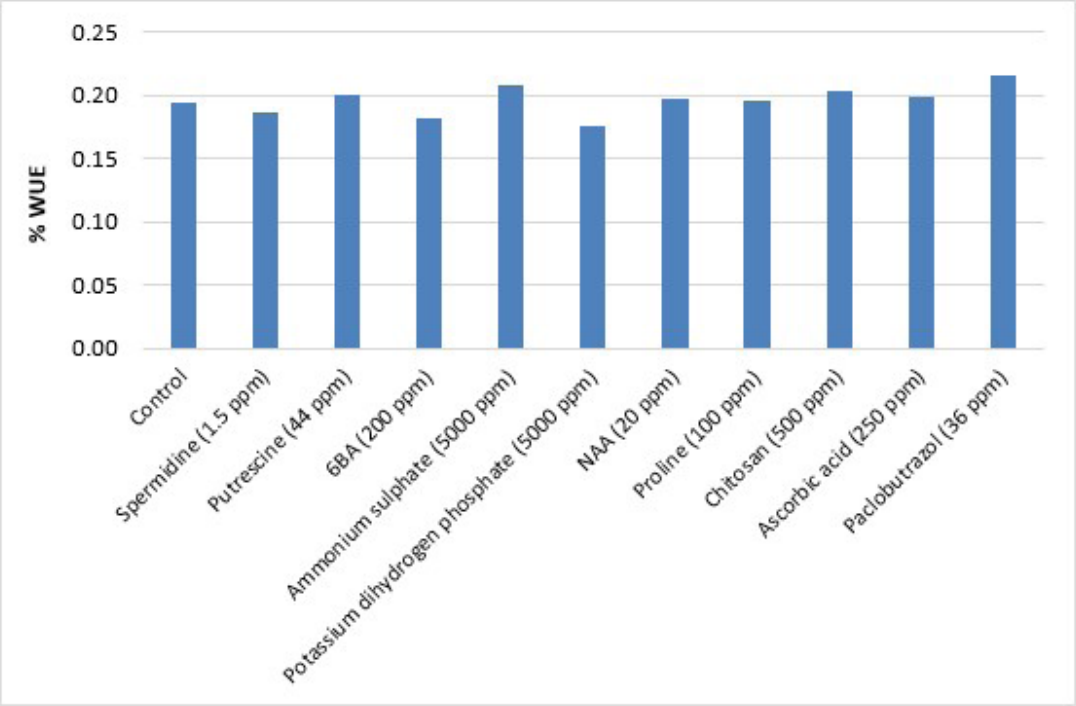


Fig 10. Changes in water use efficiency

Photosynthetic rate positively correlated with conductance (r = 0.931), intracellular CO_2 (r = 0.609), Ci/Ca (r = 0.665) and transpiration rate (r = 0.816). Conductance correlated positively with intracellular CO_2 (r = 0.742), Ci/Ca (r = 0.779) and transpiration rate (r = 0.854). Water use efficiency correlated negatively to most of studied parameters.

3.5 PROJECT: BIOTIC STRESS INDUCED BIOCHEMICAL AND EPIGENETIC CHANGES ASSOCIATED WITH MAJOR INSECT PESTS AND DISEASES IN DIVERSE POMEGRANATE (*PUNICA GRANATUM* L.) GENOTYPES

Biochemical analysis of Bhagawa in controlled greenhouse environment as well as field grown leaf samples:

Total Chlorophyll Content (TCC)

Comparisons of Bhagawa variety based on total chlorophyll content indicated that wilt stress treatment had maximum reduction of TCC (field wilt leaves sample 31.52% chlorophyll reduction and greenhouse wilt leaves samples 37.985%). The significant chlorophyll content reduction was observed in the greenhouse grown leaves samples. In case of bacterial blight stress imposition, slight reduction of TCC was observed (field BBD leaves sample 4.62% chlorophyll reduction and greenhouse wilt leaves samples 17.42%). In comparison bacterial blight and wilt, bacterial blight stress imposition in the field showed (12.8%) higher chlorophyll content reduction and wilt stress imposition showed (6.46%) slight chlorophyll content reduction.

Total Phenolic Content (TPC)

It was observed that bacterial blight stress imposition significantly increased the total phenolic content in both greenhouse condition and field growth. Whereas, moderate TPC increased

level was observed in wilt stress imposition in both field and greenhouse conditions. In case of bacterial blight stress imposition on Bhagawa pomegranate fruit showed very slight decrease in total phenolic content.

Lipid Peroxidation

In comparison with bacterial blight and wilt stress impositions, the significant increase in Malondialdehyde observed in wilt infected leaves samples. Whereas, moderate increased MDA level was observed in bacterial blight leaf samples and very slight increased MDA level was observed in bacterial blight infected samples.

Total Antioxidant Activity (TAO)

Estimation of total antioxidant activity of Bhagawa leaves and fruit samples were analyzed for bacterial blight and wilt stress impositions. The wilt stress (Bhagawa wilt leaves) imposition showed 8.55% increase in TAO and after 40 minutes it increased to 9.78%. In case of bacterial blight stress imposition (Bhagawa BBD leaves) showed 7.60% increase in TAO, whereas, 18.62% decrease in TAO after 40 min. In case of bacterial blight stress imposition (Bhagawa BBD fruit) showed slight increase 0.091% in antioxidant activity. Whereas, after 40 minutes' interval showed 1.44% decrease in TAO.

4. Crop Protection

4.1 PROJECT: DEVELOPMENT AND REFINEMENT OF INTEGRATED CROP PROTECTION TECHNOLOGIES FOR IMPROVED PRODUCTIVITY OF POMEGRANATE

Survey of insect pests affecting pomegranate orchards in Solapur District, Maharashtra

A survey was conducted in Maharashtra to assess the insect pests affecting pomegranate crop. The study covered an area of 120 acres, including 13 Tehsils in Solapur district. The primary pests identified were the shot hole borer (SHB), thrips, and stem borer. Among these, the SHB has emerged as a significant threat to pomegranate orchards in the Solapur district.

Infestation of major emerging pest- shot hole borer in different Tehsils of Solapur district

Taluka/ Tehsil	Villages	No. of observations taken	No. of Orchards covered	Per cent infestation (Range)
Mangalwedha	Mangalwedha and Khupsangi	3	8	41.8 - 66.7
Sangola	Vadegaon and Kadlas	4	10	38.8 - 65.0
Mohol	Echagoan, ,Kolegaon, Pokharpur and Penur	7	12	30.1 - 60.0
Pandharpur	Tungat, Vakhari and Bhandi-shegaon	4	8	23.6 - 37.5
Malshiras	Malshiras, sangam	4	10	32.2 - 50.0
Madha	Tembhurni and Varvade	5	8	20.0 - 30.6
North Solapur	Gulvanchi and Hiraj	3	7	15.7 - 25.2
Barshi	Dhamangaon and Chinch-Khopan	8	12	14.9 - 21.5
Akkalkot	Kumbhari and Maindaragi	2	5	15.0 - 24.3
South Solapur	Doddi	2	6	13.1 - 24.5
Total		**42**	**86**	**-**

The infestation of SHB was particularly severe in densely cultivated Tehsils such as Mangalwedha (41.8-66.7%), Sangola (38.8-65.0%), Mohol (30.2-60.0%), Pandharpur (23.6-37.5%), and Malsirus (32.2-50%). Comparatively lower infestation rates were observed in Madha (20.0-30.60%), North Solapur (15.7-25.2%), Barsi (14.9-21.5%), Akkalkot (15.0-24.3%), and South Solapur (13.1-24.5%) Tehsils, which have sparsely cultivated pomegranate orchards. Nevertheless, it is crucial to implement preventive measures in these Tehsils to prevent the further spread of SHB, as it tends to proliferate rapidly under changing climatic conditions. In newly planted orchards (less than three years old), stem borer infestation was relatively low and limited to the stem level. However, in older orchards (more than three years old), SBH infestation was observed on primary, secondary, and tertiary branches. In advanced stages, the SHB infestation reached the xylem of plants, obstructing water and nutrient uptake. This led to yellowing, wilting, and, eventually, partial or complete death of the plants. Infestation intensity increased with the age of the plants in the orchards. In Barsi Tehsil, stem borer infestation was severe (50%) in six plots in Dhamangaon.

Standardization of In-Vitro Rearing Protocol for *Euwallacea fornicatus*, the Shot Hole Borer Beetle, Using Modified Media Variants.

Evaluation of different media for standardization of *in vitro* rearing protocol for pomegranate shot hole borer

Treatments	Total female released / 6 Plate	No. of days survived (Avg.)	No. of life cycle completed
Media-I (PDA + Fungi)	6	27.7	0
Media-II PDA+ Bhagawa bark dust (100 g)	6	28.0	0
Media-III Semisynthetic media	6	35.0	1

Media-III Ingredient	Quantity (g/mg)
Yeast	6
Casein	15
Pomegranate plant bark sawdust	100
Sucrose	10
Agar	15
Wesson's salt mixture	1.5
Sterile distilled water	600
Streptomycin	350 mg

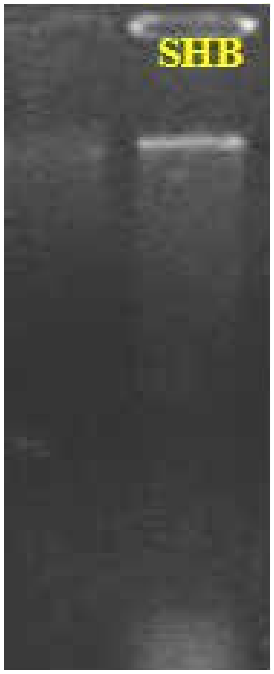
Preparation of bark and stem powder for media preparation

An experiment was carried out to standardize the *in vitro* rearing protocol for the shot hole borer beetle, *Euwallacea fornicatus*, using three media variants: Media-I (PDA + symbiotic fungi), Media-II (PDA + pomegranate bark dust), and Media-III (semisynthetic medium). The modified semisynthetic medium, containing pomegranate bark sawdust, successfully supported the *in vitro* rearing of shot hole borer beetles associated with pomegranate wilt, allowed to study their biology and aetiology.

This study improved our understanding of the beetle's tunnelling behavior and biology while demonstrating the feasibility of *in vitro* rearing. The media were prepared using the Biederman method with minor modifications to meet the nutritional requirements of the pomegranate shot hole borer. Adult females were transferred to media tubes and incubated for 40-55 days under dark conditions. The results showed that beetles survived for 27.7 and 28.0 days in Media I and II, respectively, without reproduction. However, in semisynthetic Media III, the beetles survived for 35 days and completed one life cycle. This modified medium has the potential for further refinement to enable *in vitro* mass rearing of the shot hole borer.

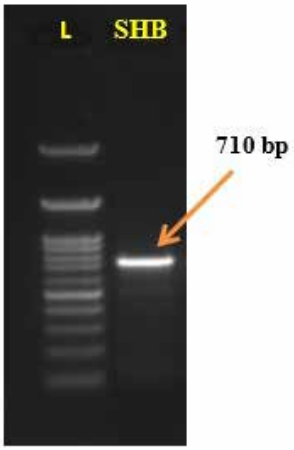
Molecular Characterization of the pomegranate shot hole borer (*Euwallacea fornicatus*) using species-specific primers and DNA sequencing

For molecular characterization of the pomegranate shot hole borer, genomic DNA was extracted using a standardized CTAB method. Species-specific primers were used to identify isolated pathogens at the species level.



Quantification and quality check of DNA of SHB

For the identification of SHB beetles collected from different locations, a set of species-specific primers targeting CO-I *i.e.* LCO1490 and HCO2198 were employed. The PCR product primed with these primers produced DNA fragments of the expected product length (710 bp), and confirmed the isolates collected were *Euwallacea fornicatus*.



PCR amplification by CO-I primers

To further verify the identity of the isolates, the CO-I region of the DNA was partially sequenced and the obtained sequences were subjected to a multiple sequence alignment using nBLAST option in NCBI database. The analysis revealed that the nucleotide sequences of our isolates were 100% identical to *E. fornicatus*. Thus, the identity of our isolates was re-confirmed through partial sequencing. This method will contribute to the understanding and molecular identification of this important pest species.

Sequence analysis of different isolates

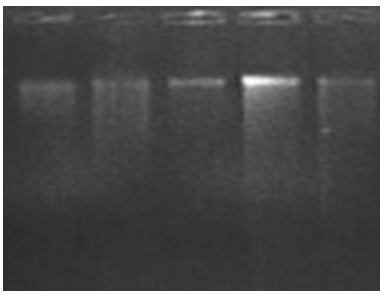
Organism	Region Amplified	Sequence ID	Isolate code	Date of Submission	Accession Number
Euwallacea fornicatus	CO-I Sequence	*Euwallacea fornicatus* isolate MH-SPR-001 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial.	E-11	24/06/2022	ON063908.1

Isolate E-11 was found 100 per cent identical to the known species of ***E. fornicatus*** sequence

Molecular characterization of fungi associated with pomegranate shot hole borer

This molecular study was carried out to characterize different fungi associated with the pomegranate shot hole borer. Genomic DNA was extracted from the fungal isolates using a standardized CTAB method, and the quality of the extracted DNA was confirmed through 1% agarose gel electrophoresis. Species-specific primers were employed for species-level identification of the isolated fungi, with the specificity of the primers confirmed through polymerase chain reaction (PCR) and gel documentation.

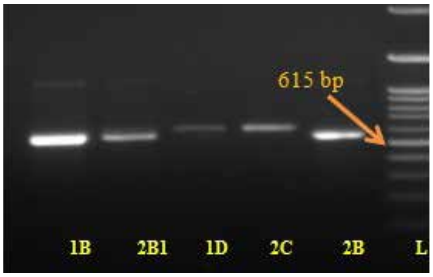
Fungal colonization on pomegranate stem



Quality check of fungal DNA

For the identification of fungal isolates collected from various locations, species-specific primers ITS1/ITS4 were used. The PCR products primed with these primers yielded DNA fragments of the expected lengths.

Fungal isolation from Shot Hole Borer



PCR amplification by ITS primers

To further validate the identity of the isolates, partial sequencing of the ITS region was performed, and the obtained sequences were analyzed using the nBLAST option of NCBI database. The blast analysis revealed that our isolates shared 94.51% and 92.14% nucleotide similarities with uncultured *Fusarium* and *Colletotrichum gloeosporioides*, respectively.

These findings provide insights into the molecular characteristics of fungi associated with the pomegranate shot hole borer. The identification and partial sequencing of these fungi contribute to our understanding of their diversity and potential involvement in the interaction between the SHB and pomegranate trees. Further research is warranted to explore the pathogenicity and ecological implications of these fungi in the context of pomegranate orchards.

Sequence analysis of different isolates

Sr. No.	Organism	Region Amplified	Sequence ID	Isolate code	Date of Submission	Accession Number
1.	Uncultured *Fusarium*	ITS	>0622_708_006_PCR_E8_ITS_PI_C05.ab1	E-8 2B-1	24/06/2022	MG462858.1
2.	*Colletotrichum gloeosporioides*	ITS	>0622_708_007_PCR_E9_ITS_PI_D05.ab1	E-9 1D	24/06/2022	OM913143.1

Incidence of shot hole borer infestation in six commercially cultivated pomegranate varieties

Plant spacing (m)	Variety	Total No. of plants	No. of plants infested by SHB	Avg no. of hole/ plant	Range of holes		% infestation
					Min	Max	
4.5*3	Ganesh	58	57	50.5	0	186	98.3
4.5*3	Super Bhagawa	58	58	30.6	4	77	100
4.5*3	Arakta	56	56	28.9	6	81	100
4.5*3	Mridula	53	53	34.9	10	82	100
4.5*3	G-137	58	58	41.9	5	136	100
4.5*3	Bhagawa	57	57	32.6	6	79	100
4.5*2.5	Bhagawa	68	68	34.0	12	68	100
4.5*2.0	Bhagawa	82	82	28.8	6	82	100
3.6* 2.5	Bhagawa	140	140	23.9	8	140	100

This study aimed to observe the incidence of shot hole borer infestation in six commercially cultivated varieties of pomegranate, namely Ganesh, Super Bhagawa, Arakta Mridula, G-137 and Bhagawa. The observations were recorded based on the average number of holes per plant, ranging from a minimum of 28.88 in the Arakta variety to a maximum of 50.53 in the Ganesh variety, using the recommended spacing of 4.5*3m. The number of holes per plant varied from 0 to 10 for the minimum category and from 77 to 186 for the maximum category. The per cent infestation ranged from 98.3% in Ganesh to 100% in all varieties.

Additionally, the Bhagawa variety was planted in three different spacing configurations (4.5*2.5, 4.5*2m, and 3.6*2.5). The average number of holes per plant ranged from a minimum of 23.9 to a maximum of 34.0, with the number of holes per plant ranging from 6 to 12 in the minimum category and from 68 to 140 in the maximum category. The per cent infestation was 100% in all three different spacing configurations.

These findings provide valuable insights into the incidence and severity of shot hole borer infestation in different commercially cultivated pomegranate varieties. Understanding the variation in infestation levels can help in the development of targeted management strategies and the selection of resistant varieties for sustainable pomegranate cultivation.

Trapping efficiency of blue sticky traps and population dynamics of different insect pests and natural enemies in a pomegranate orchard

Trap No.	Average no. of different insect pests trapped			
	Thrips (S. dorsalis)	Ladybird beetle (C. Sexmaculata)	House flies	Mosquitos
1	63.0	4.5	14.0	15.0
2	106.5	4.5	14.5	9.0
3	99.5	3.5	11.0	9.0
4	189.0	6.5	15.0	7.0
5	123.0	1.5	12.0	3.0
6	151.0	1.0	18.0	9.0
7	64.0	5.0	15.0	16.0
8	108.5	6.5	16.5	11.0
9	187.0	5.5	14.0	6.0
10	121.0	1.0	10.0	1.0
Total	**904.5**	**33.0**	**116.0**	**79.0**
Min	**63.0**	**1.0**	**11.0**	**3.0**
Max	**189.0**	**6.5**	**18.0**	**16.0**

An experiment was conducted to evaluate the efficacy of the blue sticky traps against different insect pests and natural enemies in the pomegranate crop. The given data represents the average number of different insect pests trapped using a ten-trap over a period of 10 observations. The insects captured include thrips (*S. dorsalis*), ladybird beetles (*C. sexmaculata*), house flies and mosquitoes. The average number of thrips trapped ranged from a minimum of 63.0 to a maximum of 189.0. The total number of thrips trapped over the 10 observations is 904.5. The average number of ladybird beetles trapped ranged from a minimum of 1.0 to a maximum of 6.5. The total number of ladybird beetles trapped over the 10 observations is 33.0. The average number of house flies trapped ranges from a minimum of 10.0 to a maximum of 18.0. The total number of house flies trapped over the 10 observations is 116.0. The average number of mosquitoes

trapped ranges from a minimum of 1.0 to a maximum of 16.0. The total number of mosquitoes trapped over the 10 observations is 79.0. The data provides information about the trapping efficiency for each insect pest over multiple observations. It shows the variation in the number of pests captured, both in terms of individual observations and the overall total.

Bioefficacy evaluation of newer insecticide formulations against pomegranate stem borer (*Coelosterna spinator*)

Bioefficacy evaluation of different insecticides against stem borer (*C. spinator*)

Treatments	Treatment details	Dosage/g/ml/l water
T1	**Emamectin benzoate 5% SG**	**2 gm**
T2	Imidacloprid 30.5% SC	2 ml
T3	Thiamethoxam 25 % WG	2 gm
T4	Tolfenpyrad 15 % EC	2 ml
T5	Afidopyropen 50 g/L DC	2 ml
T6	Flonicamid 50 WG	2 gm
T7	**Emamectin benzoate 3%+ Thiamethoxam 12% WG**	**2 gm**
T8	Control	Water

The objective of this study was to assess the bioefficacy of six different insecticide formulations against the pomegranate stem borer (*C. spinator*). The experiment involved three treatment methods: stem injecting, drenching, and a combination of stem injecting and drenching. The evaluation was conducted during the second season using a dosage of 2 ml/g/l water. The recovery of pomegranate plants was recorded as an indicator of the effectiveness of each treatment.

Stem Injecting: Out of the seven treatments applied through stem injection, treatments T1 and T7 demonstrated the highest plant recovery rate at 63.3%, while the remaining treatments resulted in a lower recovery rate of 30.7%. No plant recovery was observed in the control group.

Drenching: Among the seven treatments applied through drenching, treatments T1 and T7 exhibited the most promising results, with a plant recovery rate of 99%. The other treatments yielded a recovery rate of 64.7%, while the lowest recovery rate of 30.7% was observed in treatment T2. No plant recovery was observed in the control group.

Stem Injecting + Drenching: In the combined treatment of stem injecting and drenching, treatment T7 showed the highest level of control at 99%, while all other treatments resulted in a recovery rate of 30.7%. The control group did not show any plant recovery.

Based on the results of this study, treatments T1 and T7 were identified as promising for the management of pomegranate stem borer.

Bioefficacy evaluation of different insecticide formulations against pomegranate shot hole borer

Treatment	Treatment details	Dosage/g/ml/ Lit	Dosage/g/ ml/l
T1	Emamectin benzoate 5% SG+ Propiconazole 25% EC	1gm +1 ml	2+2
T2	Imidacloprid 30.5% SC + Propiconazole 25% EC	1ml + 1 ml	2+2
T3	Thiamethoxam 25 % WG+ Propiconazole 25% EC	1gm + 1 ml	2+2

Treatment	Treatment details	Dosage/g/ml/ Lit	Dosage/g/ ml/l
T4	Tolfenpyrad 15 % EC + Propiconazole 25% EC	1ml + 1 ml	2+2
T5	Afidopyropen 50 g/L DC + Propiconazole 25% EC	1 ml + 1 ml	2+2
T6	Flonicamid 50 WG + Propiconazole 25% EC	1gm + 1 ml	2+2
T7	Emamectin benzoate 3%+ Thiamethoxam 12% WG + Propiconazole 25% EC	1 gm + 1 ml	2+2
T8	Chlorpyriphos 20% EC (Check) + Propiconazole 25% EC	1ml+ 1 ml	2+2
T9	Control	Water + Sticker	Water + Sticker

The aim of this study was to assess the effectiveness of eight different insecticide formulations against the pomegranate shot hole borer using the drenching method. Two doses (1 and 2 ml/l water) of each formulation were tested, and the recovery of pomegranate plants was used to measure the treatment efficacy.

Among the nine treatments evaluated in the second season, treatment T7 exhibited the highest plant recovery rates. At a dose of 1 ml, it resulted in a recovery rate of 68.6%, while at a dose of 2 ml, the recovery rate was 97.4%. The next most effective treatment was T1, which achieved recovery rates of 57.7% and 96.2% for the 1 ml and 2 ml doses, respectively. The standard check treatment, T8, showed recovery rates of 46.5% and 68.4% for the respective doses. Treatment T5 had the lowest recovery rates of 28.0% and 34.5% for the 1 ml and 2 ml doses, respectively. The control treatment did not result in any plant recovery.

Based on the experimental findings, treatments T7 and T1 were identified as the most effective in managing the pomegranate shot hole borer as a curative measure. Treatment T7, which included Emamectin benzoate 3%, Thiamethoxam 12% WG, and Propiconazole 25% EC, showed the highest recovery rates at both doses. Treatment T1, comprising Emamectin benzoate 5% SG and Propiconazole 25% EC, also demonstrated significant efficacy against the SHB.

Bioefficacy evaluation of newer insecticides against invasive mealybugs

Trt.	Insecticides	Dose (ml/g/ l water)
T1	Alika (Thiamethoxam 12.6 % +Lambda cyhalothrin 9.5% ZC)	0.75
T2	Cyantraniliprole 10.26 % OD	0.3
T3	Spinosad 45 % SC	0.5
T4	Tolfenpyrad 15 % EC	0.75
T5	Sefina (Afidopyrofen 50G/L DC)	0.75
T6	Ulala (Flonicamid 50% W/W)	0.75
T7	Encounter (Emamectin benzoate 3%+ Thiamethoxam 12% WG)	0.75
T8	Hercules (Difenthiuron 40.1% + Acetamiprid 3.9% WP)	0.75
T9	Delegate (Spinetoram 11.7% SC)	0.75
T10	Control	Water + Sticker

The study aimed to determine the percentage reduction in mealybug infestation and the impact on fruit damage. Several treatments were tested, and their performances were compared to

the control group. Among the tested treatments, the combination of Thiamethoxam 12.6% and Lambda-cyhalothrin 9.5% in ZC formulation (T1) showed the highest percentage reduction over the control, with a value of 70.5%. This treatment demonstrated a significant decrease in mealybug infestation, resulting in a substantial number of fruits being free from damage. Following closely behind was T7, which consisted of Emamectin benzoate 3% and Thiamethoxam 12% in WG formulation, recording a reduction of 68.4% in fruit damage. T9, containing Spinetoram 11.7% in SC formulation, also showed promising results with a reduced rate of 77.2%. On the other hand, T5, using Afidopyrofen 50G/L in DC formulation, exhibited the lowest reduction rate of 66.5% in fruit damage. The control group did not show any reduction in damage.

These findings indicate that the treatments involving Thiamethoxam, Lambda-cyhalothrin, Emamectin benzoate, and Spinetoram have demonstrated higher efficacy in controlling invasive mealybugs and reducing fruit damage. However, further research is necessary to understand the long-term effects of these treatments and their potential impacts on other aspects of crop cultivation.

Mealybug infestation on pomegranate

In vitro evaluation of solar light against fruit-sucking moths

Time (pm)	No. of moth attracted	Male	Female
6.00	3	2	1
6.15	4	2	2
6.30	2	2	0
6.45	2	3	0
7.00	6	4	2
7.15	7	5	2
7.30	6	5	1
7.45	6	4	2
8.00	5	4	1
Total	**41**	**31**	**11**

The above table presents the results of a second season *in vitro* evaluation of solar light traps against fruit-sucking moths. The study aimed to assess the efficacy of two different light traps in attracting male and female moths. Both traps were operated using 230 volts AC.

Trap-1, which utilized a violet SMD UV LED with a wavelength of 395nm, attracted a total of 34 moths. Among these, 28 were male moths, while 6 were female moths. On the other hand, Trap-2, which employed a water LED blue LED with a wavelength of 465nm, did not attract any moths. The total number of moths attracted in Trap-1 was 34, while Trap-2 did not attract any moths.

These results indicate that Trap-1, with the violet SMD UV LED light source, was highly effective in attracting fruit-sucking moths, capturing a significant number of male and female moths. In contrast, Trap-2, with the water LED blue LED light source, did not demonstrate any attraction towards the moths.

The findings suggest that the wavelength and type of light source used in the trap have a substantial impact on its efficacy in attracting fruit-sucking moths. Trap-1, with its violet SMD UV LED, proved to be a promising tool for trapping these moths under *in vitro* conditions. Further research and field trials are needed to validate these results and assess the practical application of Trap-1 in controlling fruit-sucking moth populations in real-world settings.

Bioefficacy evaluation of different bioagents against stem borer (*C. spinator*) Infestation

Trt.	Treatment details	Dosage (ml)	Plants recovery (%)
1	*Metarhizium anisopliae* (CFU: 2*108/ml)	10	100
2	*Trichoderma viride* (CFU: 2*108/ml)	10	50
3	*Bacillus subtilis* (CFU: 2*108/ml)	10	100
4	*Azospirillum umbrasilense* (CFU:10*108/ml)	10	25
5	*Verticillium lecani* (CFU: 2*108/ml)	10	50
6	PSB (CFU:10*108/ml)	10	25
7	*Pseudomonas fluorescence* (CFU: 2*108/ml)	10	100
8	Control (Water)	10	0.0

The given data presents the bioefficacy evaluation of various bioagents against the stem borer insect, (*C. spinator*). The experiment involved treating the plants with different bioagents and then observing the recovery of the plants after four days of treatment (4 DAT). The treatments were conducted on 11th January 2022, and the observations were made from 12th to 15th January 2022. The dosage of each bioagent was 10 ml.

1. *Metarhizium anisopliae* (CFU: 2*10^8/ml): The plants treated with this bioagent showed a 100% recovery rate, indicating that it was highly effective in combating the stem borer.
2. *Trichoderma viride* (CFU: 2*10^8/ml): The plants treated with this bioagent exhibited a 50% recovery rate, suggesting moderate efficacy against the stem borer.
3. *Bacillus subtilis* (CFU: 2*10^8/ml): The plants treated with this bioagent demonstrated a 100% recovery rate, indicating a high level of efficacy.

4. *Azospirillum umbrasilense* (CFU: 10*10^8/ml): The plants treated with this bioagent showed a 25% recovery rate, suggesting a lower efficacy compared to the previous treatments.
5. *Verticillium lecanii* (CFU: 2*10^8/ml): The plants treated with this bioagent exhibited a 50% recovery rate, indicating moderate efficacy against the stem borer.
6. PSB (CFU: 10*10^8/ml): The plants treated with Phosphate-solubilizing bacteria demonstrated a 25% recovery rate, suggesting lower efficacy similar to *Azospirillum umbrasilense.*
7. *Pseudomonas fluorescence* (CFU: 2*10^8/ml): The plants treated with this bioagent showed a 100% recovery rate, indicating a high level of efficacy.
8. Control (Water): The control group treated with water did not show any recovery, as indicated by a 0.0% recovery rate.

In summary, based on the given data, the bioagents *Metarhizium anisopliae*, *Bacillus subtilis,* and *Pseudomonas fluorescence* demonstrated high efficacy in controlling the stem borer insect, with recovery rates of 100%. *Trichoderma viride* and *Verticillium lecanii* exhibited moderate efficacy with recovery rates of 50%. *Azospirillum umbrasilense* and PSB showed lower efficacy with recovery rates of 25%. The control group treated with water showed no recovery.

The emergence of black scale, Parasaissetia nigra (*Coccidae Hemiptra*) as a new insect pest on Pomegranate

Shoot length 10cm								Average No. of insects /10cm
Shoot No.	1	2	3	4	5	6	7	-
Width of shoot (cm)	2.3	3.2	2.7	2 .0	1.7	1 .0	1.2	2.01
No. of Insects	71	98	92	58	11	8	39	53.9

The given data pertains to the occurrence of a new insect pest problem in pomegranate, specifically the black-scale insect (*Parasaissetia nigra*) from the family Coccidae and the order Hemiptera. The data includes information on shoot length, the average number of insects per 10 cm of shoot, and the corresponding measurements for seven different shoots.

Results:

- Shoot Length: The shoot lengths range from 10 cm for all the measurements.
- Average Number of Insects per 10 cm: The average number of black scale insects varies across the different shoots, ranging from 8 to 98.
- Width of Shoot: The width of the shoots also varies, with measurements ranging from 1.0 cm to 3.2 cm.
- No. of Insects: The specific counts of black-scale insects for each shoot range from 11 to 98.

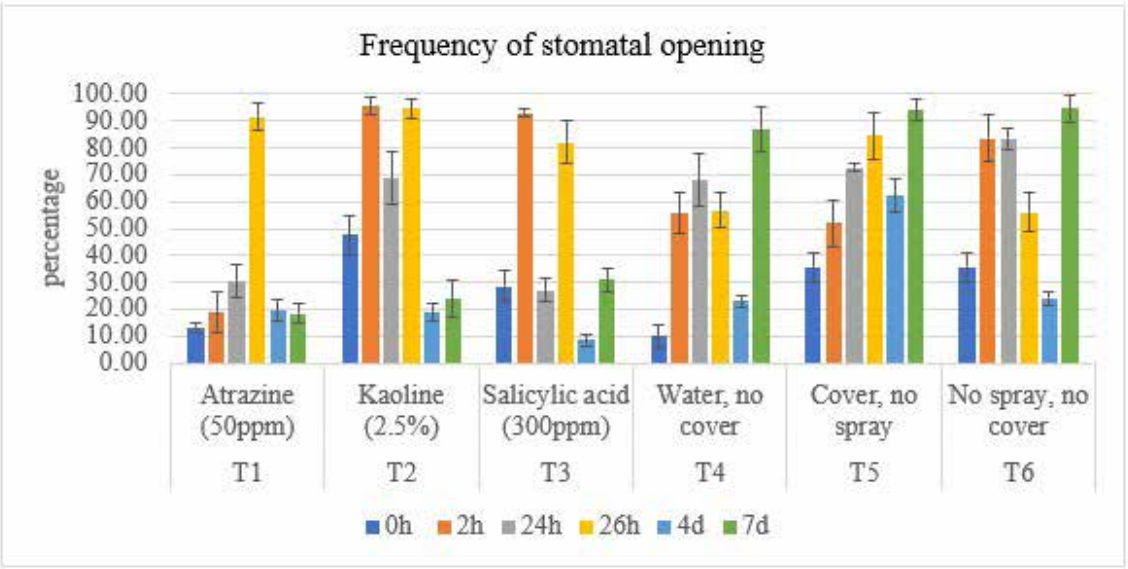
Overall, the data indicates the presence of the black-scale insect, *Parasaissetia nigra,* on pomegranate shoots. The number of insects per 10 cm of shoot varies across the measured shoots, suggesting varying levels of infestation. This data can be used to assess the severity of the pest problem and guide appropriate pest management strategies to mitigate the impact of the black scale on pomegranate crops.

Black scale, *Parasaissetia nigra* infestation on pomegranate stem

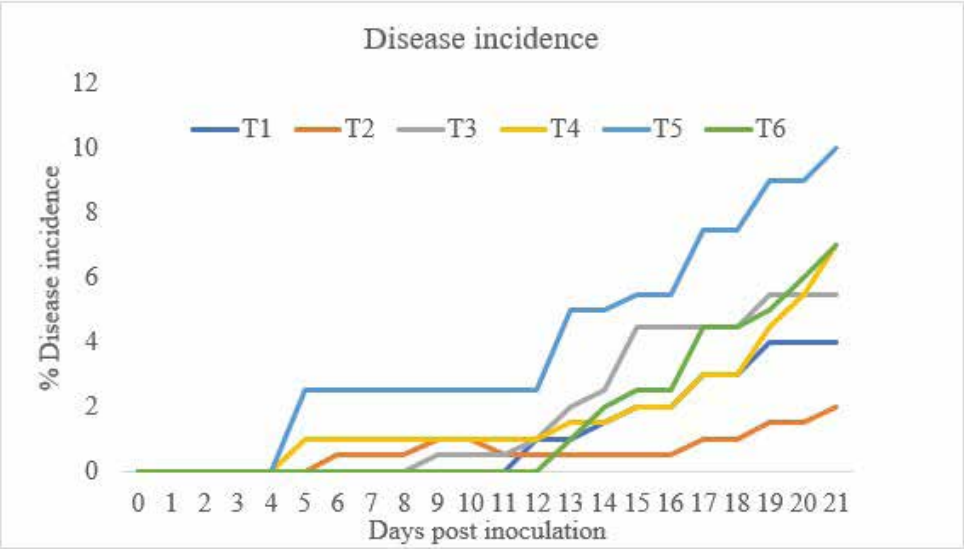
4.2 PROJECT: EPIDEMIOLOGY AND SUSTAINABLE MANAGEMENT OF ECONOMICALLY IMPORTANT PHYLLOPLANE DISEASES OF POMEGRANATE

Effect of anti-transpirants on bacterial blight disease incidence

Effect of anti-transpirants on stomatal opening and thereby on bacterial blight disease incidence was evaluated. Minimum disease incidence and/or severity was observed in plants treated with kaoline followed by atrazine and salicylic acid. The frequency of open stomata showed variation at different time points, however, a slight correlation was found between stomatal opening at 7 d and disease incidence on the plants.



Effect of anti-transpirants on stomatal opening at different days interval



Effect of anti-transpirants spray on occurrence of disease incidence of bacterial blight

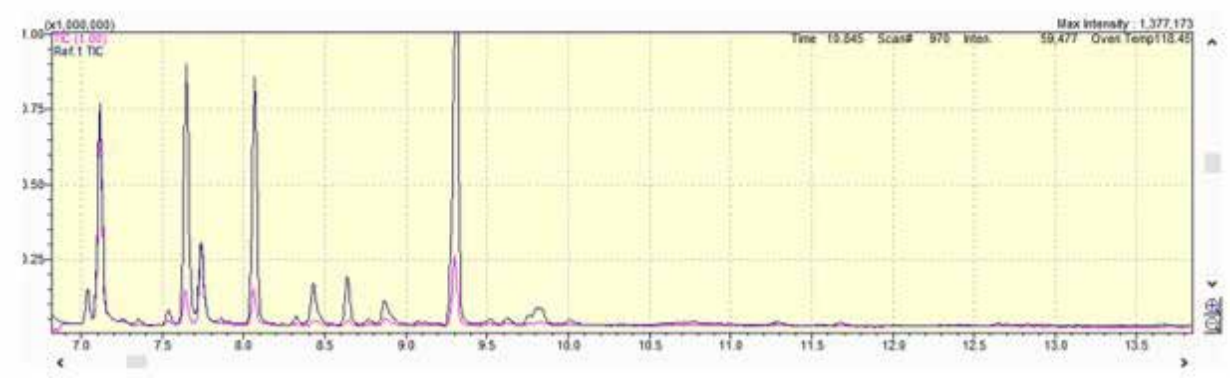
Whole genome sequence of bacterial blight causing *Xanthomonas axonopodis* pv. punicae

We carried out whole genome sequencing of one of the most prevalent and virulent isolates of *Xanthomonas axonopodis* pv. *punicae* (Xap-118) to gain insights into genomic features that will help in devising better management strategies. Sequencing was carried out by 2 next generation sequencing methods: Illumina Next seq500 and Pac Bio which allowed us to obtain both short and long reads. The hybrid assembly revealed the size of the genome to be 5.2 Mb with a GC content of 64.7%. There were more than 4000 CDS with gene average size being 980 bp. Further, approximately 2000 genes were annotated on the basis of their ontology with respect to biological process, their cellular location or molecular function. Table shows genomic features of *Xanthomonas axonopodis* pv. *punicae* as revealed by hybrid assembly of whole genome sequence.

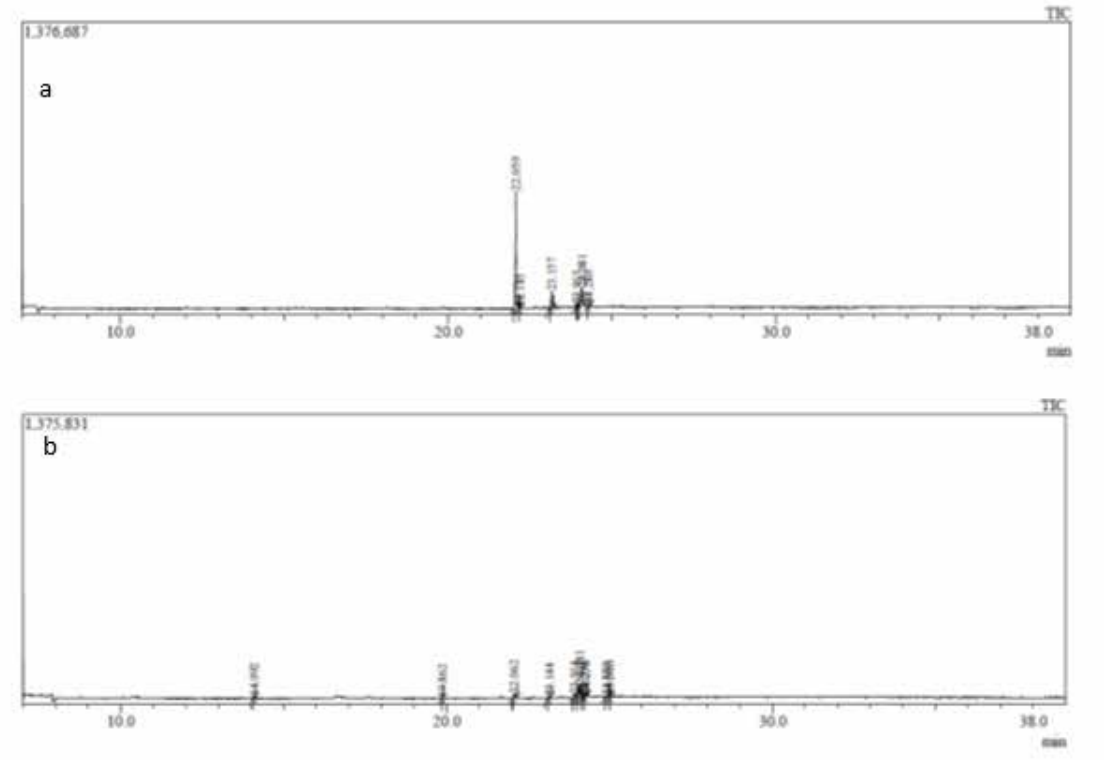
Total length (bp)	5.2 Mb
GC %	64
Total no. of predicted genes	4,371
Genes with Gene Ontology	2,432
Genes with Biological process	1,642
Genes with Molecular function	1,954
Genes Cellular component	1,181
Proteins (CDS)	4,231
rRNAs	6
tRNAs	58
Average size of genes	980
Maximum size of gene	11,694
Minimum size of gene	49

Volatile organic compounds (VOCs) profiling of bacterial endophytes and fungal bioagents using GC-MS

VOC profiling of two promising fungal bioagents and two bacterial endophytes was performed using Gas chromatography and Mass Spectrometry (GC-MS). Extraction of VOCs was performed in different solvents such as dichloromethane (DCM) and methanol with varying polarity. The results revealed that all the isolates contained bioactive compounds such as Hexadecanoic acid, methyl ester, Cyclopropaneoctanoic acid, 2-hexyl-, methyl ester, 12-Octadecenoic acid, methyl ester and Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(2-methylpropyl) that could have inhibitory action against the pathogens.



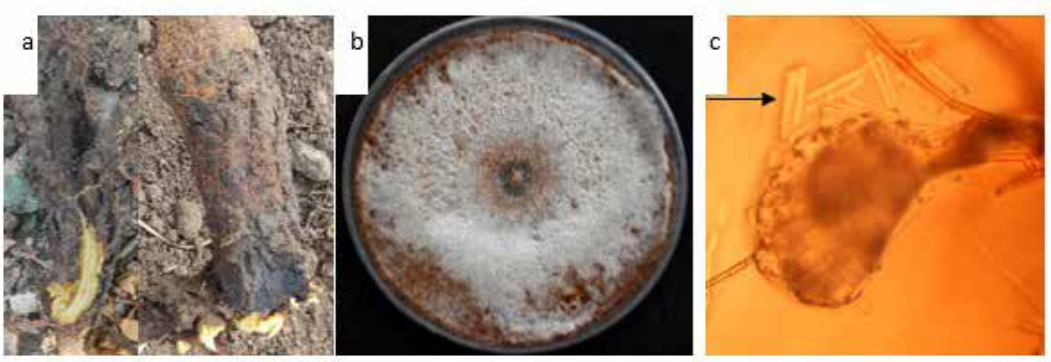
Chromatograms of Volatile Organic Compounds extracted in dichloromethane from two promising fungal bioagents KA-54: Trichoderma erinaceum (blue), KA-40: *Aspergillus flavus* (pink).



Chromatograms of Volatile Organic Compounds extracted in methanol from two promising bacterial endophytes TC-6: *Bacillus subtilis* (a) TC-310: *Bacillus tequilensis* (b)

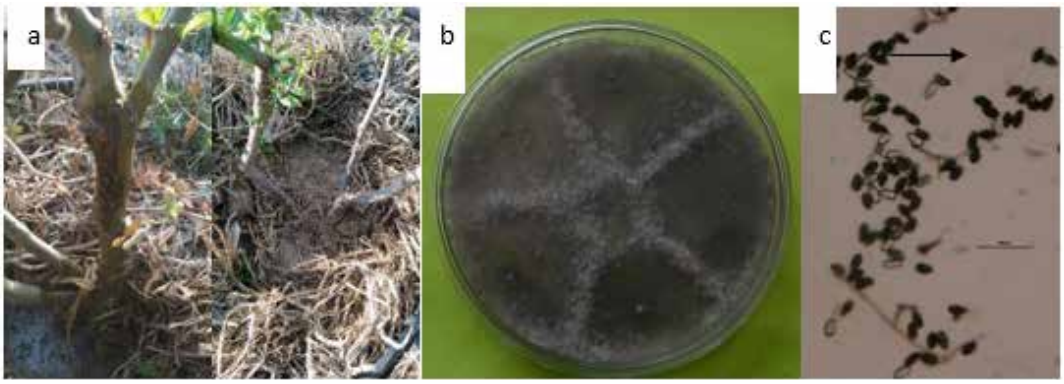
Identification and Characterisation of new pathogens causing diseases in pomegranate

During 2020–21, a typical collar rot on pomegranate plants (with 10–25% incidence) was observed in several orchards of Indapur, Maharashtra, India. Infected plants in the field exhibited yellowing and wilting of leaves, brownish-black discolouration of inner bark, blackening and rotting of roots and collar region. Isolations from symptomatic root and collar tissues showed whitish brown colonies after 2 days which turned dark brown in 7 days. Cylindrical macroconidia (40-43 x 3.5-4.8 µm), formed on penicillate conidiophores within 10 days, were hyaline and typically 0–1 septate, and stipes terminated in obpyriform to ellipsoidal vesicles. Molecular identification on the basis of gene sequencing (BankIt accession numbers: ON605200, ON605201) revealed the pathogen to be *Calonectria hawksworthii* with 98-100% homology.



Pomegranate plants exhibiting collar rot in orchards. (b) Colony morphology of the causative fungus on PDA. (c) Conidia produced by the fungus *Calonectria hawksworthii*

In March 2022, cankers and lesions appeared on the branches of 2–3-year-old pomegranate plants grown in four orchards of Hanumangarh, Rajasthan, India. The disease incidence ranged from 5-15%. Field symptoms such as dark brown lesions on one side of the branches, cracked lesions, vascular tissue discoloration and drooping of the plants were noticed. Isolations from symptomatic branches produced colonies with greyish white aerial mycelia, which became dark black after 5-7 days. Immature conidia (6.3±1.05*14.7±0.98 µm: average of 50 measurements) were single celled, hyaline, ellipsoid or ovoid, apex rounded and truncated at the base while the matured conidia (8.4±1.41*15.3±1.17 µm: average of 50 measurements) had two cells with dark septa. Molecular identification on the basis of gene sequencing (BankIt accession numbers: ON605203 and ON605204) revealed the pathogen to be *Lasiodiplodia theobromae*.

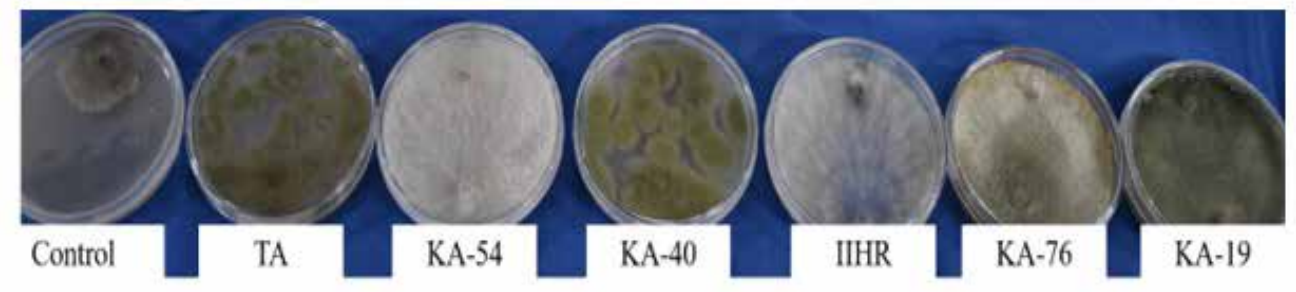


(a) Pomegranate plants exhibiting stem canker in orchards. (b) Colony morphology of the causative fungus on PDA. (c) Conidia produced by the fungus *Lasiodiplodia theobroma*

4.3 PROJECT: STUDIES OF WILT COMPLEX IN POMEGRANATE

Antagonistic activity of fungal bioagents against pomegranate wilt-causing *Ceratocystis fimbriata*

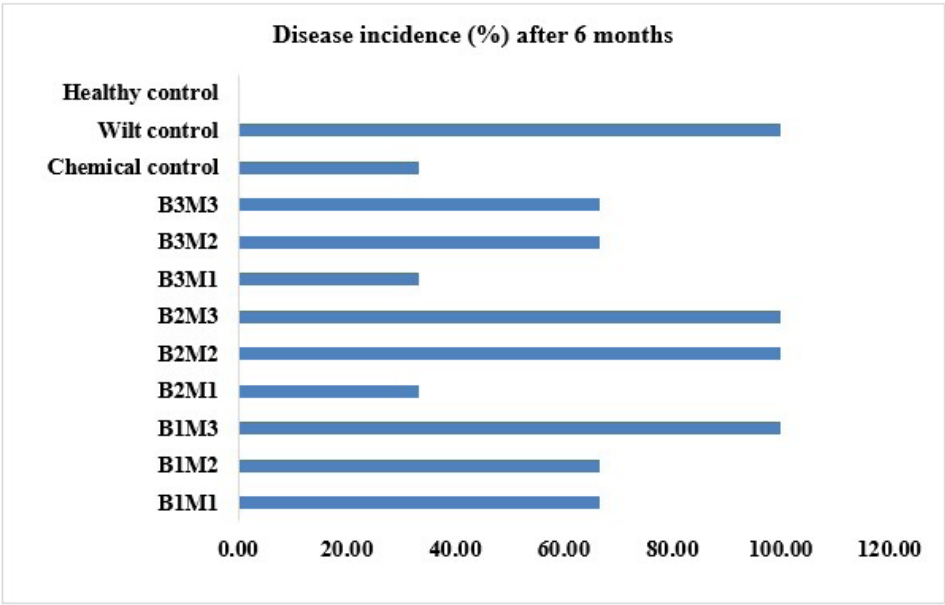
Six fungal bioagents (TA, KA-54, KA-40, KA-76, KA-19 and IIHR) were tested against *Ceratocystis fimbriata* the major wilt causing fungus in pomegranate. Results of dual culture assays revealed maximum inhibitory effect of 93.5% exhibited by *Aspergillus flavus* (two isolates KA-40 and TA). Percent inhibition by other isolates ranged between 84.8% to 63%. These bioagents were identified as *Aspergillus flavus*, *Trichoderma erinaceum, Trichoderma harzianum, Trichoderma asperellum* based on the homology search against NCBI database based on the sequences of the conserved genetic regions (ITS). The sequences have been deposited to GenBank, NCBI with accession numbers: ON629793-99. All fungal bioagents have been deposited at ICAR-NBAIM, NAIMCC, Mau Uttar Pradesh with culture accession numbers: NAIMCC-F-04292-98.



Results of dual culture technique showing antagonistic effect of fungal bioagents upon *Ceratocystis fimbriata*

Three bioagents: KA-54: *Trichoderma erinaceum* (B1), MH-1: *Trichoderma asperellum* (B2) and KA-40: *Aspergillus flavus* (B3) were tested against *C. fimbriata* in pots under polyhouse conditions. Bioagents were applied 15 days before (M1), at the time (M2) and 15 days after (M3) planting. The mortality rate after 6 months ranged from 33-100% with 100% mortality in control plants. *Trichoderma asperellum* (B2) and *Aspergillus flavus* (B3) when applied before planting performed at par with chemical treatment.

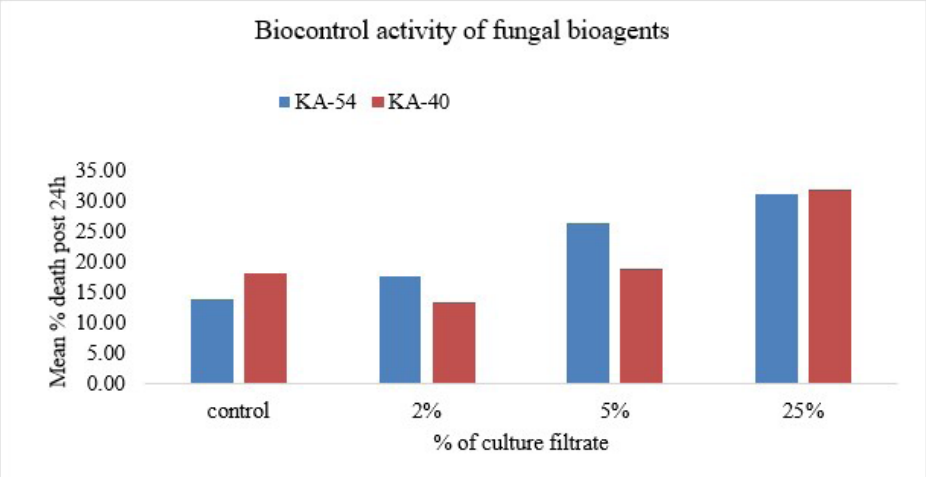
Evaluation of fungal bioagents against wilt causing *Ceratocystis fimbriata* under polyhouse condition. Bioagents were applied 15-days before (a), at the time of (b) and 15 days after (c) planting. Control plants were not inoculated by any bioagents



Effect of fungal bioagents on the mortality rate of pomegranate plants when challenged with wilt causing *Ceratocystis fimbriata*

Antagonistic activity of fungal bioagents against root knot nematode

Culture filtrate was obtained from 7-day old culture of fungal bioagents: *A. flavus* (KA40) and *T. erinaceum* (KA54). These were diluted to 2, 5 and 25% and tested against nematodes *in vitro*. Total number and number of dead nematodes were counted after 24h. The highest mortality i.e., up to 30% was observed when 25% filtrates were used.



Effect of fungal bioagents on the mortality rate of nematodes *in vitro*

5. Post-harvest Management and value Addition

5.1 Project: POST-HARVEST MANAGEMENT AND VALUE ADDITION IN POMEGRANATE FOR ENTREPRENEURSHIP DEVELOPMENT

Osmotic assisted convective drying of pomegranate arils

The dehydration is an age old technique for the preservation of the food. However, the dehydration process in mechanical tray dryers is the energy intensive, costly and affects adversely to bioactive compounds present in arils. Osmotic dehydration is the partial removal of moisture by direct contact of the product with the hypertonic medium i.e. sugar solution. The osmotic dehydration has been studied here as pre-treatment before tray drying for improvement in shelf life, reduction in drying time. In order to optimize the process of osmotic drying a statistical technique of response surface methodology has been used. A Box-Behnken experimental design with three factors and three levels was followed to study the response pattern and to determine the optimum combination of variables. The experiment was planned for osmotic dehydration of pomegranate arils with three factors temperature (30, 45 and 60°C), time (50,150 and 250 minutes) and TSS (40, 50 and 60 °B). The responses studied were water reduction (WR) (%), water loss (WL) (%), solid gain (SG) (%), total anthocyanin (mg/100g FM), ΔE, total phenols (mg GAE /kg FM), and antioxidant activity (mg AAE /100 g FM).

Total 17 experimental runs were conducted and the results were graphically represented. Results were discussed in detail here and optimized process conditions for osmotic pre-treatment before drying were arrived at to obtain desired water reduction, solid gain and water loss for the osmotic dehydration pre-treatment. The results of experiment on drying of the pomegranate arils pre-treated at optimized osmotic dehydration conditions are given below.

Drying Kinetics

Water reduction and Solute gain

The most important parameter in osmotic dehydration is the water reduction and solute gain. It can be observed that there was no water reduction from 30 to 45 °C even for maximum pre-treatment time of 250 minutes. Further, higher water reduction has been observed at higher temperature of 48°C and above. The little water reduction or meagre solute gain up to 48 °C can be explained by the fact that the higher temperature decreases the viscosity of the sugar solution reducing the external resistance to the mass transfer of the moisture from the aril and solute transfer to the aril through the membrane. It is interesting to observe that at constant TSS of 50°B there is rapid water reduction up to the 180 minutes of the pre-treatment time and it's constant thereafter. Similarly, it has been observed that the solute gain is also rapid up to 180 minutes, which is constant thereafter and reduced later on. The equilibrium has been reached in present case after 180 minutes, which was varied in different cases studied in past by the researchers depending on the commodity.

It has also been observed that the water reduction and solute gain increases with increase in TSS. It can be observed from the contour lines that, for the same amount of water reduction or solute gain the lower osmosis time is required at higher TSS. The water reduction is more pronounced at higher TSS as compared to solute gain. The water reduction was maximum at TSS of 45 to 55 °B and reduces there onwards. The increase in solute gain is quite lower compared to the water reduction.

Change in color

During osmotic dehydration process the L* value has been increased and a* and b* values decreased. The increase in osmosis temperature beyond 50°C has shown significant increase in the ΔE thereby showing change in color. At temperature of 50°C and beyond the time of osmosis has significant effect on the ΔE. The change in ΔE and with higher temperature of osmosis and time of treatment may be attributed to the leaching of anthocyanin induced by osmotic driving force. The similar results were observed by researchers driven by reduced viscosity at higher temperature. The TSS has significant effect on ΔE only beyond 54°C temperature for TSS of 50°B and beyond. The higher L* values are due to the protective effects of sugars on color and presence of the sugar on osmo dehydrated samples which increases lightness of the arils.

Anthocyanin

The anthocyanin color pigments are responsible for the red color of the arils and with increase in temperature and time of the osmosis the anthocyanin content reduces. It can be very clearly seen that the temperature has significant effect on anthocyanin as compared to the time. The temperature beyond 42 °C shows decrease in the anthocyanin content. It is also evident that at particular temperature the osmosis time also has significant effect on the loss of anthocyanin. Further, it can also be observed that the TSS doesn't have significant effect on the anthocyanin content of the aril samples in osmosis process.

Total Phenols

Total phenols in pomegranate arils were affected by the osmosis process. The total phenols are affected significantly by the temperature of the osmosis process. The time of the osmosis process has also seems to affect the total phenols however the effect is more pronounced at low temperatures. Further, the TSS of the osmotic solution does not have significant effect on the total phenols.

Antioxidant capacity

Antioxidant capacity is one of the important quality parameter of the food material. The pomegranate antioxidant capacity is mainly contributed by the total phenols, flavonoids, anthocyanin and ascorbic acid present in the arils. During osmotic dehydration the temperature of hypertonic solution and osmosis time both significantly affects the antioxidant capacity during osmotic dehydration of pomegranate arils. The total soluble solids or concentration of osmotic solution doesn't have significant effect on the antioxidant activity during osmotic dehydration of pomegranate arils.

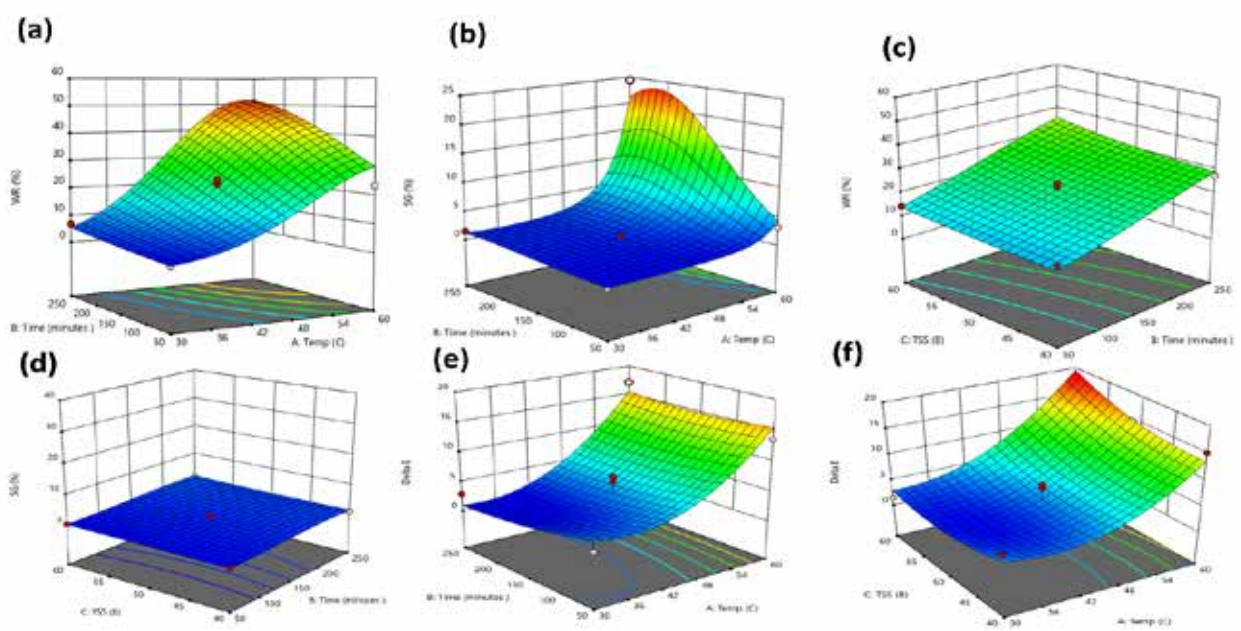
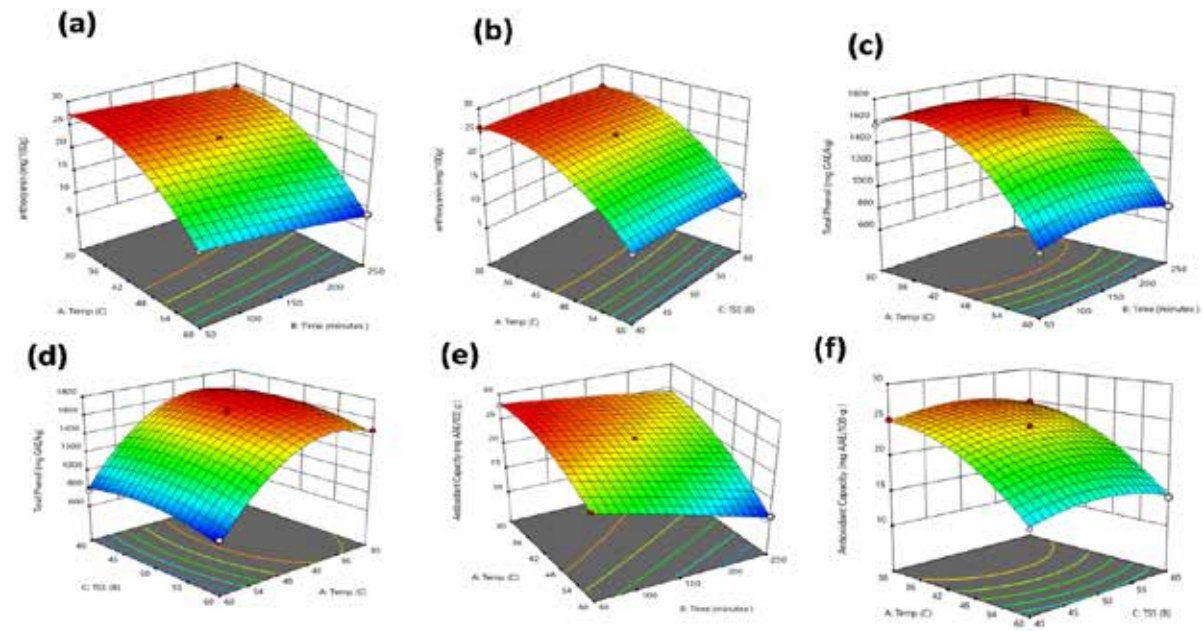


Fig. 1

Effect of temperature, time on (a) the water reduction and (b) solid gain (e) color change (ΔE); TSS and time on (c) the water reduction and (d) the solid gain (f) color change (ΔE)



Sup. 1

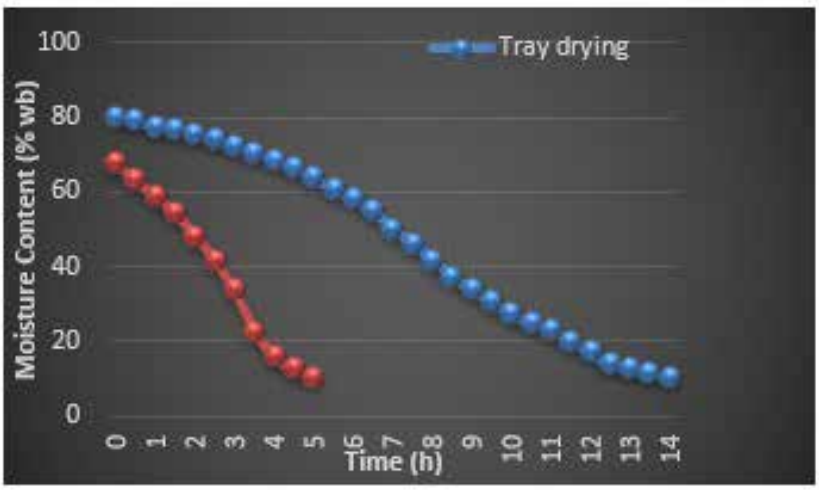
Effect of temperature and time on (a) anthocyanin content (c) total phenols (e) antioxidant capacity; temperature and TSS on (b) anthocyanin content (d) total phenols (f) antioxidant capacity

Optimization of osmotic dehydration process

Myers and Montgomery's desirability function was employed for the optimization process. The factors temperature, treatment time and TSS were set in range. The response parameters water reduction, solid gain were set for maximization, Δ E set for minimization, anthocyanin, total phenols, antioxidant capacity set in range. The final optimized process conditions obtained were temperature (48.52 °C), time (209.65 min) and TSS (51.31°B) with desirability of prediction 0.62. The predicted values of responses at optimized process conditions were water reduction (34.98 %), SG (2.25%), ΔE (5.48), anthocyanin (19.93 mg/100g), total phenols (1453.42 mg GAE /kg) and antioxidant capacity (20.23 mg AAE /100 g). The average of three replications for the observed responses were water reduction (29 %), SG (3.11 %), ΔE (6.98), anthocyanin (19.77 mg/100g FM), total phenols (1405.43 mg GAE /kg FM) and antioxidant capacity (20.32 mg AAE /100 g FM) very close to the predicted one thereby highlighting the accuracy of the models for prediction.

Tray drying

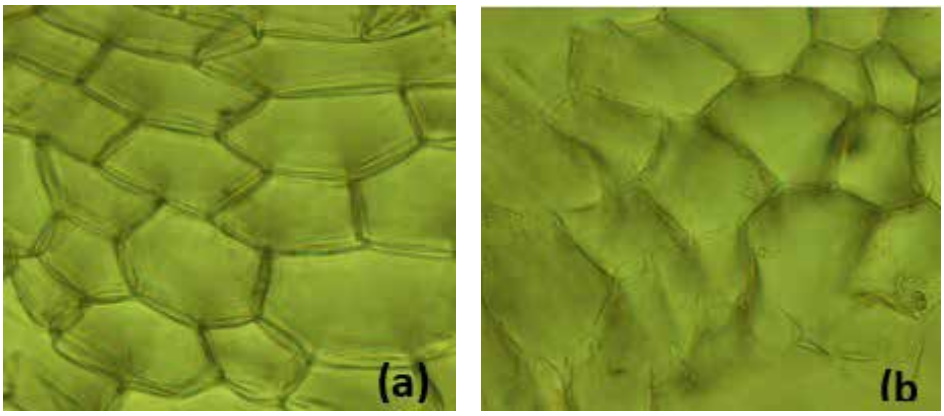
The fresh aril samples were osmotic pre-treated at optimized condition and further dried in a tray dryer. The drying conditions for tray drying used were temperature (50°C), tray loading (1.25 kg/m^2). The osmotic pre-treated samples and control samples were dried at above mentioned concentration up to the approximate moisture content of 10% (wb). The drying curves for the control and osmotic pre-treated samples were plotted. It has been observed that the osmotic dehydration pre-treatment has reduced the moisture content of the arils to (67.42%wb) from initial moisture content of (80%wb). The drying curve shows that the pre-treated samples requires drying time of 5 h whereas the control samples took 14 hours of drying time thus saving drying time by 9hrs and corresponding savings on electric energy in drying process . It is very clear from the drying curves that the osmotic pre-treatment took lesser drying time as compared to the tray drying alone even when compared from same moisture content levels. This might be due to the cell wall expansion and cell wall breakage during osmotic dehydration pre-treatment of pomegranate arils. The microscopic image of the cut section of the control and osmotic pre-treated arils shows the disruption of cell walls. The fresh, tray dried and osmo assisted tray dried samples of pomegranate arils were depicted.



Effect of osmotic pre-treatment on drying of pomegranate arils

Quality of dried pomegranate arils

The fresh arils (FA), tray-dried (TD), osmo-dried/pre-treated (OD), and osmo-assisted tray-dried (OATD) arils were studied for quality characterization. The texture of the OD arils was softer, however among the final dried products, OATD arils were softer and had a lower texture (77.83 N) as compared to the TD samples (89.65 N) and are in agreement with the observations of the previous researchers. The change in colour (ΔE) with respect to fresh aril was significantly different for all the treatments, with the highest colour change being noticed in OD, followed by OATD and TD. The higher colour change in osmotic pre-treatment (OD) can be attributed to the loss of the anthocyanin colour pigments. The higher colour change in OD than OATD suggests that the losses of the anthocyanin due to leaching are greater during OD. Further, TD followed by OD during OATD reduces more moisture, and the concentration effect of anthocyanin due to the reduction in moisture shows a lower colour change. The comparative evaluation of the final dehydrated product shows that the TSS of the OATD samples is significantly higher (25.03°B) as compared to that for TD (20.83°B), which can be attributed to the loss of moisture and solid gain. Thus, we can observe the highest TSS in OATD samples where there is solid gain during osmotic treatment and moisture loss during both osmosis and tray drying. The higher TSS to the tune of 25°B certainly affects positively in acceptability of the dried arils. Lower AC (17.81 mg/100 g FM), TP (1289 mg GAE/kg FM), and AOC (18.48 mg AAE/100 g FM) were observed during OATD compared to AC (22.09 mg/100 g FM), TP (1504 mg GAE/kg FM), and AOC (22.97 mg AAE/100 g FM) during TD.



Microscopic view of control aril (a) and osmo pretreated arils (b)

Fresh (a), tray dried (b) and osmo assisted tray dried (c) pomegranate arils

Quality of fresh pomegranate arils in comparison with tray-dried and osmotic-assisted tray-dried arils

Quality Parameters	Treatment			
	FA	TD	OD	OATD
ΔE	0.00±0^{d}	5.36±0.23^{c}	6.98±0.43^{a}	6.17±0.13^{b}
Texture (N)	32.06±1.41^{c}	89.65±4.12^{a}	29.25±4.07^{d}	77.83±4.36^{b}
TSS (°B)	16.23±0.06^{d}	20.83±0.29^{c}	22.83±0.29^{b}	25.03±0.06^{a}
AC (mg/100g FM)	27.61±1.54^{a}	22.09±3.09^{b}	19.77±1.07^{bc}	17.81±0.31^{c}
TP (mg GAE /kg FM)	1717±10.00^{a}	1504±15.28^{b}	1405±7.64^{c}	1289±10.41^{d}
AOC (mg AAE /100g FM)	28.28±0.35^{a}	22.97±0.00^{b}	20.32±0.35^{c}	18.48±0.35^{d}

(Where, FA: Fresh arils; OD: Osmotic dried/pre-treated; TD: Tray dried; OATD: Osmotic-assisted tray-dried; **Δ**E: Colour change; AC: Anthocyanin content; TP: Total phenols; AOC: Antioxidant capacity)

Values followed by the different letters within a same row are significantly different (P<0.05)

Determination of maturity indices for pomegranate variety Solapur Lal

To determine the maturity indices for harvesting of pomegranate var. Solapur Lal, the flowers were tagged on the day of anthesis. The fruit samples were collected after fruit set at an interval of 15 days. Once maturity is approached, the samples were collected at 5 days interval to fix up the appropriate maturity indices for harvesting. Solapur Lal attained maturity at 160 days after anthesis with highest total soluble solids content (17.6°Brix).

Maturity indices for pomegranate variety Solapur Lal

Stage of fruit development (Days after anthesis)	Fruit weight (g)	TSS (°Brix)	Titrable acidity (%)	TSS/Acid ratio
90 days	170.6	13.0	0.58	22.4
105 days	196.2	14.2	0.52	27.3
120 days	222.8	15.3	0.49	31.2
135 days	245.2	16.1	0.46	35.0
150 days	263.2	16.9	0.43	39.3
160 days	271.6	17.6	0.40	44.0
165 days	272.5	17.8	0.40	44.5

Determination of anardana recovery

Anardana is the dried form of arils and arils are the edible parts of pomegranate. It is obtained by drying the arils of pomegranate in the hot air oven with air circulation facility. It is useful as souring agent. Assessment of anardana recovery from ten sour type pomegranate hybrids was undertaken. The results revealed that anardana recovery ranged from 17.5-21.2°B. Anardana recovery was highest in Solapur Anardana (21.2%) closely followed by NRCP H-4 (20.8%). The recovery was lowest in Amlidana (17.5%).

Anardana recovery from pomegranate hybrids

S.No.	Variety/ Hybrid	Anardana recovery from arils (%)
1	NRCP H-1	19.8
3	NRCP H-3	18.8
4	NRCP H-4	20.8
5	NRCP H-11	20.4
6	NRCP H-12 (Solapur Anardana)	21.2
7	NRCP H-15	20.6
8	6/4	19.4
9	6/5	18.6
10	Hybrid A	20.2
11	Amlidana	17.5

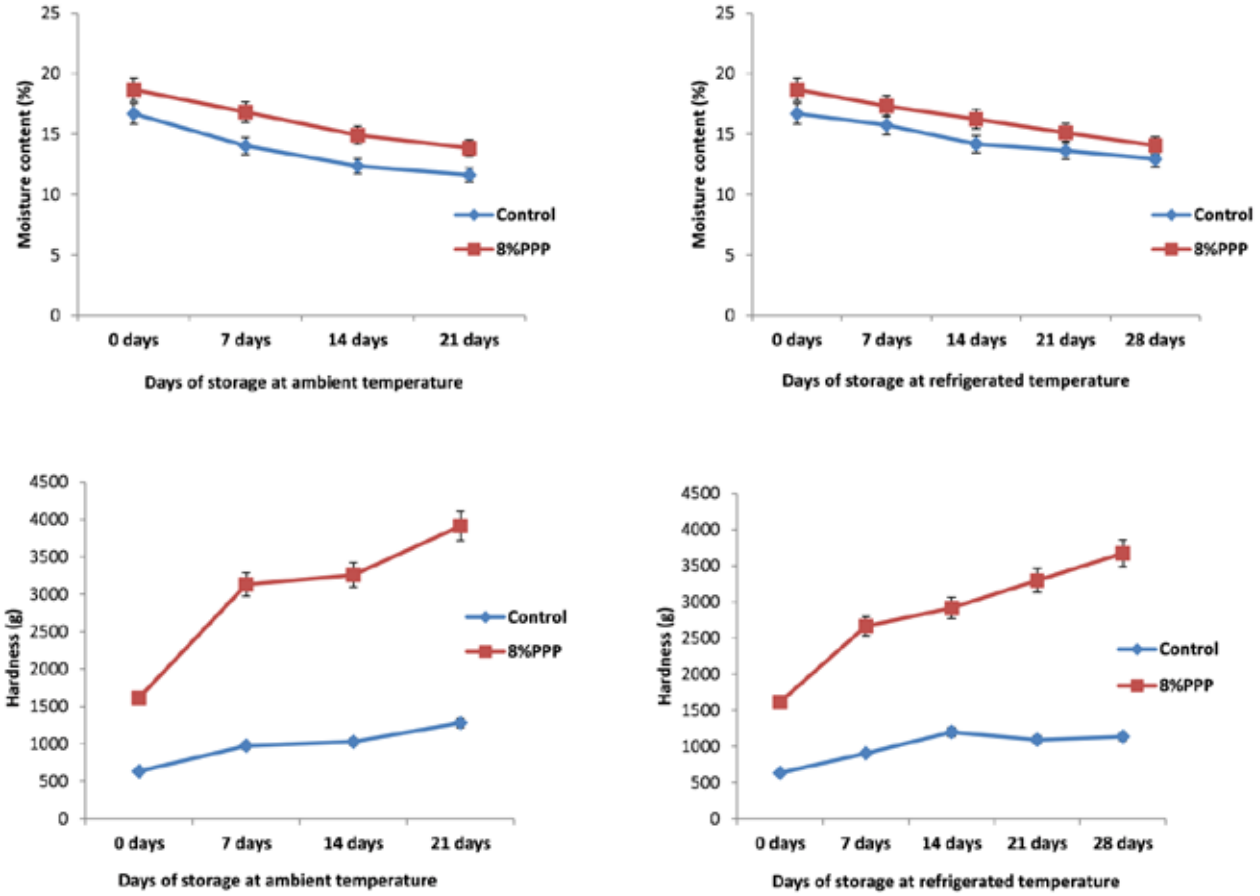
5.2. PROJECT: DEVELOPMENT OF FUNCTIONAL FOOD PRODUCTS AND WASTE UTILIZATION FROM POMEGRANATE

Shelf life evaluation of muffins fortified with pomegranate peel powder for oxidative and microbial stability

Muffins are a bakery product most preferred by consumers for its taste, soft texture, and convenience. It is generally made from refined wheat flour which lacks fiber content. However, health conscious consumers besides taste prefers food products rich in bioactive compounds and fibers, and free from synthetic preservatives or additives due to awareness regarding carcinogenic effect with long time consumption. The utilization of pomegranate peel in food products will not only improves the nutritional status of food product, but also acts as a natural preservative and reduces the stress on environmental pollution.

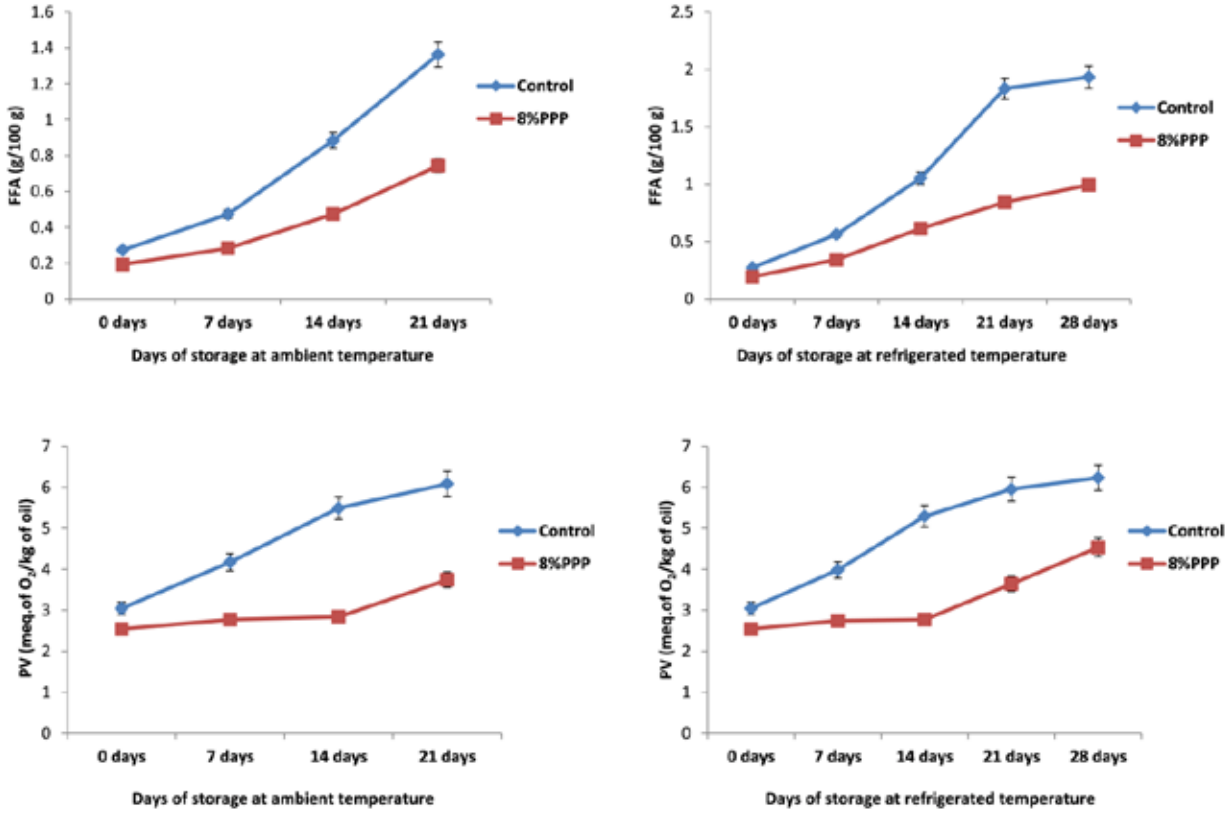
A muffin made from 100% refined wheat flour was treated as control. The other muffins samples were fortified with different levels of pomegranate peel powder (PPP) as 2% PPP, 4% PPP, 6%PPP, 8%PPP, and 10%PPP. The oxidative and microbial stability of control sample and muffin with 8% PPP that shows acceptable sensory score was selected for storage studies. Both samples were stored at ambient and refrigerated temperature for 21 and 28 days respectively. The moisture (%) and texture (hardness), free fatty acid (FFA) content, peroxide value (PV) and total microbial plate count were performed at the interval of 7 days.

The moisture content of control and fortified muffins (8%PPP) were decreased from 16.68 to 11.62% and 18.67 to 13.83% during storage at room temperature and from 16.68 to 12.94% and 18.67 to 14.05% during storage at refrigerated temperature. In contrast, the hardness of control sample as well as fortified muffin (8% PPP) significantly increased from 633.06 to 1280.1g and 1614.5 to 3912.6 g at ambient temperature respectively, at the end of 21 days of storage. Similarly, the increase in hardness was also observed in muffins stored at refrigerated temperature.



Moisture content and hardness of control and fortified (8% PPP) muffin sample during storage

It can be depicted that, with the increase in storage days, FFA content was significantly increased from 0.273 to 1.363% in control sample and 0.193 to 0.743% in muffin with 8% PPP at ambient temperature. Similarly, samples stored at refrigerated temperature showed the increase in the FFA from 0.273 to 1.933% (control) and 0.193 to 0.993% (8% PPP). The rate of increase in FFA formation was recorded higher in control sample than sample with 8% PPP. At the end of 21st days of storage at ambient temperature, the per cent decrease in FFA content of muffin with 8% PPP was 45.48%, when compared with the control. The peroxide formation was noted highest in control sample as compared to muffin with 8% PPP. PV was significantly increased to 6.083 and 3.743 meq. of O_2/kg of oil at the end of 21st days of storage. The per cent decrease in the PV was observed as 38.467% in PPP containing muffins as compared to control. Similar trend was perceived in case of muffins stored at refrigerated temperature. The muffins fortified with PPP showed higher oxidative stability when compared with control sample due to high phenols content and antioxidant activity.



FFA content and PV of control and fortified (8% PPP) muffin sample during storage

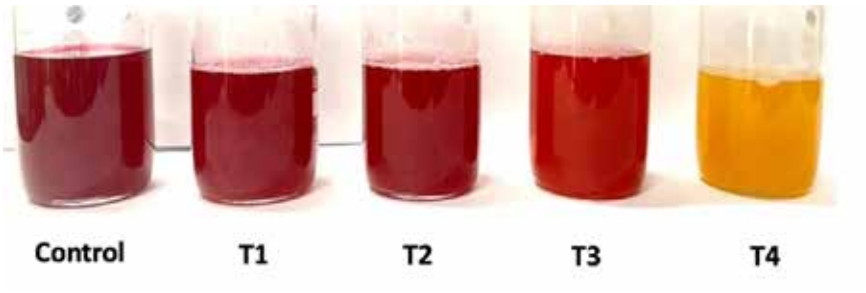
Visible mold spores were observed on control sample at the end of storage days. The total plate count of control sample and sample with 8% PPP varied from 1.67 to 2.53 log CFU/g and 1.07 to 2.24 log CFU/g. The microbial count of muffin sample with 8% PPP showed lower count as compared to control. It was observed that, the muffins with PPP showed higher resistance towards microbial growth than control sample.

Effect of pomegranate peel powder fortification on microbial count of muffins

Treatments	Total plate count (log CFU/g)			
	0 days	7 days	14 days	21 days
Control	1.67	2.20	2.53	Visible growth
8% PPP	1.07	1.72	1.98	2.24

Development of pomegranate squash blended with muskmelon

Pomegranate squash with enhanced nutritional and sensorial properties was developed by blending it with muskmelon. The formulation for the preparation of pomegranate squash blended with muskmelon was control (100% pomegranate juice), T1 (75% pomegranate juice: 25% Muskmelon juice), T2 (50% pomegranate juice: 50% Muskmelon juice), T3 (25% pomegranate juice: 75% Muskmelon juice) and T4 (100% muskmelon juice). The juice of both the fruits were blended as per the formulation and squash were developed with the specification of Juice: 25%, TSS: 40 °B and acidity: 1.5%. The pomegranate squash blended with muskmelon in different combinations is shown. The squash needs to be diluted in the ratio of 1:3 before consumption.



Pomegranate squash blended with muskmelon juice

RTS from pomegranate squash blended with muskmelon juice

The significant decrease in anthocyanin and total phenols content were found from 13.47 to 3.90 mg cyanidin/100ml and 504.4 to 84.4 mg GAE/L when increased the percent of muskmelon in blend. Moreover, the ascorbic acid content was recorded significantly higher in squash containing increase in the level of muskmelon juice. The 'L', 'a' and 'b' value of all the samples were measured and found that increase in the 'L' value and decrease in 'a' value in samples with the increase in the level of muskmelon in the blend. It is due to the presence of anthocyanin which is responsible for dark red colour of pomegranate juice and carotene pigment which is responsible for orange yellow colour of muskmelon juice. The 'ΔE' value is the colour difference of sample with respect to the colour of control sample. The blending of muskmelon juice in pomegranate juice for the preparation of squash resulted in significant difference in colour value from 0 to 48.52. The organoleptic parameters were considered as colour and appearance, taste, mouth feel, aroma, aftertaste and overall acceptability. Based on the total sensory score received, the sample prepared with 75% pomegranate juice and 25% muskmelon juice was found overall acceptable.

Chemical composition of pomegranate squash blended with muskmelon

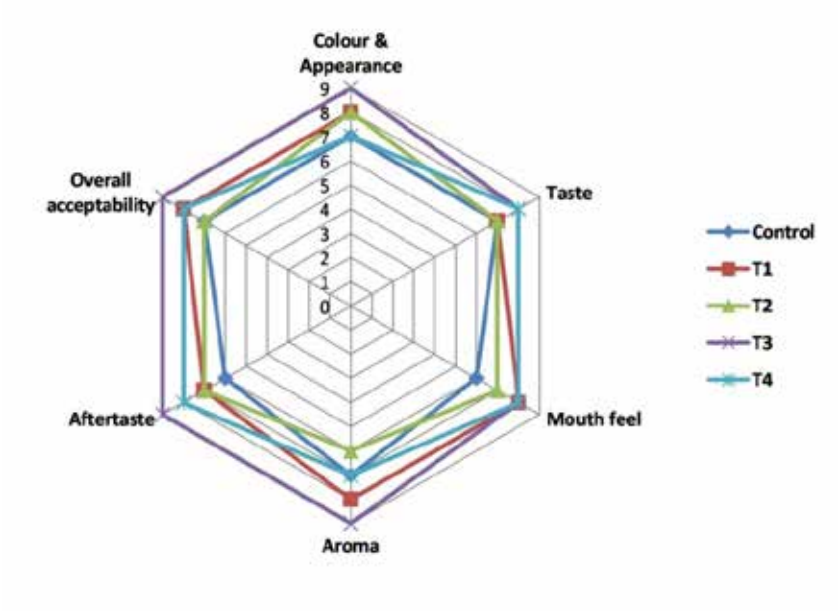
Treatments	Total Sugar (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Anthocyanin (mg cyanidin /100ml)	Total phenol (mg GAE/L)	Antioxidant capacity (mg/100ml AAE)	Ascorbic Acid (mg/100g)
Control	37.3±0.05^{d}	4.71±0.05^{b}	32.6±0.01^{d}	13.5±0.05^{a}	504.4±0.05^{a}	4.26±0.03^{a}	5.0±0.05^{d}
T1	28.7±0.05^{e}	3.11±0.03^{c}	25.6±0.05^{e}	10.3±0.05^{b}	404.4±0.05^{b}	3.99±0.03^{b}	9.5±0.05^{b}
T2	44.5±0.03^{a}	10.0±0.01^{a}	34.5±0.05^{c}	7.54±0.03^{c}	384.4±0.05^{c}	3.78±0.05^{b}	7.5±0.03^{c}
T3	38.4±0.01^{c}	2.08±0.05^{d}	36.3±0.03^{b}	5.87±0.03^{d}	284.4±0.03^{d}	3.68±0.05^{b}	10±0.01^{b}
T4	39.7±0.05^{b}	1.94±0.05^{d}	37.7±0.01^{a}	3.90±0.05^{e}	84.4±0.05^{e}	3.53±0.03^{b}	11.2±0.01^{a}

(Values are expressed as mean ± SD of three independent determinations. Values in columns followed by the same letter are not significantly different at $p \leq 0.05$ as measured by Duncan's test)

Color value of pomegranate squash blended with muskmelon

Treatments	L	a	b	ΔE
Control	21.0±0.03^{e}	49.2±0.01^{a}	41.2±0.02^{b}	0.00±0.05^{e}
T1	24.2±0.03^{d}	48.8±0.05^{b}	40.0±0.03^{c}	3.46±0.05^{d}
T2	27.0±0.05^{c}	47.8±0.05^{c}	40.2±0.03^{c}	6.26±0.03^{c}
T3	34.3±0.05^{b}	44.8±0.01^{d}	33.8±0.05^{d}	15.8±0.03^{b}
T4	52.1±0.03^{a}	12.3±0.05^{e}	46.4±0.05^{a}	48.5±0.05^{a}

(Values are expressed as mean ± SD of three independent determinations. Values in columns followed by the same letter are not significantly different at p ≤ 0.05 as measured by Duncan's test)



Sensory evaluation of pomegranate squash blended with muskmelon

Utilization of underutilized and unexploited Karonda (*Carissa carandas*) fruit in development of pomegranate-karonda mix fruit jam

The pomegranate-karonda mix fruit jam was developed with the purpose of the utilization of nutritional benefits of the highly underutilized karonda fruit along with pomegranate. The formulation for the development of pomegranate-karonda mix fruit jam was as control (100% pomegranate juice), T1 (50% pomegranate juice: 50% karonda pulp), T2 (70% pomegranate juice: 30% karonda pulp) and T3 (100% karonda pulp). The level of pectin and sugar added as 2-5% and 55-60% and 0.2% citric acid in the preparation of pomegranate-karonda mix fruit jam.

The best quality of jam with good spread ability and sensory properties was obtained by blending of 50% karonda fruit pulp with 50% pomegranate juice. The obtained pomegranate-karonda mix fruit jam had 65°BX TSS and provides 260kcal/100g. Pomegranate-karonda mix fruit jam can be made using fresh, natural ingredients without any artificial additives (colour and flavour). Commercial jams often contain high amounts of sugar, artificial colour and flavours. The processing of pomegranate and karonda fruit into mixed fruit jam created distinct and delicious product by combining the natural sweetness of pomegranate with the tartness of karonda fruit.

Sensory evaluation of pomegranate-karonda mix fruit jam

Treatments	Colour and appearance	Taste	Flavour	Texture / Spread ability	Overall acceptability
Control	8.0± 0.01	6.5± 0.02	6.5± 0.01	7.0± 0.01	6.5 ± 0.01
T1	9.0± 0.03	8.5± 0.05	8.0± 0.01	9.0± 0.03	8.5 ± 0.01
T2	8.0± 0.03	7.0± 0.01	7.0± 0.04	8.0± 0.03	7.0 ± 0.05
T3	9.0± 0.01	7.5± 0.03	7.0± 0.05	8.5± 0.01	7.5 ± 0.01

Pomegranate-karonda mix fruit jam

6. Externally Funded / Collaborative Projects

6.1 PROJECT: INDUCED MUTAGENESIS IN POMEGRANATE FOR BIOTIC STRESS RESISTANCE:

This project got sanctioned during July 2022 under BARC-BRNS, GOI. The pomegranate cultivar 'Bhagawa' and 'Solapur Lal' were selected during the stress period for inducing desirable mutation through gamma rays mutagenesis. Twig cuttings of size 12-13 cm length and 2- 3cm width of 'Bhagawa' and 'Solapur Lal' were used for gamma rays treatment with GC 5000 at FIPLY, BARC, Mumbai. The number of cuttings were 1048 and 575, respectively for 'Bhagawa' and Solapur Lal were selected.

Validation of LD50 and sprouting percentage

The cuttings of Bhagawa and Solapur Lal has been irradiated at different doses (given in methodology) and below observations has been recorded. The observations were recorded on sprouting percentage of the irradiated cuttings on the 5th day after plantation and the sprouting percentage ranged from 1.9 % - 38.3 % and observations were recorded on every week till 9th March 2023, where sprouting has been continued. The highest sprouting percentage was observed in Bhagawa @ 20Gy (91.7%). The lowest sprouting percentage was observed at 50Gy (20%). Previous studies LD50 was at 45 Gy and in our study we got LD50 of Bhagawa cultivar at 48.774 Gy. In Solapur Lal the observations were recorded on sprouting percentage of the irradiated cuttings on the 5th day after plantation and the sprouting percentage ranged from 0-52 % and observations were recorded on every week till 9th March 2023, where sprouting has been continued. The highest sprouting percentage was observed @ 15Gy (98.0%). The lowest sprouting percentage was observed at 50gy (24%). Through this study we are able to determine LD50 of Solapur Lal (52.5 Gy) and Bhagawa (48.8 Gy).

6.2 PROJECT: GENOME WIDE ASSOCIATION MAPPING IN POMEGRANATE TO IDENTIFY NOVEL GENES

This project got sanction during July 2022- SERB, Power Grant scheme. Under this project genomic DNA was isolated from 100 germplasm lines. Screened 50 SSR, 10 ISSR and 20 RAPD markers to identify polymorphic markers and to use for the association studies. The morphological evaluation is in Progress. The sequencing of these genotypes by adopting GBS is in progress.

6.3 PROJECT: ESTABLISHMENT OF DUS CENTRE ON POMEGRANATE AT ICAR- NRCP, SOLAPUR

- On-Site DUS testing of farmer variety "Sharad King" was carried out at farmer field Aurangabad, Maharashtra along with the DUS monitoring team constituted by PPV&FRA, New Delhi on July 14, 2022. The tested candidate variety (Shard King) was found distinct for the traits like petal length (large), petal width (large), fruit shape (round), aril length (short), fruit maturity (medium) in comparison to reference variety 'Bhagawa' (medium, medium, ovate, medium, late). The uniform fruit maturity in the cv. "Sharad King' was also observed.
- Developed DUS catalogue of 24 pomegranate reference varieties (Bhagawa, Solapur Lal, Solapur Anardana, Ganesh, Phule Arakta, Mridula, Ruby, Jyoti, Dholka, Yercaud-I,

Jallore Seedless, Kabul Yellow, G-137, Kalpitiya, KRS, Kandhari, Bedana Sri, Muscat, P-13, P-16, P-23, P-26, Gul-e-Shah Red, Bassein Seedless) based on 36 DUS characters as per PPV&FRA guidelines.

On-site DUS testing of farmer variety ("Sharad King") by DUS monitoring team at Aurangabad, Maharashtra on July 14, 2022

DUS characteristic features of farmer variety ("Sharad King")

6.4 PROJECT: ALL INDIA COORDINATED RESEARCH PROJECT ON ARID ZONE FRUITS

Multi Location Trials (MLT) on evaluation of sweet type variety 'Solapur Lal'

Multi-locational trial on pomegranate variety Solapur Lal was conducted in Lead Centre Solapur besides four other coordinating centres under All India Coordinated Research Project on Arid Zone Fruits during 2022-23. The planting material distributed to other centres for MLT include, HRS–APHU, Ananthapuram; ICAR-CIAH, Bikaner, ICAR-IIHR, Bengaluru and MPKV, Rahuri.

At ICAR-NRC on Pomegranate, Solapur the trial was initiated by planting the air-layered progenies in C2 block, Kegaon Experimental Farm, during Nov 2018. The growth performance revealed that sweet type varieties differed significantly with respect to different growth parameters. Among four varieties, Solapur Lal recorded the highest value for plant height (217.64cm), E-W spread (236.78cm), N-S spread (225.36cm), followed by Ganesh variety whereas Bhagawa had the lowest value. For stem diameter (4.40cm) and stem girth (13.24cm), Ganesh recorded second highest value followed by Solapur Lal, due to its hybrid vigour. The check variety, Bhagawa recorded the lowest value for stem diameter and girth.

Growth performance of pomegranate varieties during fourth year under Solapur condition

Variety	Plant height (cm)	Plant spread East-West (cm)	Plant spread North-South (cm)	Stem diameter (cm)	Stem girth (cm)
Ganesh	189.8	206.8	195.2	4.40	13.2
Solapur Lal	217.6	236.8	225.4	4.11	12.4
Phule Bhagawa Super	175.0	198.2	188.4	3.70	11.1
Bhagawa (Check variety)	153.9	175.3	163.9	3.50	10.6

Flowering and fruit set was recorded from all four varieties during 2022-23 due to crop regulation during Mrig bahar. Fruit set was highest in Solapur Lal (62.0%), whereas it was lowest in Bhagawa (49.9%).

Flowering and fruit set of pomegranate varieties during fourth year under Solapur condition

Variety	No. of bisexual flowers / tree	No. of fruits/ tree	Fruit set (%)
Ganesh	135.0	78.1	57.9
Solapur Lal	164.5	102.0	62.0
Phule Bhagawa Super	154.0	80.3	52.1
Bhagawa (Check variety)	144.5	72.1	49.9

Fruit yield/tree ranged from 18.3 to 25.0 kg/tree. Total soluble solids content ranged from 15.5 to 17.8 ° Brix, whereas the titrable acidity ranged from 0.38 to 0.45%. Brix-acid ratio ranged from 34.4 to 44.5. Solapur Lal recorded the highest yield (25.0 kg/tree) besides TSS (17.8° Brix) and Brix- acid ratio (44.50).

Yield and quality of pomegranate varieties during fourth year under Solapur condition

Variety	No. of fruits/tree	Fruit weight (g)	Yield (kg/ tree)	TSS (^{0}Brix)	Titrable Acidity (%)	Brix – Acid ratio
Ganesh	78.1	260.0	20.3	16.0	0.38	42.1
Solapur Lal	102.0	245.2	25.0	17.8	0.40	44.5
Phule Bhagawa Super	80.3	256.4	20.6	15.7	0.43	36.5
Bhagawa (Check variety)	72.1	254.1	18.3	15.5	0.45	34.4

Ganesh

Bhagawa

Super Bhagawa

Solapur Lal

Multi Location Trials of Solapur Lal

MLT on evaluation of sour type variety "Solapur Anardana'

Multi-locational trial on pomegranate variety Solapur Anardana was conducted in Lead Centre Solapur besides four other coordinating centres under All India Coordinated Research Project on Arid Zone Fruits during 2022-23. The planting material distributed to other centres for MLT include, HRS, Ananthapuram; ICAR-CIAH, Bikaner, ICAR-IIHR, Bengaluru and MPKV, Rahuri.

At ICAR-NRC on Pomegranate, Solapur the trial was initiated by planting the air-layered progenies in C2 block, Kegaon Experimental Farm, during Nov 2018. The data on vegetative growth parameters *viz.,* plant height (cm), plant spread (East West), plant spread (North South), and stem girth were recorded at four years after planting.

The results revealed that sour type varieties differed significantly with respect to different growth parameters. Among three varieties, Solapur Anardana recorded the highest value for plant height (235.14cm), E-W spread (261.07 cm), N-S spread (246.07cm), stem diameter (4.50 mm) and stem girth (13.50cm) due to its hybrid vigour. This was followed by IC-1181. The check variety, Amlidana recorded the lowest value for different growth parameters.

Growth performance of pomegranate varieties during fourth year under Solapur condition

Variety	Plant height (cm)	Plant spread East-West (cm)	Plant spread North-South (cm)	Stem diameter (cm)	Stem girth (cm)
IC-1181	210.0	229.4	216.4	4.00	12.0
Solapur Anardana	235.1	261.1	246.1	4.50	13.5
Amlidana	125.0	143.6	132.7	2.80	8.40

Flowering and fruit set was recorded from all four varieties during 2022-23 due to crop regulation during Mrig bahar. Fruit set was highest in Solapur Anardana (65.0%), whereas it was lowest in Amlidana (51.8%).

Flowering and fruit set of pomegranate varieties during fourth year under Solapur condition

Variety	No. of bisexual flowers	No. of fruits/tree	Fruit set (%)
IC-1181	52.0	25.0	48.1
Solapur Anardana	120.2	78.1	65.0
Amlidana	112.5	58.3	51.8

Fruit yield/tree ranged from 4.51 to 19.9 kg/tree. Total soluble solids content ranged from 15.2 to 16.8° Brix. Solapur Anardana recorded the highest yield (19.9 kg/tree) besides titrable acidity (4.8%).

Yield and quality of pomegranate varieties during fourth year under Solapur condition

Variety	No. of fruits	Fruit weight (g)	Yield (kg/tree)	TSS (°Brix)	Titrable acidity (%)
IC-1181	25.0	180.5	4.51	15.2	3.2
Solapur Anardana	86.1	255.2	19.9	16.8	4.8
Amlidana	58.3	220.5	12.8	16.4	4.2

IC-1181

Amlidana

Solapur Anardana

Multi Location Trials of Solapur Anardana

6.5 PROJECT: HORTICULTURE PEST SURVEILLANCE ADVISORY PROJECT (CROP SAP-HORTSAP)

Survey of insect pests affecting pomegranate orchards in Solapur District, Maharashtra

The survey of insect pests of pomegranate was carried out in Maharashtra in an area of 120 acres covering 11 Tehsils of Solapur district to assess the incidence of shot hole borer. At present shot hole borer has become a major insect pest in the majority of the pomegranate orchards of the Solapur district. The infestation of SHB is very severe in densely cultivated pomegranate growing Tehsils *viz.,* Mangalwedha, Sangola, Mohol Pandharpur and Malshirus. While the infestation was comparatively low in Madha, North Solapur, Barshi, Akkalkot South Solapur Tehsils having sparsely cultivated pomegranate orchards. However, in these Tehsils also it is required to take necessary measures on priority to check the further spread of SHB, which otherwise spreads very quickly under changing climatic conditions. In newly planted orchards (< 3 years old) the infestation of SBH is comparatively low and confined to the stem level. In other orchards (> 3 years old) the infestation of SBH was observed on primary, secondary and tertiary branches also.

Activities under Tribal Sub-plan and SCSP

Brief description of activities:

- In order to address these major bottlenecks, a team of scientist from ICAR-NRC on Pomegranate, Solapur consisting of Dr. Nilesh N. Gaikwad, Sr. Scientist, Dr. Somnath Suresh Pokhare, Scientist, Dr. Namrata Ankush Giri, Scientist and Mr. Rahul Damale, Scientist of ICAR-NRCP organized three days' workshop on "Awareness and promotion of good agricultural practices for tribal farmers of Gadchiroli District" during 22-24th March, 2022 in collaboration with KVK, Gadchiroli (under PDKV, Akola). During this three days' workshop, various lectures were delivered and demonstrations were conducted. The lectures were mainly on effective utilization of agricultural inputs distributed, processing and value addition of locally grown fruits and vegetables.
- Agriculture inputs like Mung bean seeds were distributed to the farmers having source of irrigation. Mung bean variety selected for distribution was IPM 410-3 commonly known as Shikha. This variety is released by Indian Institute of Pulse Research, Kanpur in the year 2016. This is short duration summer variety, matures in 65-70 days and has higher yield potential 11-12 q/ha with resistance to yellow mosaic virus. The vegetable seed kit includes combination of different vegetable preferred by tribal for daily intake. This vegetable seeds kit includes (Okra, Raddish, Brinjal, Chilli, Coriander, Palak and Tomato) which can fulfill their daily nutritional requirement. We have also supplied the Mango and Sapota saplings to tribal farmers. These inputs (pulse, vegetables and horticultural saplings) can ensure the livelihood security and also helps them to generate additional income.
- The other inputs like PDKV- Krishi diary which has production and protection technologies for crops grown in Vidarbha, PDKV- farm Calendar, PDKV Micrograde II (micronutrient mixture based formulation), Trichoderma based bioformulation and bicycles were distributed to the tribal beneficiaries of the Gadchiroli district. During this workshop, the demonstration of ICAR-NRCP technologies (especially processing of pomegranate in to juice and RTS beverage) has been arranged. A team of KVK, Gadchiroli (under PDKV, Akola), led by Mr. S. S. Karhale, Programme Co-ordinator, and Mr. Dhnyaneshwar Tathod, SMS, Mr. N. Buddhewar, SMS and Mr. Suchit Lakade, SMS also contributed significantly for the successful organization of the different programmes during workshop.

Tribal farmers adopted by ICAR-NRCP, Solapur under TSP/STC

State	District	Sub-district	Village	ST population benefited	Year of adoption	Status as on 31.12.2022
Maharashtra	Gadchiroli	Mulchera	Bolepalli	100	2022	Supplied agriculture inputs which includes Summer Mung seeds (4 bags each); Vegetable seed kit (1 each); PDKV-diary (1 no each); PDKV-Calendar (1 no each); PDKV Microgrande II (2 Nos each); Trichoderma based bioformulation (2 Nos each), Mango sapling (10 nos each) and Sapota saplings (3 nos each)
Maharashtra	Gadchiroli	Etapalli	Gattepalli	30	2022	The input kits were distributed to the beneficiaries (30 Nos) which includes PDKV-Diary (1 no each), PDKV-Calendar (1 no each), Mango saplings (09 nos. each), sapota saplings (2 nos. each), Battery (01 no each) and Bicycle (Ladies: 15 nos. & Gents 15 nos.).
Maharashtra	Gadchiroli	Bhamragarh	Bhamragarh	70	2022	The input kits were distributed to the beneficiaries (70 Nos) which includes PDKV-Diary (1 no each), PDKV-Calendar (1 no each), Mango saplings (09 nos each), Sapota saplings (2 nos each), Battery (01 no each) and Knapsack Sprayer (total 50 Nos).

Training programme/workshop organized for tribal farmers

Sl. No.	Name of the training programme	Place	Date	Farmers benefited (Nos.)
1.	Three days' workshop on "Awareness and promotion of good agricultural practices for tribal farmers of Gadchiroli District" Organizing secretory: Dr. Somnath S. Pokhare; Co- Organizing secretory: Dr. Namrata Giri, Dr. Nilesh Gaikwad and Mr. Rahul Damale	Gadchiroli	22-24th March, 2022	200
2.	One-day workshop on awareness and dissemination of agriculture technologies tribal sub-plan of Gadchiroli district.	KVK Sonapur Gadchiroli	18.08.2022	74

Organized a one-day workshop on "awareness and dissemination of agriculture technologies tribal sub-plan of Gadchiroli district." on August 18, 2022, in collaboration with KVK, Gadchiroli (under PDKV, Akola). During this one workshop, various lectures were delivered and demonstrations were conducted. The lectures on Pest and disease management, Nutrient management, handling of pesticides and the importance of tribal sub-plan for the welfare of tribal farmers. Agriculture inputs like Biofertilizer-Phosphate solubilizing bacteria (PSB), Biopesticide-*Trichoderma virdae,* Micronutrient: (PDKV-Grdae-2), Literature: Crop reference Book (POP) Krushi *Sawadini*-2022 and Equipment/Tools: Battery-operated Knapsack sprayer and Secateurs were distributed to the TSP farmer-beneficiaries.

Introduction of the one-day workshop of TSP at KVK Sonapur, Gadchiroli

Distribution of Agriculture inputs and equipment in a one-day Workshop under TSP at KVK Sonapur, Gadchiroli

Group photo of Distribution of Agriculture inputs and equipment in a one-day Workshop under TSP at KVK Sonapur Gadchiroli

लोकमत

शेतकरी प्रशिक्षणात वाटप केले साहित्य

कृषी विज्ञान केंद्रात कार्यक्रम : फवारणी करताना काळजी घ्या

Media coverage of the one-day Workshop of TSP at KVK Sonapur, Gadchiroli

Tribal farmers adopted by NRCP

S.No.	State	District	Taluk	Village	ST Population Benefited	Year of adoption	Status as on 31.12.2022
1	Maharashtra	Gadchiroli	Gadchiroli	Sonapur	49	2022-23	49

Farmers adopted by ICAR-NRCP, Solapur under SCSP scheme

State	District	Sub-district	Village	SC population benefitted	Year of adoption	Status as on 31.12.2022
Maharashtra	Solapur	North Solapur	Kegaon	100	2022	Educational material provided to SC students
Karnataka	Kalaburagi	Aland	Vaijapur Suntour Kadaganchi	30	2022	Agri inputs and minor farm equipment were distributed to SC farmers

Training program and input distribution to SC students of Solapur, Maharashtra under SCSP scheme

Training program and agri-input distribution to SC farmers of Kalaburagi, Karnataka under SCSP scheme


Training program for SC farmers of Kalaburagi, Karnataka under SCSP scheme


Training for SC farmers at Tikamgarh, MP under SCSP intervention of ICAR-NRCP

Training programmes/ workshop/farmers' field day organized for tribal and SC farmers under SSCP / STC

S. No.	Name of the training programme	Place	Date	SC Farmers benefited (Nos.)
1.	One-day "Educational Awareness cum Training Program on Agriculture"	ICAR-NRC on Pomegranate, Solapur	12.8.2022	100
2.	One-day "Awareness cum Training Program on Pomegranate cultivation"	ICAR-NRC on Pomegranate, Solapur	19.9.2022	30
3.	One-day Awareness-cum-training programme on 'Scope for pomegranate cultivation"	KVK, Kalaburagi	29.11.2022	94
4.	Training on package of practices for pomegranate cultivation in Tikamgarh	Jatara, Tikamgarh	12.03.2022	38

Outreach Activities

TRAININGS/ WORKSHOPS/ FARMERS FAIR/ FIELD DAY

Several trainings, workshops and interactive meets were organized by different organizations in collaboration with ICAR-NRCP Solapur, where different scientists/ technical staffs of ICAR-NRCP participated as resource persons to disseminate the technologies developed to different stake holders. These outreach activities are given below.

Trainings/ Workshops/ Farmers' Fair/ Field Day

S. No.	Title of Trainings/ Workshops/ Farmers Fair/ Field Day/ FLD	Venue	Name of organizers	Date	No. of participants
Training:					
1.	Scope for pomegranate cultivation in Kalaburagi District of Karnataka	KVK, Kalaburagi	Dr. Roopa S	29/11/2022	94
2.	Brain Storming session on Road map for shot hole borer management in Pomegranate (An International Event)	ICAR –NRCP, Solapur (Online)	Dr. Roopa S, Dr. Mallikarjun H	20/05/2022	100
3.	Quality pomegranate production and value addition for doubling farmer's income.	ICAR-NRCP, Solapur	Program director: R.A. Marathe, Program coordinators: Dr. Somnath S. Pokhare & Dr. Manjunatha N.	24th – 26th February 2022	25 company officials (Team of Bayer Crop Sciences Ltd)
4.	Delivered presentation on post-harvest management, value addition and export of pomegranate	ICAR-NRCP, Solapur.	Dr. Nilesh Gaikwad	11th Jan. 2022	pomegranate farmers of Maharashtra organized by
5.	Delivered presentation on "Value Chain Intervention in Horticulture Sector: A Case Study of Pomegranate" in training programme on "Extension: From TOT to Value Chain Extension" organized by MANAGE	Online	Dr. Nilesh Gaikwad	10th February 2022	50 officers from state horticulture department
6.	Delivered presentation on Pomegranate processing and value addition for entrepreneurship development during Training programme on Quality pomegranate production and value addition for doubling farmer's income.	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	25th Feb. 2022	-

S. No.	Title of Trainings/ Workshops/ Farmers Fair/ Field Day/ FLD	Venue	Name of organizers	Date	No. of participants
7.	Delivered presentation on Intellectual Property Rights with respect to farm innovations in one day workshop on Awareness for protection of farmer's rights in areas of farm innovations, breeding and protection of varieties.	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	3rd June 2022	30 participants
8.	Delivered invited presentation on Scope of pomegranate cultivation and value addition in awareness programme of Cluster Development Programme for Pomegranate organized by NHB, cluster development agency and state agril. Dept.	Sangola, Solapur	Dr. Nilesh Gaikwad	29th June, 2022	Around 500 farmers
9.	Delivered invited presentation in training programme on GAP in pomegranate organized by the MAGNET and delivered presentation on PHM and VA in Pomegranate.	Hotel Dhanashri Pandharpur.	Dr. Nilesh Gaikwad	19th July 2022	Around 200 farmers
10.	Delivered invited presentation in training of trainer's programme on Post Harvest Management of Banana and Pomegranate organized by the MAGNET and delivered presentation on PHM and VA in Pomegranate.	National Institute of Post-Harvest Technology (NIPHT), Pune.	Dr. Nilesh Gaikwad	13th Dec. 2022	40 participants officials from state government of Maharashtra
Workshop:					
1.	"Awareness for Protection of Farmer's Rights in Farm Innovations, Breeding and Protection of Varieties" organized by ICAR-NRCP, Solapur and KVK, Solapur on 03.06.2022	ICAR –NRCP, Solapur	Dr. Nilesh Gaikwad	3rd June 2022	28 farmers
2.	Three days' workshop on "Awareness and promotion of good agricultural practices for tribal farmers of Gadchiroli District"	Gadchiroli	Organizing secretory: Dr. Somnath S. Pokhare; Co- Organizing secretory: Dr. Namrata Giri, Dr. Nilesh Gaikwad and Mr. Rahul Damale	22-24th March, 2022	200 farmers
3.	Organized stakeholders meet on "Hi-tech Pomegranate Cultivation for Higher Productivity and Income" under *Azadi Ka Amrit Mahotsav*	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	6th Jan. 2022	100

S. No.	Title of Trainings/ Workshops/ Farmers Fair/ Field Day/ FLD	Venue	Name of organizers	Date	No. of participants
4.	Organized Webinar on "Smart Cities and Vertical Gardening" under *Azadi Ka Amrit Mahotsav*	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	8th Feb. 2022	45
5.	Three Days' Workshop on Awareness and Promotion of Good Agricultural Practices to Tribal Farmers of Gadchiroli District in collaboration with KVK, Gadchiroli (under PDKV, Akola)	Gadchiroli	Dr. Nilesh Gaikwad	22-24th March, 2022	500
6.	Organized one day workshop on "Awareness for protection of farmer's rights in areas of farm innovations, breeding and protection of varieties" as organizing secretary	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	3rd June 2022	30
7.	Acted as a Co-organizing secretary to conduct "Brainstorming Session on Roadmap for Shot Hole Borer Management in Pomegranate".	ICAR-NRCP, Solapur	Dr. Nilesh Gaikwad	20th May, 2022	-
Farmers fair:					
1.	Farmers' Fair under SCSP scheme at Tikamgarh	Jatara, Tikamgarh, M.P.	Dr. Roopa S	14.03.22	100
2.	Participated in the programme and exhibition on Expansion of Value Chain in India Potential and Opportunities organized BY NHB and showcased ICAR-NRCP technologies (especially pomegranate processing and value addition) to the visitors.	VAMNICOM, Pune	Dr. Nilesh Gaikwad	1st Nov. 2022	Around 1500 farmers participated in the exhibition
Field Day:					
1.	Field Day for pomegranate organized by ICAR-NRCP, Solapur	Wakil Vasti, Surwad, Indapur, Pune (TC, Solapur Lal)	Dr.K.Dhinesh Babu, Dr. N.V.Singh, Dr. J.S.Sharma, Dr. C.Awachare, Mr.R D.Damale	15.07.2022	50
2.	Pomegranate field day to show the performance of ICAR-NRCP released bio-fortified pomegranate variety 'Solapur Lal'	Jaloli village, Taluka-Pandharpur	Dr.K.Dhinesh Babu, Dr. Nilesh Gaikwad	6th January 2022	80
3.	**Farmer-Scientist Interface meet:** Pomegranate stakeholders meet	Jaloli village, Taluka-Pandharpur	Dr. Nilesh Gaikwad	6th January 2022	80

S. No.	Title of Trainings/ Workshops/ Farmers Fair/ Field Day/ FLD	Venue	Name of organizers	Date	No. of participants
4.	**Farmer-Scientist Interface meet:** On Shot / Pin hole borer management in Pomegranate	at Ajnale Sangola, Dist Solapur		15th February 2022	77
T.V. Programme					
1.	Dr. Nilesh Gaikwad has participated as subject specialist in the Hello Kisan – Phone in programme entitled "Pomegranate farming and value addition"	DD Kisan	Dr. Nilesh Gaikwad	22nd June 2022	Viewers of DD Kisan
2.	Dr. Nilesh Gaikwad has participated as subject specialist in the Hello Kisan – Phone in programme entitled "Pomegranate processing and entrepreneurship development"	DD Kisan	Dr. Nilesh Gaikwad	21st December 2022	Viewers of DD Kisan

Farmers trainee from S. Solapur Tk, Solapur

Certificate distribution to trainee, 12.01.2022

- Successful organization of one-day workshop on "Awareness for Protection of Farmer's Rights in Farm Innovations, Breeding and Protection of Varieties" at ICAR-NRCP, Solapur and felicitation of pomegranate progressive farmer for developing 'Sharad King' variety

Group Photo with participants attended the Workshop programme on 03.06.2022 Brainstorming Session on Roadmap for Shot Hole Borer Management in Pomegranate organized jointly by ICAR-National Research Centre on Pomegranate and Society for Advancement of Research on Pomegranate on 20th May, 2022.

The Session was attended by pomegranate experts from India and Abroad. Four International delegates- Dr. Beatriz Nobua-Behrmann and Dr. Shannon Lynch, University of California Cooperative Extension, California USA; Dr. Kobus Bothma, Crop Nutrient Specialist, South Africa and Dr. Mazahar Yousefi, Pomegranate Scientist, Iran alongwith more than 90 Indian delegates from different parts of the country participated in this scientific deliberation. There were two invited talks by international speakers in the inaugural session followed by the group discussion and finally the Panel discussion in the afternoon session presided over by Dr. A.K. Singh, Deputy Director General (Horticultural Science), ICAR, New Delhi. The inaugural session was chaired by the Dr. R.A. Marathe, Director, ICAR-NRCP and also had august presence of Dr. D.P. Waskar, Director of Research, VNMKV, Parbhani; Shri Prabhakar Chandane, President, All India Pomegranate Growers Association; Dr. K.B. Patil, Vice-President, Jain Irrigation Systems Ltd. and subject matter experts, progressive growers, industry representatives, students and other stakeholders of pomegranate industry. Dr. N.V. Singh was the organizing Secretary of the Brainstorming Session.

Brainstorming Session on Roadmap for Shot Hole Borer Management in Pomegranate



Farmers' Fair-cum-Agri Input distribution programme at Tikamgarh under SCSP

Interactive meeting on SHB at Ajnale, Solapur

Team of Scientists from ICAR -NRCP visited the pomegranate orchards affected with Shot Hole Borer pest and other diseases. Interactions were held in the field followed by in-house Interactive meeting with pomegranate growers from Ajnale, Solapur areas were held on 15.02.2022 to address various problem related to pomegranate cultivation especially shot hole borer. More than 300 farmers were presented in the meeting.


Interaction in the pomegranate orchards **Inhouse Interaction with pomegranate orchards**

SCIENTIFIC AGRO ADVISORIES

Brief report

Likewise every , this year (2021) five bimonthly scientific agro-advisories were published on office website, Dalimbmitra-a social digital platform and daily newspaper for the benefit of farmers regulating three bahars in English, Hindi, Marathi, Kannada language for updating their knowledge.


फलोत्पादन

मृग बहार डाळिंब बागेसाठी नियोजन


Pune 21 Sep 2021 Page 11

अॅग्रो प्लॅनिंग

डाळिंब पिकावरील खोड किडा व्यवस्थापन

In response to queries of farmers, information on pomegranate was provided to the farmers through e-mail and phone. Scientific agro-advisories were sent to more than 4961 pomegranate growers through the “m-Kisan portal” during the period under report.

Providing inputs to stakeholders through Dalimb Mitra platform and other social media platforms.

Scientific Agro-advisory: In response to queries of farmers, information on pomegranates was provided to the farmers through e-mail and phone. Scientific agro-advisories were sent to more than 1350 pomegranate growers through the “m-Kisan portal” during the period under the report.

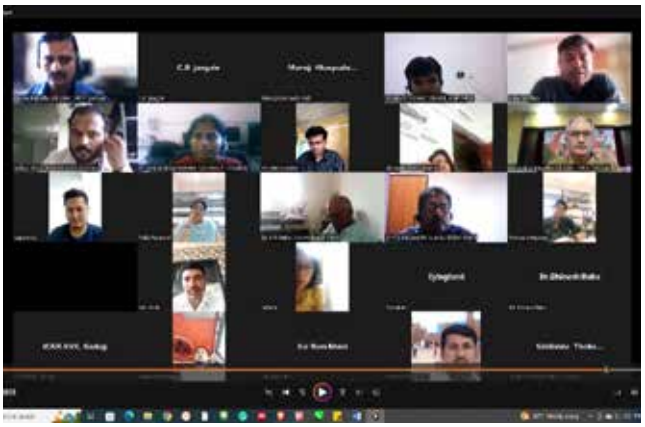
Transfer of Technology and Entrepreneurship Development

ICAR-NRCP, Solapur organized the following trainings, workshops/ field day/ FLD, technology transfer agreement for entrepreneurs and MoU for students. In addition, ICAR-NRCP actively participated in several exhibitions besides facilitating the visit of farmers/ stakeholders to the Institute to provide information on pomegranate.

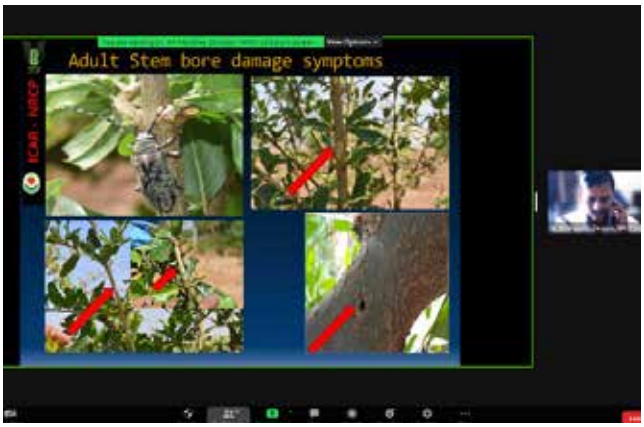
Trainings conducted by ICAR-NRCP, Solapur

S. No.	Name of Training Programmes (Duration: 3 or more days)	No. of participants	Name of organizers	Period	
Duration: 3 days or more				**From**	**To**
1.	Training Programme & Farmers' Fair-cum- Field Day (SCSP) Tikamgarh, M.P.	150	Dr. N.V. Singh, Dr. Shilpa P, Dr. Roopa S	12.03.2022	14.03.2022
2.	MANAGE, Sponsored Online Off-Campus collaborative training program on "Recent Advanced Practices for Export Quality Pomegranate Production and value addition. (Mallikarjun)	104	Dr. Mallikarjun H	06.06.02022	10.06.2022
3.	Fertis India Pvt. Ltd. Sponsored training programme on Good Agriculture Practices for Quality Pomegranate Production and value addition" (Mallikarjun)	25	Dr. Mallikarjun H	10.08.2022	12.08.2022
4.	Department of Agriculture, Govt. Maharashtra, sponsored collaborative training program on "Shot hole borer and disease management in Pomegranate (Mallikarjun)	149	Dr. Somnath Pokhare	5.04.2022	6.04.2022
Duration: < 3 days					
1.	One day farmers training program on Integrated pest and disease management in Pomegranate organized in association with Bhartiya Kisan Sangh, Maharashtra	50	Dr. Somnath Pokhare	24.04.2022	24.04.2022
2.	One day farmers training program on "Good Agricultural Practices in Pomegranate" on the occasion of 18th foundation day of ICAR-NRCP, Solapur	120	Dr. Somnath Pokhare, Dr.Nilesh Gaikwad	25.09.2022	25.09.2022

Training Programme And Farmers's Fair Cum Field Day (SCSP) Tikamgarh, M.P



Address by: Dr. R.A. Marathe, Director, NRCP, Solapur



Lecture by: Dr. Mallikarjun, on IPM in pomegranate

Training title, date: MANAGE, Sponsored Online Off-Campus collaborative training program on "Recent Advanced Practices for Export Quality Pomegranate Production and value addition from June, 6-10th, 2022

Inaugural address by: Dr. R.A. Marathe, Director, NRCP, Solapur

Field visits and on-farm explanations on insect pest and disease diagnosis by Dr. Mallikarjun

Training title, date: Fertis India Pvt. Ltd. Sponsored training programme on Good Agriculture Practices for Quality Pomegranate Production and value addition" from August, 10-12th, 2022

Inauguration of the training programme by officials of the State Department and NRCP, Solapur

Lecture by: Dr. Mallikarjun on Diagnosis and management of Shot hole borer in pomegranate

Training title, date: Department of Agriculture, Govt. Maharashtra, sponsored collaborative training program on "**Shot hole borer and disease management in Pomegranate**" from April, 5-6th, 2022

Workshop/ Field day/FLD conducted

S. No.	Name of Training Programme	No of Participants	Name of organizers	Date
1.	"Brainstorming Session on Roadmap for Shot Hole Borer Management in Pomegranate" at ICAR-NRC on Pomegranate, Solapur.	-	Co-organizing secretary-Dr. Nilesh Gaikwad	20th May, 2022
2.	Celebration of NRCP foundation Day cum farmers workshop on Good Agricultural Practices for Pomegranate Cultivation	675	Dr. Somnath Pokhare, Dr. Nilesh Gaikwad	September 25, 2022




ICAR-NRCP foundation Day and Training Programme on GAP in pomegranate

Brainstorming Session on Roadmap for Shot Hole Borer Management in Pomegranate organized jointly by the ICAR-National Research Centre on Pomegranate & Society for Advancement of Research on Pomegranate on 20th May, 2022

The shot hole borer, which was a minor insect-pest of pomegranate, has suddenly become a havoc for pomegranate growers during last one year. With this preview, the brainstorming session was organized to formulate an effective and holistic management strategy against shot hole borer.

The Session was attended by pomegranate experts from India and Abroad. Four International delegates- **Dr. Beatriz Nobua-Behrmann and Dr. Shannon Lynch,** University of California Cooperative Extension, California USA; **Dr. Kobus Bothma,** Crop Nutrient Specialist, South Africa and **Dr. Mazahar Yousefi,** Pomegranate Scientist, Iran alongwith more than 90 Indian delegates from different parts of the country participated in this scientific deliberation. There were two invited talks by the international speakers in the inaugural session followed by the group discussion and finally the Panel discussion in the afternoon session presided over by **Dr. A.K. Singh, Deputy Director General (Horticultural Science), ICAR, New Delhi**. The inaugural session was chaired by the **Dr. R.A. Marathe, Director, ICAR-NRCP** and also had august presence of **Dr. D.P. Waskar, Director of Research, VNMKV, Parbhani**; **Shri Prabhakar Chandane, President, All India Pomegranate Growers Association**; **Dr. K.B. Patil, Vice-President, Jain Irrigation Pvt. Ltd.** and subject matter experts, progressive growers, industry representatives, students and other stakeholders of pomegranate industry. The session ended with the finalization of draft adhoc advisory for the management of shot hole borer followed by the vote of thank by the Organizing Secretary, Dr. N.V. Singh.

Presidential Remarks by Dr. A.K. Singh, DDG (Horticultural Science)

Release of Publication during the Brainstorming Session

AGREEMENT WITH VARIOUS STAKEHOLDERS

For Academics

Sr. No.	Purpose	Instsitutes	Validity (Years)	From	To
1.	Training and Research work for student	ICAR-NRCP, Solapur and **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**	5	16.3.2022	15.3.2027
2.	Training and Research work for student	ICAR-NRCP, Solapur and **School of Biotechnology and Bioinformatics DY Patil Deemed to be University, Navi Mumbai**	3	09.02.2022	09.02.2025
3.	Training and Research work for student	ICAR-NRCP, Solapur and **Progressive Educations Society Modern College of Pharmacy, Pune, Maharashtra**	3	09.02.2022	09.02.2025
4.	Education and Training	ICAR - NRCP, Solapur **and a-IDEA Technology Business Incubater of ICAR-NAARM, Hyderabad**	5	09.07.2022	08.07.2027

Dr R A Marathe Director, NRCP, Solapur **Signed MoU with Dr. Ch Srinivas Rao, Director NAARM, Hyderabad as a a-IDEA Technology Business Incubater of ICAR-NAARM, Hyderabad** with the support of DST& DBT & NABARD govt. of India **on July 9, 2022 in presence of Dr. G. Venkateshwarlu, JD, NAARM and Dr. R. C Agrawal, DDG (Education), ICAR, New Delhi**

MOU with MAGNET

ICAR-NRC on Pomegranate has been recognized as Centre of Excellence for Pomegranate by the MAGNET, An Asisan Development Bank Funded project of Government of Maharashtra. Dr. R A Marathe, Director, ICAR-NRC on Pomegranate, Solapur and Sh. Deepak Shinde, Project Director, MAGNET has signed MoU to that effect on 20th July 2022.

Dr. R A Marathe and Sh. Deepak Shinde signed MoU and ICAR-NRCP has been recognized as COE in Pomegranate.

For Entrepreneurs

ICAR-NRCP's technologies were transferred to the following entrepreneurs through signing of Memorandum of Understanding (MoU).

MoU with Entrepreneurs

S. No.	Technology transferred	Address of beneficiary	Date of signing MoU	Revenue received (Rs.)
1	A novel bio-formulation for potassium fertilizer supplement in pomegranate and process of preparation there of	M/s. Bharti Green Tech, Satara Road, Dahiwadi, Taluka Maan, Dist.- Satara Maharashtra 415508	20.08.2022	3.54 lakh
2	Propagation of planting material of pomegranate var. Solapur Lal	Jain Irrigation Systems Private Limited, Jalgaon	20th May 2022	Rs. 3,54,000/-
3	Bio-hardening of *in vitro* raised pomegranate plants	Jain Irrigation Systems Private Limited, Jain Plastic Park (JISL), PO Box 72, NH No. 6, Bambhori, Jalgaon, Maharashtra 425001	28th July 2022	1,18,000/-
4	Bio-hardening of *in vitro* raised pomegranate plants.	Sheel Biotech Ltd.,Main Jagdamba Road, Tughalakabad Ext., New Delhu 110019	28th July 2022	1,18,000/-

MoU was signed between ICAR-NRCP, Solapur and M/s. Jain Irrigation Systems Pvt. Ltd, Jalgaon for transfer of technology on "Propagation of pomegranate variety Solapur Lal through micropropagation " on 20th May, 2022

Dr R A Marathe Director Handed over Technology Licensing MoU of Biohardening Protocol to Mr. Anil Patil Vice President, Jain Irrigation Systems Ltd. on 28.07.2022.

MoU was signed between ICAR-NRCP, Solapur and M/s. Sheel Biotech for transfer of technology on "A novel bio-formulation for potassium fertilizer supplement in pomegranate and process of preparation thereof" on 20th August, 2022 28.07.2022

MoU was signed between ICAR-NRCP, Solapur and M/s. Bharti Green Tech for transfer of technology on "A novel bio-formulation for potassium fertilizer supplement in pomegranate and process of preparation thereof" on 20th August, 2022

Others MoU:

Special program

S.No	Programme	Chief Guest	Beneficiary	Date
1	PM Kisan Samman Sammelan and Agri Startup Conclave and Exhibition	Hon. Member of Parliament Dr. Jaisiddeshwar Mahaswami	Farmers (80) and Agri startups (3)	17/10/2022

Prime Ministers Kisan Samman Sammelan and Agri Startup Conclave and Exhibition attended by Hon. Member of Parliament Dr. Jaisiddeshwar Mahaswamiji on 17th October 2022

Exhibitions

S. No.	Name of the exhibition	Organizer	Venue	No. of Visitors	Date
1.	Farmers Mela	KVK,	Piprikota bihar	2000	April 2022
2.	Participated in the Kisan Mela and Agricultural Exhibition organized	KVK, Solapur in association with ATMA, Solapur	at KVK, Solapur	250	26th April 2022
3.	Kisan Agri show	Kisan	Pune	Daily 2000	14th to 18th Dec 2022
4.	Sidddeshwar Krushi Exhibition		Solapur	Daily 300	29th December 2022 – 2nd January 2023
5.	Expansion of Value Chain in India Potential and Opportunities	National Horticulture Board, Govt. of India	VAMNICOM, Pune	2000 farmers, entrepreneur's etc.	1st Nov.2022

POMEGRANATE GROWERS/ VISITORS TO ICAR-NRCP, SOLAPUR

Following beneficiaries/ visitors visited this Centre during 2022

Visitors to ICAR-NRCP, Solapur

S. No.	Date	Organization/ Place of beneficiaries	Category	No. of beneficiaries
1	9/02/2022	Farmers of Vanaparthy, with Staff of Dept. of Horticulture, Telanganna	Farmers	48+2
2	22/02/2022	Farmers of Nagar kurnool, AP with Staff of Dept. of Horticulture, AP.	Farmers	48+2
3	22/02/2022	ATMA Latur	Farmers	60
4	26/03/2022	Farmers' exposure visit to ICAR-NRCP, Solapur coordinated by KVK, Bidar, Karnataka.	Farmers	50
5	07/04/2022 13/04/2022	University of Agricultural Sciences, Dharwad	IV year B. Sc (Agri.)	124
6	24/04/2022	Bhartiya Kisan Sangh, Solapur	Farmers	50
7	25/06/2022	Punyashlok Ahilyadevi Holkar Solapur University, Solapur	IIrd year Ph. D (Botany)	3
8	02/09/2022	ATMA Solapur, Scientist Farmer Interaction		100

Farmers of Vanaparthy, visited ICAR –NRCP, Solapur through Dept. of Horticulture, on 9.02.2022

Farmers of Nagarkurnool, AP visited ICAR –NRCP, Solapur through Dept. of Horticulture, AP on 22.02.2022

Interacted with the IIrd year Ph. D (Botany) students from Punyashlok Ahilyadevi Holkar Solapur University, Solapur visited ICAR-NRCP, Solapur on 25.06.2022

Students

S. No.	Date	Organization/Place	Category Student	No. Beneficiaries
1.	17/04/2022	College of Agriculture, Hanumanamatti, UAS Dharwad	Students	52
2.	20.04.2000	CoA, Bijapur, UAS DWD	Students	35
3.	12/05/2022	Vasundhara kala mahavidyalaya, Jule solapur	Students	50
4.	31/05/2022	Sri Sant Damaji Mahavidyalaya, Mangalwedha	Students	50
5.	02/06/2022	DBF dayanand College, Solapur	Students	59
6.	08/08/2022	Sadguru college of Agriculture, Mirajgaon	Students	120
7.	29/08/2022	College of Agriculture, Akluj	Students	31
8.	19/09/2022	College of Aghriculture, Osmanabad	Students	69
9.	24/09/2022	College of Agri. Parbhani	Student	115
10.	26/09/2022	College of Biotechnology, Latur	Students	106
11.	27/09/2022	College of Agri. Parbhani	Student	123
12.	17/10/2022	College of Biotechnology, Latur	Students	40
13.	19/10/2022	College of Agriculture, Pathari	Students	68
14.	15/11/2022	Vidya Pratishthan College, Baramati	Students	98
15.	18/11/2022	Brahmadev Mane Junior college, Belati Solapur	Student	75
16.	22/12/2022	DBF dayanand college of Arts and science	Students	50
17.	27/12/2022	Lokmangal college of Agriculture, Wadala	Student	22
18.	27/12/2022	College of Agriculture, Umerkhed, yavaatmal	Student	75
19.	29/12/2022	Walchand college Solapur	Students	65

CoA, Hanumanmatti UAS, Dwd Students and staff visited ICAR –NRCP, Solapur on 17.04.2022 as part of Education cum exposure visit

Delievered lecture on ICAR - NRCP technologies to Students from CoA, Hanumanmatti UAS, Dwd

CoA, Bijapur, UAS, Dwd Students and staff visited ICAR –NRCP, Solapur on 20.04.2022 as part of Education cum exposure, Delivered lecture on NRCP technologies

Institutional Activities

Quinquennial Review Team (QRT-III) Meeting

The third Quinquennial Review Team (QRT-III) for the ICAR-NRCP, Solapur (Maharashtra) was constituted by the Director General, Indian Council of Agricultural Research, vide ICAR order F. No. HS/1(1)/2015-IA.V dated, July 20, 2021 (Annexure III). The composition of the second Quinquennial Review Team (QRT-III) is given below.

1.	Dr. K.P. Vishwanatha, Former Vice-Chancellor, MPKV, Rahuri, Maharashtra	**Chairman**
2.	Dr. D.P. Waskar, Director of Research, VNMKV, Parbhani, Maharashtra	**Member**
3.	Dr. S.D. Gorantiwar, Professor & Head, Department of Agril. Engg. MPKV, Rahuri	**Member**
4.	Dr. (Mrs.) Indu S. Sawant, Ex. Director (Acting) ICAR – NRCG, Pune	**Member**
5.	Dr. Rajesh Parbhatrao Kadam, Prof. & Head, Dept. of Extension Education VNMKV, Parbhani-431402, Maharashtra	**Member**
6.	Dr. C. K. Narayana, Principal Scientist, Division of PHT, ICAR – IIHR, Bengaluru-560089, Karnataka	**Member**
7.	Dr. Ashis Maity, Sr. Scientist, ICAR-NRCP, Solapur-413255 Maharashtra	**Member Secretary**

The preliminary meeting of the third Quinquennial Review Team was held on October 26, 2021. Dr. R. A. Marathe, Director briefed about 16 years journey of NRCP and highlighted the research works done at NRCP, Solapur. Dr. A K Singh, DDG (HS), ICAR, New Delhi held interaction with QRT members. On the same day QRT members interacted with pomegranate growers from Karnataka, Madhya Pradesh, Chattisgarh, Rajasthan and Maharashtra. At this occasion technical bulletin on "Outreach Porgarmme of ICAR-NRCP, Solapur under SCSP and STC to disseminate pomegranate production technologies" and technical manual on, "Model Propogation and Orchard Management Practices for sustainable Pomegranate Production" where released by QRT members.

The first review meeting of the QRT was convened on January 5-6, 2022 at NRCP, Solapur. The meeting was attended by all the members of QRT, The Director and staff of NRCP. The team visited research fields, laboratories, polyhouses and water harvesting structures. The action taken report on recommendations of previous QRT were presented in the meeting. The QRT interacted with the scientists and suggested several recommendations for improvement of the ongoing research programmes.

On January 6, 2022, a field visit to pomegranate orchards at village Jaloli Taluka: Pandharpur was organized to see the pomegranate cv. Solapur Lal variety released by NRCP, Solapur. In the field itself interactive meeting with various pomegranate stakeholders viz. Progressiv farmers, Nursery growers, Exporters, Enterpruners, State Govt. Agrivultural and Extention officials. Various problems faced by the stakeholders and review of the NRCP's technologies dissemination was discussed by the QRT members.

The first review meeting of the QRT on January 5-6, 2022 at NRCP, Solapur.
Field visit of QRT members to pomegranate orchards at village Jaloli Taluka: Pandharpur

Meeting of 3rd Quinquennial Review Team, ICAR – NRCP, Solapur with Dr. Himanshu Pathak, Hon'ble Secretary, DARE & Director General, ICAR, New Delhi

Meeting of the **Third Quinquennial Review Team** (QRT-III) for the ICAR-NRCP, Solapur under the Chairmanship of Dr. Himanshu Pathak, Secretary, DARE & DG, ICAR, New Delhi, was held at New Delhi on September 6, 2022 to review the 3rd QRT report submitted by the duly constituted QRT. Dr. A. K. Singh, DDG (HS), Dr. Vikramaditya Pandey, (ADG) ICAR, New Delhi, Dr. RA Marathe, Director, and Dr. Jyotsana Sharma, Pr. Sci. from ICAR-NRCP Solapur (MS) were also present in the meeting while all QRT members joined online.

Dr. A. K. Singh, DDG (HS) highlighted the need for research to develop low cost technologies with quality produce, breeding dwarf varieties and desirable selections for protected cultivation along with modifications in field technologies to meet the challenges of changing environmental scenario with more rains or longer dry spells of high temperature.

Dr. Himanshu Pathak, Hon'ble DG appreciated the technologies developed and promoted by ICAR-NRCP and QRT efforts for reviewing the work of ICAR-NRCP, Solapur and guidance for future research work. He urged the institute to focus on low cost technologies and avoid general research being carried out by other institutions. He suggested to priorities and focus 2 - 3 most promising technologies for the benefit of stakeholders. Dr. RA Marathe, Director, ICAR-NRCP, agreed to implement all the recommendations of QRT and suggestions given by DDG (HS) and DG, ICAR. The meeting ended with vote of thanks by Dr. Vikramaditya Pandey, ADG, Div. of HS, New Delhi.

Institute Management Committee

Institute Management Committee meeting was held at NRCP, Solapur on 07.11.2022 through physical and online mode under the chairmanship of Dr. R. A. Marathe, Director, NRCP, Solapur. The committee has revived the ongoing institutional activities and recommended to procure essential research requirements *viz.,* utility vehicle, equipment besides suggested the enhanced budget for the research activities.

Sl. No	Name	IMC Member	
1.	Dr. R A Marathe	Director, ICAR-NRCP, Solapur	**Chairman**
2.	Dr. PG Patil	Vice-Chancellor MPKV, Rahuri	**Member**
3.	Dr. KP Mote	Director, Horticulture, Maharashtra	**Member**
4.	Dr. Rohita Lenka	Director, Horticulture, Odisha	**Member**
5.	Dr. VK Pandey	ADG (I/c), (Horticulture-I), ICAR, New Delhi	
6.	Dr. Ashutosh Murkute	Principal Scientist, ICAR-CCRI, Nagpur	**Member**
7.	Dr. Anuradha Upadhyay	Principal Scientist, ICAR-NRCG, Pune	**Member**
8.	Dr. DV Sudhakar Rao	Principal Scientist, ICAR-IIHR, Bengaluru	**Member**
9.	Dr. Jyotsana Sharma	Principal Scientist, ICAR-NRCP, Solapur	**Member**
10.	Sh. Shrinavas Rao	Finance & Account Officer, ICAR-IIRR, Hyderabad	**Member**
11.	Sh. RB Rai	Administration Officer	**Member Secretary**

Institute Research Council (IRC) Meeting

The meeting of sixteenth Institute Research Council (IRC) of ICAR- National Research Centre on Pomegranate was held on September 1st 2022, at ICAR-NRCP, Solapur under the Chairmanship of Dr. R. A. Marathe, Director, ICAR-NRCP, Solapur. The following Scientists / IRC members attended the meeting.

Institute Research Council of ICAR-NRCP, Solapur

	Chairman IRC		
1	Dr. R. A. Marathe, Director, ICAR-NRCP, Solapur (MS)	**9.**	Dr. Shilpa Parashuram, Scientist (Plant Breeding), ICAR-NRCP
	Members	**10.**	Dr. Namrata Giri, Scientist (Food Technology), ICAR-NRCP
2	Dr. Jyotsana Sharma, Pr. Scientist (Plant Pathology), ICAR-NRCP	**11.**	Dr. Chandrakant Awachare, Scientist (Hort.-Fruit Sc.,), ICAR-NRCP
3	Dr. P. S. Shirgure, Pr. Scientist (L&W Mg.Engg), ICAR-NRCP	**12.**	Dr. Mallikarjun Harsur, Scientist (Entomology), ICAR-NRCP
4	Dr. N.V. Singh, Sr. Scientist (Hort.-Fruit Sc.), ICAR-NRCP	**13.**	Dr. Roopa Sowjanya P, Scientist (Plant Breeding), ICAR-NRCP
5	Dr. Nilesh N. Gaikwad, Sr. Scientist (AS & PE), ICAR-NRCP	**14.**	Mr. Rahul Damale, Scientist (Plant Biochemistry), ICAR-NRCP
6	Dr. Pinky Raigond, Sr. Scientist (Plant Physiology), ICAR-NRCP	**15.**	**I/c Member Secretary**
7	Dr. Manjunatha N, Scientist (Plant Pathology), ICAR-NRCP		Dr. K.Dhinesh Babu, Pr. Scientist (Hort.-Fruit Sc.), ICAR-NRCP
8	Dr. Somnath Pokhare, Scientist (Nematology), ICAR-NRCP		

The IRC meeting was started on September 1st , 2022 at 9.30 am in the Director's Board Room. Dr. K. Dhinesh Babu, Pr. Scientist, Member Secretary IRC extended a warm welcome to Hon'ble Chairman Dr. R.A Marathe, Director, ICAR-NRCP, Solapur and all the members. Then presentations on salient achievements of 15 ongoing research projects besides 2 new research project proposal and future line of work were made by each scientist.

Suggestions & Recommendations:

General

- Research project proposals should be focused to solve the problems of farmers/ clients.
- Research Projects should have delivery and outcome oriented approach.
- Development of technologies for income maximization besides yield maximization
- Climate resilient agriculture
- Scientists should have the focus: one scientist – one product wrt. variety, technology, concept, etc.
- Timely submission of RPP and Addition –Deletion proforma for inclusion / exclusion of scientists in different research projects to PME Cell.
- Promote use of Bio-formulations for disease management in pomegranate for environmental safety
- Commercialization of NRCP technologies and products for entrepreneurship development.

The meeting ended with vote of thanks by Dr. K. Dhinesh Babu, Member Secretary, IRC.

17th IRC of ICAR-NRCP, Solapur conducted on 01.09.2022

Release of the Pomegranate Genome cv. Bhagawa

In a path-breaking development for genome research and horticultural science in India, a team of scientists has completed the genome sequencing and chromosome level assembly of pomegranate cv. Bhagawa. The ICAR-NRCP has released the Chromosome Scale Genome Assembly of Indian pomegranate cv. Bhagawa for press and media on 24th September under Chairmanship of the Dr. A.K. Singh, DDG (HS) and the same has been released at a public event on 25th September, on the occasion of 18th foundation day of ICAR-National Research Centre on Pomegranate or NRCP. The team involved in this landmark research comprised Dr. N.V. Singh, Dr. P. Roopa Sowjanya, Dr. Shilpa Parashuram, Dr. P.G. Patil and Dr. R.A. Marathe, all at ICAR-NRCP, Solapur. The chromosome scale genome assembly of the 'Bhagawa' developed by ICAR-NRCP under aegis of Indian Council of Agricultural Research, New Delhi is a huge reservoir of publicly accessible genomic resources for pomegranate researchers across the globe and will provide a great impetus to the pomegranate improvement programme in India.

Release of Pomegranate Genome by the DDG (HS) & Director, ICAR-NRCP

Pomegranate genome Release in Press & Media

Celebration of Foundation day

NRCP celebrated its 18th Foundation Day on 25th September, 2022 in collaboration with MAGNET, Govt. of Maharashtra, Pune. One-day training programme was organized on different aspects of pomegranate production for the pomegranate stakeholders of the region. Dr. K.V. Prasad, Director (DFR) presided over the function and Shri. Deepak Shinde, Project Coordinator, MAGNET and Shri. Balasaheb Shinde, DSAO, Solapur was Chief Guest of the function. Shri. Prabhakar Chandane, Shri. Shahaji Jachak, Shri. Bhausaheb Kate and from Pomegranate growers association graced the function. On this occasion, bulletins on different aspects *viz.* Genomics, DUS, Management of Short Hole Borer and Success Stories of Stem Solarization techniques were released. Different institute awards were given to the progressive farmers, NRCP staff and workers, authors of best research papers & other.

Release of technical bulletin on Shot hole borer management, Six step Stem Solarization technique on BBD management, DUS bulletin and Pomegranate Genomics Garib Kalyan Sammelan organized under PM-KISAN programme on 31 May 2022.

Hon'ble Shri Ramdas Bandu Athawale, Union Minister of State for Social Justice and Empowerment of India, Hon'ble Shri Jai Sidheshwar Shivachary Mahaswamiji, PM, Solapur grace the occasion.

Swachh Bharat Abhiyan:

- The swachhta Pakhwada is celebrated every year during the 16th December to 31st Dcember, likewise Swachhta Pakhawada has been celebrated at ICAR-NRC on Pomegranate, Solapur, and Maharashtra. Swachhta pakhwada is celebrated to create awareness among the society. The swachhta pledge was taken on the occasion of swachhta event at auditorium hall with awareness among the staff. Coconut, Mangos plantations were conducted at Hiraj research field ICAR-NRCP. Building premises, laboratories, library, guest house and research field were cleaned with the active involvement of ICAR-NRCP staff. The public places were cleaned with awareness among the people and dustbins also given to the public places eg. Khandoba temple Bale Solapur, Shardha residency Bale etc. On the occasion of Kisan Diwas swachhta activity was conduted at Jaloli Ta. Pandharpur Dist. Solapur with the compost making dmontration to the MGMG farmers. The debate competition and drawing competitions were conducted at Shree Sharadchandra Patil School, Solapur.








MGMG (Mera Gaon Mera Gaurav):

Mera Gaon Mera Gaurav scheme has been implemented by ICAR-NRCP at 6 villages. In total 13 number of scientist were involved in implementation of MGMG programme through 4 groups. ICAR-NRC on pomegranate has conducted 6 visits during the period reported upon and organized 6 demonstrations and interface meetings were conducted.

ICAR-NRCP scientists were involved in the collection of the soil samples from adopted villages, soil health cards were prepared and nutrition recommendations for pomegranate. Integrated disease and insect, pest management and integrated nutrient management schedule was extended to the farmers of the adopted villages. Awarenes regarding pomegranate processing and value addition was created amongst the pomebranate farmers.

DISTINGUISHED VISITORS TO NRCP, SOLAPUR

Padmashri Dr. Vikas Mahatme, Member of Rajya Sabha visited NRCP, Solapur on 05.03.2022 and held interactive meeting with Scientists and pomegranate growers of the region especially to assess damage caused by shot hole borer pest on pomegranate.

Welcome by Dr. R. A. Marathe and staff for interactive meeting

Visit of Dr. Vikas Mahatme, MP to entomology laboratory

Shri G.P. Sharma, Joint Secretary (Finance), ICAR, New Delhi visited NRCP on 26.04.2022

Hon'ble Dr. Vilas M. Bhale, Vice Chancellor of Dr PDKV, Akola Maharashtra visited NRCP on 26.07.2022 and interacted with scientists

INFRASTRUCTURE CREATED

Genomics Laboratory

State of art genomics lab equipped with sophisticated instruments like PCR machine, RT-PCR, Fragment analyzer, Gel documentation system, Nano drop Spectrophotometer, high throughput liquid handling system, tissuelyzer, and other minor equipment's related to genomics work.

Molecular Breeding Laboratory

Molecular Breeding lab to carry out molecular breeding oriented works like marker assisted selection, germplasm characterization by using molecular markers like SSR, RAPD, ISSR and SRAPs. Identification of trait specific markers through genotyping tools. Designing and development of genomic resources like primers development. Linkage map, QTLs mappings. The development of new breeding lines will be evaluated by using identified markers. Lab working tables has been installed in the lab. The instruments like Spectrophotometer, Deep freezer, Electronic Balance, freezers, Refrigerated Centrifuge, Autoclave has been procured to functionalize the lab through Institution and SERB Projects

Demonstration block of NRCP technologies

Demonstration block was established to showcase the technologies developed by ICAR – NRC on Pomegranate, Solapur to the stake holders.

- The demonstration block comprises of air layered and tissue cultured planting materials of Solapur Lal and Bhagwa, grafting of Solapur Lal and Bhagwa onto four different rootstocks (ACC-2; IC-318707; IC-318712 and IC- 798838).

Inauguration of demonstration block of NRCP Technologies.
(L-R : Shri Shahaji Jachak, Ex President Maharashtra Pom. Growers Asso. Dr. R.A. Marathe, Shri Deepak Shinde, Project Director, MAGNET, Shri Prabhakar Chandane, President, All India Pom. Growers Asso. and Dr K.V. Prasad, Director, ICAR-DFR, Pune)

New Plantation for demonstration block in presence of staff of NRCP.

Electrical Connection to Hiraj Research Farm

New electrical connections were provided in Research Farm, Located in Hiraj. Four transformers were installed in four farm ponds located in all corners of the farm. This will help to ensure proper irrigation to all experimental blocks of the centre and lighting facility on the farm.

New equipment procured during the year

Sr. No.	Name of the equipment	Cost (Rs. in Lakhs)
1	Leaf Image Analyser	7.98
2	Homogenizer	5.00
3	Temperature controlled high speed Refrigerated Centrifuge	4.95
4	BOD, BOD Shakers	4.50
5	Refrigerated Centrifuge	3.28
6	Viscometer	3.47
7	Minor equipments	9.81
8	UPS 15 KVA	5.90
9	150 KVA Stabilizer	4.75
10	Air Conditiones	2.19
Farm Implements		
11	Tractor 55 & 25 HP	17.20
12	Rotavator	1.04
13	Plough	0.45

Human Resource Development

TRAINING ATTENDED

During the year under report, scientists, technical staff, administrative and finance staff have undergone the following need based training as part of the capacity building. The details of trainings undergone by different categories of staff are given below.

TRAINING ATTENDED BY THE STAFF OF ICAR-NRCP, SOLAPUR

S. No.	Name of training	Date	Venue	Name of participant
a.	**Scientific staff**			
1.	Attended virtual training on "Analysis of Experimental data" organized by ICAR-NAARM, Hyderabad	17/01/2022-22/01/2022	ICAR-NAARM, Hyderabad	Chandrakant Awachare
2.	Participate in New Agricultural Innovation Programme – "Achieving Food Security Using Smart Farming Solutions - Study Visit"	13/09/2022-19/09/2022	Galilee International Management Institute (GIMI), Israel	Chandrakant Awachare
3.	Advances in application of Phenomics tools for assessment of abiotic stress responses of crop plants	28/02/2022-09/03/2022	ICAR -NIASM, Baramati	Dr. P. Roopa Sowjanya
4.	Production Protocol for Bio control agents (Predators, parasitoids, microbial bio pesticides and Bio fertilizers)	29/06/2022-19/07/2022	National Institute of Plant Health Management, (NIPHM), Rajendranagar, Hyderabad	Dr. Somnath Suresh Pokhare
5.	Competency Enhancement programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR (online)	21/02/2022 to 23/02/2022	ICAR-NAARM, Hyderabad-Online	Dr. Mallikarjun
6.	DBT-sponsored Training on "Biosecurity and Biosafety: Policies, Diagnostics, Phytosanitary Treatments and Issues"	02/08/2022 to 11/08/2022	ICAR- NBPGR-Online	Dr. Mallikarjun
7.	IP Awareness/Training program under National Intellectual Property Awareness Mission organized by Intellectual Property Rights Office, India	5/8/2022 to 5/8/2022	Online Mode	Dr. Nilesh N. Gaikwad
8.	National Dialogue on Soil Use – Problems and Solutions	19.08.2022	NEERI, Nagpur	Dr. R. A. Marathe
b.	**Technical staff**			
c.	**Administrative staff**			

CONFERENCES, WORKSHOPS AND MEETINGS ATTENDED

The scientists of the Centre participated in conferences/workshops and meetings conducted by various organizations in India besides the meetings mentioned in the chapter on institutional activities. Conferences, seminars, symposia, workshops and important meetings attended by the scientists are enlisted below.

Conference/ Seminar/ Symposia, *etc.* attended

S. No.	Title of Conference/ Seminar/ Symposia	Date	Venue	Name of the participant(s)
1.	Webinar on Pomegranate Orchard Management and Integrated Pests and Disease Management Organized by the Maharashtra Agriculture Department	23/03/2022	Online mode, Department of Horticulture, Government of Maharashtra and ICAR-NRCP	Dr. N.V. Singh & Dr. Mallikarjun M.H.
2.	National Press Conference on the eve of Foundation Day of ICAR-NRCP	24/09/2022-24/09/2022	Online, ICAR-NRCP, Solapur	Dr. A.K. Singh, Dr. R.A. Marathe, Dr. Jyotsana Sharma, Dr. N.V. Singh, Dr. P.G. Patil, Dr. Shilpa Parashuram, Dr. Roopa Sowjanya and Dr. Somnath Pokhare
3.	7th International Conference On Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022)"	29/10/2022-31/10/2022	St. Joseph Vaz Spiritual Renewal Centre, Cruz Dos Milagres, Old Goa	Dr. P. Roopa Sowjanya
4.	International webinar on "Exchange of Post PVP Control Measures" on -PPV&FRA	08/04/2022	Online, ICAR-NRCP	Dr. P. Roopa Sowjanya
5.	National Press Conference on the Eve of Foundation Day of ICAR – NRCP, Solapur	24/09/2022	Online, ICAR-NRCP	Dr. P. Roopa Sowjanya
6.	"International conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022)"	22/08/2022	UAS, Bangalore	Dr. Namrata Ankush Giri
7.	"7th International Conference on Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022)"	29/10/2022-31/10/2022	Don Bosco College of Agriculture, Old Goa.	Dr.Namrata Ankush Giri
8.	"Prospects of Varieties/Crops Developed through Genome Editing (regulatory framework, technologies and experience)" Under Indo-German Cooperation on Seed Sector Development	24/05/2022	On-line	Dr. Shilpa Parashuram

S. No.	Title of Conference/ Seminar/ Symposia	Date	Venue	Name of the participant(s)
9.	'1st National Conference on Plant Genetic Resources Management (NCPGRM 2022)	22/11/2022	New Delhi	Dr. Shilpa Parashuram
11.	National Seminar on "Managing Soils in a Changing Climate"	24/03/2022-26/03/2022	ICAR-NBSS & LUP, Nagpur	Dr. Ashis Maity
12.	International Conference on "Advances in Agriculture and Food System towards Sustainable Development Goals"	22/08/2022-24/08/2022	University of Agricultural Sciences, Bangalore	Dr. Ashis Maity
13.	Brainstorming session on Roadmap for shot hole borer management in Pomegranate	20/05/2022	ICAR-NRCP, Solapur	Dr. Mallikarjun
14.	International Conference on Harnessing Indian Agriculture for Indigenous and Global Prosperity.	22/07/2022 – 23/07/2023	NAS Complex, ICAR, New Delhi	Dr. Mallikarjun
15.	4th International Conference Global Agriculture, Forestry, Environment and Food Security	17/9/2022 -19/9/2022	Institute of Forestry, Pokhara Campus Pokhara, Nepal-Online	Dr. Mallikarjun
16.	National Conference on Tribal Horticulture	17/10/2022-18/10/2022	Dr. YSR Horticulture University Andhra Pradesh- Online	Dr. Mallikarjun
17.	National Dialogue on Soil Use: Problems and Solutions;	19/08/2022	National Environmental Engineering Research Institute (NEERI), Nagpur	Dr. R.A. Marathe, Dr. Mallikarjun Mr. Rahul Damale
18.	National Webinar on 'Application of Nanotechnology in Crop Protection: Current Status and Future Prospects	19/01/2022	Sri Sri University Faculty of Agriculture, Cuttack, Odisha-Online	Dr. Mallikarjun
19.	ICAR NBAIR- Webinar on Application of Genome Editing in Insect Pest Management.	20/01/2022	NBAIR, Bengaluru-Online	Dr. Mallikarjun
20.	"International conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022)"	22/8/2022 to 24/8/2022	UAS, Bangalore	Dr. Nilesh N. Gaikwad

WORKSHOPS ATTENDED

S. No.	Title of Workshop	Date	Venue	Name of Participant(S)
1.	Clean Plant Nursery Certification Workshop Jointly organized by Department of Horticulture, Government of Himachal Pradesh, and Asian Development Bank	06/07/2022-07/07/2022	Hotel Claridges, New Delhi.	Dr. N.V. Singh
2.	Agri-Drone Projects for Orientation Session at AAU Anand on 7 July 2022	07/07/2022	Anand Agricultural University, Anand	Dr. N.V. Singh
3.	Workshop on "Awareness for protection of farmer's rights in areas of farm innovations, breeding and protection of varieties	03/06/2022	ICAR-NRCP, Solapur	Dr. Mallikarjun
4.	One-day workshop on "awareness and dissemination of agriculture technologies tribal sub-plan of Gadchiroli district.	18/08/2022	KVK, Sonapur, Gadchiroli	Dr. Mallikarjun Mr. Rahul Damale

17th "Parthenium Awareness Week" 16-22 August 2022

The "Parthenium Awareness Week" was celebrated by ICAR-DWR Jabalpur, Madhya Pradesh in every year during 16th August to 22nd August. The various activities have been conducted under this program such as releasing of Mexican beetle, parthenium uprooting, making compost, spraying of herbicides, student's rally, demonstrations and exhibitions.

The 17th parthenium awareness week has been conducted at ICAR- National Research Centre on Pomegranate by uprooting and making of compost from parthenium and other weeds, waste stubbles from Kegaon and Hiraj field. The program was inaugurated by Dr. R. A. Marathe Director ICAR-NRC on Pomegranate, Solapur by uprooting the parthenium grass with ICAR-NRCP staff at Crop Cafeteria, Kegaon & Hiraj field. The parthenium awareness week program was attended by 35 to 40 participants with uprooting of parthenium and other weed. Uprooted weeds and parthenium were dumped for compost. The awareness was created among participants.

Parthenium hysterophorus L. is commonly known as carrot weed in the Hindi speaking region but, it is known as Congress grass in other parts of India. The weed has spread throughout the India after its noticeable occurrence in Pune (Maharashtra) in 1955. Now it has achieved the status of the "worst weed" of the country owing to its allelopathic effects on agricultural crop production and harmful effects on people and animals. During the 1980s, parthenium weed used to be considered a weed of fallow and wasteland but now it has become a weed of every crop and also into the forested land.

The severity of the parthenium weed problem has compelled researchers and people to from various action groups and societies to provide a forum for those in need and affected by parthenium weed. It is an exotic weed of Mexican origin, which has now spread throughout India. It has emerged as one of the most problematic weed in the country. Recent nationwide survey has revealed its presence in about 35 million hectares of land. Parthenium has established in varied climate and extreme weather conditions of India. It has been reported to cause severe loss in

crop productivity. It has also been found to occupy large area of pasture land hence reducing the fodder availability to animals. Parthenium is notorious for causing health problems in man and animals. In human beings, it causes allergic contact dermatitis and several other skin diseases. The pollens of the weed which are released in the air also cause asthma. The animals feeding on the plant usually develop ulcers in mouth and intestine.

The milk of the cattle feeding on the weed also gets infected. Once this weed is established in a region, it soon replaces local vegetation. Owing to all these hazards, Parthenium requires immediate management through various approaches among which public awareness is one of them. Although there are mechanical, chemical and biological methods to control Parthenium but each method has some limitations due to its presence throughout the year in varied climate, high reproductive rate, small and light weight seeds and adaptability to survive in extreme climatic conditions. Public participatory approach involving stakeholders from all sectors of society may be one of the strategies to manage Parthenium in the country.


Parthenium uprooting and awareness programme at Kegaon School


17th "Parthenium Awareness Week"16-22 August 2022 at ICAR-NRCP,Solapur

MEETINGS ATTENDED

S. No.	Title of meeting	Date	Venue	Name of participant(s)
1.	Board of Studies Meeting of the Department of Botany, Walchand College of Arts and Science (as a BoS member)	11/05/2022	Online	Dr. N.V. Singh
2.	Meeting with the team of research leaders from Bayers Crop Science Ltd. led by Mrs. *Sangeeta Mendiratta,* Lead- Government Affairs, Public Affairs, Science & Sustainability, IBSL	07/02/2022	ICAR-NRCP, Online	Dr. N.V. Singh, Dr. Manjunatha N., Dr, Somnath Pokhare, Dr. Mallikarjun, M.H.
3.	NRCP- Bayer to strengthen capacity building in Pomegranate.	16/05/2022	ICAR-NRCP,	Dr. R.A. Marathe, Dr. Jyotsana Sharma, Dr. N.V. Singh, Dr. Manjunatha N., Dr. Somnath Pokhare, Mr. Chandrakant & others
4.	QRT meeting	05/01/2022-06/01/2022	ICAR– NRCP, Solapur	Dr. P. Roopa Sowjanya
5.	Interactive meeting with APEDA, Chairman	28/01/2022	ICA – NRCP, Solapur	Dr. P. Roopa Sowjanya
6.	Project presentation review meeting of BARC	29/03/2022	ICAR – NRCP, Solapur (Online)	Dr. P. Roopa Sowjanya
7.	Interaction with Ex-DDG (HS)	30/03/2022	ICAR – NRCP, Solapur	Dr. P. Roopa Sowjanya
8.	Brainstorming session on "Roadmap for Shot hole borer management in pomegranate"	20/05/2022	ICAR – NRCP, Solapur	All NRCP Staff
9.	HORTSAP meeting on modification of the pomegranate survey proforma for pest scouts and monitors at Sakhar Sankul Shivajinagar, Pune, Maharashtra	11/03/2022	Sakhar Sankul Shivajinagar, Pune, Maharashtra	Dr. Mallikarjun, Dr. Jyotsana Sharma and Dr. Manjunatha, N.
10.	State-Level Project Screening Committee (SLSC) meeting for funding under RKVY for the Biocontrol laboratory project.	11/9/2022-12/9/2022	Central Building Mumbai, Maharashtra	Dr. Mallikarjun, Dr. Jyotsana Sharma and Dr. Manjunatha, N.
11.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	15/02/2022	Ajnale- Sangola, Maharashtra	Dr. Mallikarjun, Dr. R.A. Marathe Dr. Somnath Pokhare and DR. Manjunatha N.
12.	Farmer- Scientist- interaction meets on diagnosis and management of shot hole borer in pomegranate and Agrowon Anniversary Event.	20/04/2023	Pandharpur-Maharashtra	Dr. Mallikarjun

S. No.	Title of meeting	Date	Venue	Name of participant(s)
13.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer and diseases in pomegranate	07/06/2022	Sangola, Maharashtra	Dr. R.A. Marathe Dr. Mallikarjun Dr. Manjunatha N. Dr. Somnath Pokhare and Dr. Nilesh Gaikwad
14.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	17/06/2022	Daund, Maharashtra	Dr. Mallikarjun
15.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	21/09/2022	Korti-Pandharpur, Maharashtra	Dr. Mallikarjun
16.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	27/09/2022	Gadegaon, Pandharpur, Maharashtra	Dr. Mallikarjun
17.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	13/10/2022	Nimgaon-Indapur, Maharashtra	Dr. Mallikarjun Dr. Jyotsana Sharma and Dr. Somnath S.P.
18.	31st State-level Sanctioning Committee (SLSC) Meeting for funding under RKVY for the Biocontrol laboratory project.	23/11/2022	Central Building Mumbai, Maharashtra	Dr. R.A. Marathe Dr. Mallikarjun
19.	Farmer- Scientist- interaction meet on diagnosis and management of shot hole borer in pomegranate	01/12/2023	Goudwadi-Sangola, Maharashtra	Dr. Mallikarjun
20.	Scientific Advisory Committee (SAC) meeting of KVK Indi	18/10/2022	KVK Indi, Karnataka-Online	Dr. Mallikarjun
21.	APEDA, Financial Assistance Orientation Programme for Government Universities	05/7/2022	APEADA, Mumbai Online	Dr. Mallikarjun
22.	Agriculture Research Management System (ARMS) meeting	8/02/2022	NRCP, Solapur-Online	Dr. Mallikarjun
23.	Meeting with Bayer India Pvt. Ltd.	7/02/2022	NRCP, Solapur-Online	Dr. Mallikarjun
24.	HORTSAP meeting	04/11/2022	NRCP, Solapur-Online	Dr. Mallikarjun
25.	APEDA meeting on Standardization of sea protocol for export of Indian pomegranate to Australia	11/11/2022	NRCP, Solapur-Online	Dr. Mallikarjun
26.	DPC meeting of LDC	18/11/2022	NRCP, Solapur	Dr. Mallikarjun
27.	DG, staff review meeting	4/01/2022	NRCP, Solapur-Online	Dr. Mallikarjun
28.	Hortsap project meeting	28/01/2022	NRCP, Solapur	Dr. Mallikarjun
29.	Interaction meeting with Angamuttu Chairman APEDA	28/01/2022	NRCP, Solapur	Dr. Mallikarjun

Meetings attended by Dr. R. A. Marathe, Director, ICAR-NRCP, Solapur during the year 2022

1.	Indian Crop Improvement Programme: New Vistas lecture. Dr. Mohapatra, Sec, DARE &DG, ICAR shall chaired the session.	Dr. T R Sharma DDG (CS) ICAR	07.01.2022	Online
2.	Good Agricultural Practices for Export Quality Pomegranate Production and Value Addition" ICAR-NRCP, Solapur 10-12 Jan 2022	NRCP Solapur	10 To 12 Jan 2022	Online/ In person
3.	Novel approaches in the biological control of insect pests	Dr. M. L. Jeeva PS & Head (Acting) ICAR-CTCRI,	17.01.2022	Online
4.	Monthly Meeting with Directors of Hort. Sci. Division	DDG HS, ICAR	20.01.2022	Online
5.	Presentation on Agricultural Research Management System (ARMS)	Dr. Anil Rai ADG (ICT)	08.02.2022	Online
6.	Pre-Research Review Committee meeting in Horticulture	HoD Horticulture, MPKV., Rahuri	14.02.2022	Online
7.	V International Symposium on Pomegranate and Minor Mediterranean Fruits Guest Speaker for Day 2: 16th February 2022	-	February 15-17, 2022	Online
8.	Research Review Committee meeting in Horticulture	HoD Horticulture, MPKV., Rahuri	17 & 18 Feb.2022	Online
9.	Meeting regarding expenditure review	DDG (HS) ICAR	03.03.2022	Online
10.	ICAR-SOC meeting for discussion on budget utilization and related issues	Kodapi S. ADG, IPR ICAR	07.03.2022	Online
11.	Meeting to discuss budget utilization	DDG (HS) ICAR	28.03.2022	Online
12.	Budget and Expenditure Review for 2021-22 under the chairmanship of DG, ICAR	G. P. Sharma Director,(Fin.) ICAR	29.03.2022	Online
13.	The details of the Lecture #57 under Azadi Ka Amrit Mahotsav Dr. T. Mohapatra shall chair the session. Topic: AI and IOT: Enabling Sustainable Digital Agriculture	RC Agrawal DDG Agr Ext.	11.05.2022	Online
14.	ICAR-IIHR : EFC meeting of Scheme-I (Pre-merged)	Dr. Prakash Patil ICAR-IIHR	30.05.2022	Online
15.	Garib Kalyan Sammelan and Live Webcasting of Hon'ble Prime Minister's Address to the farmers: **Guest of Honour**	Head, KVK, Solapur	31.05.2022	In Person
16.	Online Off-campus collaborative training programme on "Recent advanced practices for export quality pomegranate production and value addition"			
17.	ICAR-IIHR : EFC Meeting - Scheme I Project Coordinator Fruits	Dr. Prakash Patil ICAR-IIHR	13.06.2022	Online
18.	Brain Storming Session for finalizing the guidelines for varieties / products / technologies, etc.	Dr. Debi Sharma ICAR-IIHR	14.06.2022	Online

19.	Meeting Budget utilization with DDG HS, ICAR, New Delhi	Kanchan Singh PPS to DDG	29.06.2022	Online
20.	Meeting VC held under the Chairmanship of Secretary, A&FW to review the progress and effectiveness of CoEs Sanctioned under Indo - Israel and Indo-Dutch Cooperation	Project Unit, MIDH Division, DoA&FW	07.07.2022	Online
21.	VC for Procurement through GeM	Account section ICAR	12.07.2022	Online
22.	ICAR-IIHR : EFC Meeting - Scheme I Project Coordinator Fruits	Dr. Prakash Patil PC (Fruits), IIHR, Bengluru	14.07.2022	Online
23.	International Conference on "Harnessing Indian Agriculture for Indigenous and Global Prosperity"	BKS,BAERC, ICAR	22-23 July 2022	In Person
24.	ICAR-IIHR : EFC Meeting - Scheme I Project Coordinator Fruits	Dr. Prakash Patil PC (Fruits), IIHR, Bengluru	01.08.2022	Online
25.	Interaction Meeting with Directors with DG, ICAR	Sh. AK Varma (ICT) Unit	30.08.2022	Online
26.	IRC meeting of ICAR NRC on Pomegrnate, Solapur	NRCP	01.09.2022	In Person
27.	मॅग्नेट प्रकल्प अंतर्गत प्रशिक्षक प्रशिक्षण कार्यक्रम डाळिंब निर्यातविषयक क्षमता वृद्धीसाठी प्रशिक्षण कार्यक्रम	श्री.राजेंद्र महाजन म.रा.कृ.प.मंडळ, पुणे	02.09.2022	In person
28.	Meeting on QRT presentation before DG ICAR, New Delhi.	Dr. Manish Das, PS, HSD, ICAR	06.09.2022	In Person
29.	Review Meeting on MIDH under the chairmanship of Dr. Abhilaksh Likhi, Addl. Sec. (DA&FW), New Delhi	DDG (HS) ICAR	12.09.2022	Online
30.	Lead Lecture presentation in the 4th International Conference on "Global Efforts on Agriculture, Forestry, Environment and Food Security (Theme: Climate Change and Its Impact) (GAFEF-2022)"	AETDS, India, TU, Nepal, AFU, Nepal, GBPUAT, Pantnagar	September 17-19, 2022	In Person
31.	VC meeting with Dr. Abhilaksh Likhi, Additional Secretary (DA&FW), New Delhi while during his visit to ICAR-IIVR, Varanasi, UP for review the progress of Indo_Dutch and Indo-Israel Centre of Excellence	Project Unit, MIDH Division, DoA&FW	22.09.2022	Online
32.	18th Foundation day of NRCP, Solapur	NRCP, Solapur	25.09.2022	In person
33.	Special Campaign 2.0 for disposal of Pending Matters from 2nd October to 31st October, 2022	DG ICAR	26.09.2022	Online
34.	Meeting of Dr. Abhilaksh Likhi, Additional Secretary, DA&FW with ICAR institutes of Horticulture Sciences on where presentation is to be done by 3 institutes of ICAR institutes of Horticulture Sciences	O/o Additional Secretary MoA&FW, KB New Delhi	06.10.2022	Online

35.	Meeting regarding budget	DDG (HS)	12.10.2022	Online
36.	Participated in Horticulture Value Chain Function to be held on 01.11.2022 at Pune.	Mission Director MSHMB Pun	01.11.2022	In person
37.	ICAR Regional Committee-IV meeting to be held at IIVR, Varanasi on 7th November 2022 in hybrid mode	T.K.Behera Director, ICAR-IIVR, Varanasi	07.11.2022	Online
38.	Institute Management Committee meeting of ICAR-NRCP, Solapur in hybrid mode	NRCP, Solapur	07.11.2022	Online/ offline
39.	Attended the RAC Meeting of MRDBS, Pune at ICAR-NIASM, Baramati and to visit the pomegranate orchards around Baramati & Phaltan areas	MRDBS, Pune	10.11.2022	In person
40.	Meeting Notice regarding presentation by Secretary, DARE & DG, ICAR on "Revitalizing ICAR: Aspirations and Action Plan	ICT Unit ICAR	11.11.2022	Online
41.	Webinar on Presentation by DDG(CS) on activities and aspirations of ICAR	DG, ICAR	14.11.2022	Online
42.	Stakeholders Meeting - Export of Pomegranate to Australia, Hosted by APEDA HO	V.Sudhanshu DGM, APEDA	15.11.2022	Online
43.	Webinar on Presentation by DDG (Agril. Engineering) on activities and aspirations of ICAR	DG, ICAR	17.11.2022	Online
44.	Webinar on Presentation by DDG (Animal Science)	DG, ICAR	22.11.2022	Online
45.	Lecture by DDG (Education) Agricultural Education	DG, ICAR	25.11.2022	Online
46.	Lecture by DDG (NRM)	DG, ICAR	02.12.2022	Online
47.	Presentation by DDG (Horticulture)	DG, ICAR	05.12.2022	Online
48.	Webinar: International Year of Millets opening ceremony/side event at Amsterdam, Berlin, Rome, Stockholm, Vienna	ADG ICT ICAR	06.12.2022	Online
49.	Review meeting with ICAR-NRCP, Solapur, ICAR-NRCSS, Tabiji and ICAR-NRCB, Tiruchirapalli for Cooperation on Education, Research and Extension on signed MoUs	Dr.K.DHANUMJAYA RAO M.Sc(Hort.), Ph.D(IARI) Director	12.12.2022	Online
50.	Mid-Term Meeting to review the ATR of 26th meeting of ICAR Regional Committee No. VII	Director ICAR-CIAE, Bhopal	12.12.2022	Online
51.	Presentation by DDG (Fisheries)	DG, ICAR	13.12.2022	Online
52.	Meeting VC of stakeholders to discuss various issues under Clean Plant Programme under the chairmanship of Joint Secretary MIDH for Selection of suitable crops to be included under Clean Plant Programme.	Project Unit, MIDH Division, MoA&FW Krishi Bhawan, New Delhi	22.12.2022	Online
53.	Celebration of KISAN DIWAS, 2022 under the Chairmanship of Shri Narendra Singh Tomar, Hon'ble Minister of Agriculture & Farmers Welfare. Sushri Shobha Karandlaje & Shri Kailash Choudhary, Hon'ble Ministers of State	Dr. Anil Rai ADG (ICT) ICAR New Delhi	23.12.2022	Online

Publications

Research articles:

S. No.	Research paper
1.	Patil PG, Jamma S, Manjunatha N, Bohra A, Pokhare SS, Dhinesh Babu K, Murkute AA and Marathe RA 2022. Chromosome specific potential intron polymorphism markers for large-scale genotyping applications in pomegranate. Frontiers in Plant Science. doi: 10.3389/fpls.2022.943959. (NAAS rating: 12.63)
2.	Rahul D. Damale., Anirban Dutta., Nasiruddin Shaikh., Anita Pardeshi., Raviraj Shinde., Dhinesh Babu., Nilesh N. Gaikwad and Kaushik Banerjee 2022. Multiresidue analysis of pesticides in four different pomegranate cultivars: investigating matrix effect variability by GC-MS/MS and LC- MS/MS. (Journal of Food Chemistry). (NAAS rating: 15.24)
3.	Manjunatha, N.; Sharma, J.; Pokhare, S. S.; Agarrwal, R.; Patil, P. G.; Sirsat, J. D.; Chakranarayan, M. G.; Bicchal, A.; Ukale, A. S.; Marathe, R. A. 2022. Characterization of Alternaria and Colletotrichum Species Associated with Pomegranate (*Punica granatum* L.) in Maharashtra State of India. Journal of Fungi. 8, 1040. https://doi.org/10.3390/jof8101040. (NAAS rating: 11.82)
4.	Roopa Sowjanya P, Shilpa P. , Patil PG, Babu KD, Sharma J, Sangnure VR, Mundewadikar DM, Natarajan P, Marathe RA, Reddy UK and Singh NV, 2022. Reference quality genome sequence of Indian pomegranate cv.'Bhagawa' (Punica granatum L.). Frontiers in Plant Science, 13:947164, doi:10.3389/fpls.2022.947164 (NAAS rating: 11.75)
5.	Singh, N.V., Sharma, J., Dongare, M.D., Gharate, R., Chinchure, S., Manjunatha N, Parashuram, S., Patil, P.G., Babu, K.D., Mundewadikar, D.M., et al. 2022. *In vitro* and in planta antagonistic effect of endophytic bacteria on blight causing *Xanthomonas axonopodis* pv. *punicae*: a destructive pathogen of pomegranate. *Microorganisms* 11(1):5. 10.3390/microorganisms11010005 (NAAS rating: 10.93)
6.	Patil, P.G., Singh, N.V., Bohra, A., Jamma, S., Manjunatha, N., Venkatesh, S.C, Babu K.D., Sharma, J. and Marathe, R.A. 2022. Novel miRNA-SSRs for improving seed hardness trait of pomegranate (*Punica granatum* L.). *Frontiers in Genetics* 13: 866504. doi:10.3389/fgene.2022.866504. (NAAS rating: 10.77)
7.	Shilpa, P., Singh, N.V., Gaikwad, N.N., Corrado, G., Roopa Sowjanya, P., Basile, B., Nitesh S.D., Chandra, R., Babu, K.D., Patil, P.G., Kumar, P., Singh A and Marathe R.A. 2022. Morphological, biochemical, and molecular diversity of an indian ex situ collection of pomegranate (*Punica granatum* L.). *Plants-Basel,* 11(24): 3518. https://doi.org/10.3390/plants11243518, (NAAS rating: 10.66)
8.	Maity, A. Marathe, R.A., Sarkar, A., Basak, B. 2022. Phosphorus and potassium supplementing bio-mineral fertilizer augments soil fertility and improves fruit yield and quality of pomegranate. *Scientia Horticulturae,* https://doi.org/10.1016/j.scienta.2022.111234 , (NAAS rating: 9.46)
9.	Patil, P.G., Sharma, J., Nanjundappa, M., Singh, N.V. *et al.* 2022. Identification and validation of SSR markers for *Xanthomonas axonopodis* pv. *punicae* an incitant of bacterial blight of pomegranate. *3 Biotech* 12: 153. doi:10.1007/s13205-022-03209-z, (NAAS rating: 8.89)
10.	Jyotsana Sharma, Nanjundappa Manjunatha, Somnath S. Pokhare, Prakash G. Patil, Ruchi Agarrwal, Mansi G. Chakranarayan, Anita Aralimar, Priya Devagire and Rajiv A. Marathe. 2022. Genetic Diversity and Streptomycin Sensitivity in Xanthomonas axonopodis pv. punicae Causing Oily Spot Disease in Pomegranates. horticulturae 8, 441. https://doi.org/10.3390/horticulturae8050441. (NAAS rating: 8.33)

S. No.	Research paper
11.	Maity A., Sharma J., Sarkar A., Basak B. B. 2022. Zinc nutrition improves fruit yield, quality and reduces bacterial blight disease severity in pomegranate (*Punica granatum* L.). Journal of Plant Nutrition, https://doi.org/10.1080/01904167.2022.2118610 (NAAS rating: 7.71)
12.	Singh, N.V., Salunkhe, O., Awachare, C., Salutgi, U., Sharma, B., Parashuram, S. and Marathe, R.A. 2022. Healthy Saplings – Key to Sustainable Pomegranate Production. *Biological Forum – An International Journal* 14(4): 1188-1194. (NAAS rating: 5.11)
13.	Tonde A.B., Bhoite, A.A. and Gaikwad N.N. 2022. Studies on microencapsulation of Lactobacillus acidophilus NCIM 5306 and evaluation of matrix material efficiency in pomegranate juice. Food Research 6(2): 255-264.

S.No.	BOOKS
1	Marathe R.A., Mallikarjun M. H, Manjunatha N, Venkata Rao B., 2022. High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition. National Institute of Agricultural Extension Management (MANAGE), Hyderabad & ICAR-National Research Centre on pomegranate. Published by MANAGE, Hyderabad as e-publication (ISBN: 978-93-91668-12-9).
2.	Deepa, Roopa Sowjanya, P., Asha Rani, Anita Singh, Environmental Resources: uses and Management, 2022, AGPH Books, Bhopal, M.P, India. ISBN-978-93-95936-03-3.

S.No.	BOOK CHAPTERS
1.	Singh, S.K., Pradhan, S., Krishna, H., Alizadeh, M., Kumar, C., Singh, N.V., et al., 2022. Development of Abiotic Stress Resistant Grape Vine Varieties. In: *Genomic designing of abiotic stress resistant crop plants: Fruits & Nuts* (ed: Chitranjan Kole) Springer Nature, Switzerland AG Publication pp 61-159 ISBN 978-3-031-09874-1 (eBook) ISBN 978-3-031-09875-8 https://doi.org/10.1007/978-3-031-09875-8.
2.	Singh, N.V. 2022. Orchard establishment, canopy management and impact of high-density planting in pomegranate. In: High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition (eds: Marathe R.A., Mallikarjun M. H, Manjunatha N, Venkata Rao B). National Institute of Agricultural Extension Management (MANAGE), Hyderabad & ICAR- National Research Centre on Pomegranate, Solapur (ISBN: 978-93-91668-12-9).
3.	Singh, N.V. 2022. Recent advances in propagation methods in pomegranate. In: High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition (eds: Marathe R.A., Mallikarjun M. H, Manjunatha N, Dr. Venkata Rao B). National Institute of Agricultural Extension Management (MANAGE), Hyderabad & ICAR- National Research Centre on Pomegranate, Solapur (ISBN: 978-93-91668-12-9).
4.	Patil PG, Singh NV, Shilpa P,, Roopa Sowjanya P, Sharma J, Marathe RA, 2022. Recent advances in pomegranate genomics: Status and prospects: In Omics in Horticultural Crops, Pages 193-203, ISBN 978032389905510.1016/B978-0-323-89905-5.00023-9.
5.	Roopa Sowjanya, P. 2022. Conservation and utilization of Pomegranate genetic resources for quality pomegranate production. In: High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition (eds: Marathe R.A., Mallikarjun M. H, Manjunatha N, Dr. Venkata Rao B). National Institute of Agricultural Extension Management (MANAGE), Hyderabad & ICAR- National Research Centre on Pomegranate, Solapur (ISBN: 978-93-91668-12-9).
6.	Maity A. and Kashyap P. 2022. Integrated nutrient management for sustainable pomegranate production. In: Natural Resource Management in Horticultural Crops (Eds. Roy, S.S., Kashyap, P., and Adak, T.). Today & Tomorrow's Printers and Publishers, New Delhi-110002 pp. 31-47.

S.No.	BOOK CHAPTERS
7.	Babu N., Kashyap P., Prusty A.K., Samant D. and Maity A. 2022. Role of horticulture for sustainable food production under climate change scenario. In: Natural Resource Management in Horticultural Crops (Eds. Roy, S.S., Kashyap, P., and Adak, T.). Today & Tomorrow's Printers and Publishers, New Delhi-110002 pp. 293-313.
8.	Mallikarjun M.H., 2022. Integrated management of insect pest of pomegranate. High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and Value addition. National Institute of Agricultural Extension Management (MANAGE), Hyderabad & ICAR-National Research Centre on pomegranate. Published by MANAGE, Hyderabad as e-publication (ISBN: 978-93-91668-12-9).
9.	Gaikwad. N. N. 2022. Pomegranate processing and value addition for entrepreneurship development. In E-book on "High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition". (Ed. Marathe R.A. et al.). Hyderabad: National Institute of Agricultural Extension Management (MANAGE) & ICAR- National Research Centre for Pomegranate. ISBN: 978-93-91668-12-9. 99-104.
10.	Gaikwad, N., Giri, N.A., Marathe, R.A. 2022. Pomegranate beverage, Pomegranate juice, pomegranate lime ginger beverage, pomegranate wine, minimally processed arils and pomegranate juice powder. In Innovative foods @icar, Indian Council of Agril. Research 110.
11.	Namrata Giri, Krishnakumar T, Jeevarathiram G and Sajeev M.S. 2022. Thermo-Physical and Physicochemical Technologies for Drying of Food Products In. "Novel and Alternate Methods in Food Processing, Biotechnological, Physicochemical, and Mathematical Approaches (Ed. Veena N.,Megh R. Goyal and Ritesh B. Watharkar). Apple academic Press, Taylor Francis Group, USA, ISBN 9781774911624.
12.	Sakhale B.K., Namrata A. Giri and Borse B.B. 2022. Role of Phytochemicals in Human Health. In. Novel Processing Methods For Plant–Based Health Foods: Extraction, Encapsulation and Health Benefits of Bioactive Compounds (Ed. Megh R. Goyal, Ritesh B. Watharkar and Veena N). Apple academic Press, Taylor Francis Group, USA, ISBN: 9781774910740.

S.No.	POPULAR ARTICLES/ TECHNICAL ARTICLE
1.	Singh, N.V., Maity, A., Manjunatha, N., Roopa Sowjanya P., Sharma, A., Chandrakant, A. and Marathe R.A. 2022. Exploring rootstocks for climate smart pomegranate production. Krishi Science – eMagazine for Agricultural Sciences, 3(40):1-4.
2.	Krishna, H., Singh, A.K., Maheshwari, S. and Singh, N.V. 2022. Basant mein karein bagon ki vishesh dekhbhal. Phal Phool, March April: 69-74
3.	Krishna, H., Singh, A.K., Maheshwari, S. and Singh, N.V. 2022. January-Febrary mein bago ka karya. Phal Phool, Jan-Feb: 61-66
4.	Sharma, J., Maity, A., Singh, N.V., Mallikarjun, M.H., Manjunatha, N., Pokhare, S. and Chaudhari, D. 2022. Bimonthly Pomegranate Advisory for Bearing Orchards (October-November 2022) https://nrcpomegranate.icar.gov.in/files/Advisory/123.pdf
5.	Sharma, J., Maity, A., Singh, N.V., Mallikarjun, M.H., Manjunatha, N., Pokhare, S. and Chaudhari, D. 2022. Bimonthly Pomegranate Advisory for Bearing Orchards (August-September 2022). https://nrcpomegranate.icar.gov.in/files/Advisory/119.pdf
6.	Sharma, J., Maity, A., Singh, N.V., Mallikarjun, M.H., Pokhare, S. and Chaudhari, D. 2022. Bimonthly Pomegranate Advisory for Bearing Orchards (June-July 2022). https://nrcpomegranate.icar.gov.in/files/Advisory/117.pdf
7.	Sharma, J., Maity, A., Singh, N.V., Mallikarjun, M.H., Manjunatha, N., and Pokhare, S. 2022. Bimonthly Pomegranate Advisory for Bearing Orchards (Feb-March, 2022). https://nrcpomegranate.icar.gov.in/files/Advisory/114.pdf

S.No.	POPULAR ARTICLES/ TECHNICAL ARTICLE
8.	Sharma, J., Maity, A., Singh, N.V., Mallikarjun, M.H., Pokhare, S. and Chaudhari, D. 2022. डाळिंब फळधारक बागांसाठी द्वैमासिक सल्ला (जुन-जुलै२०२२) बागेची अवस्था – पिक नियमन, फुलधारणा आणि फळधारण. Mrugdhara.
9.	Singh, N.V., Babu, K.D. and Maity, A. 2022. Adverse effects of high temperature on pomegranate. Available on Dalimbmitra Platform https://dalimbmitra.com/wp-content/uploads/2022/04/Effects-of-rising-temperature-on-pomegranate-sent-o-Dalim-mitra-on-12.04.2022.pdf.
10.	Awachare, C., Singh, N.V., Babu, K.D. and Marathe, R.A. 2022. Canopy management in pomegranate for improved fruit quality and yield. Biotica Research Today 4(1): 011-013.
11.	राहुल डमाळे, शिल्पा परशुराम, रूपा सौजन्या, दिनेश बाबू, निरपेंद्र सिंग, आर. ए. मराठे, डाळिंबाच्या व्यावसायिक जाती आणि त्यांची वैशिष्ट्ये, आई. सी. ए. आर. राष्ट्रीय डाळिंब संशोधन केंद्र, केगाव, सोलापूर, कृषी सहकार, ०१ जानेवारी २०२३.
12.	नीलेश गायकवाड, नम्रता गिरी आणि राजीव मराठे. 2022. डाळींबाचे मूल्यवर्धन आणि उद्योजकता विकास संधी. .डाळिंबवृत्त (जानेवरी- मार्च).26-29
13.	नीलेश गायकवाड, नम्रता गिरी, दिनेश बाबू आणि राजीव मराठे. 2022. डाळिंब फळाचे काढणीपशयात व्यवस्थापन. डाळिंबवृत्त (जानेवरी- मार्च).22-25.
14.	नीलेश गायकवाड, नम्रता गिरी, आणि राजीव मराठे. 2022. डाळिंब प्रक्रिया उद्योगातील संधी. डाळिंब निर्यात विषयक क्षमता वृद्धीसाठी प्रशिक्षण कार्यक्रम. 45-51.
15.	नीलेश गायकवाड, नम्रता गिरी, दिनेश बाबू, स्वाती सूर्यवंशी आणि राजीव मराठे. 2022. फळ प्रक्रिया उद्योग: डाळिंब प्रक्रिया विशेष संदर्भ. शेतकरी. 53-55.
16.	Singh, N.V., Salunkhe, O., Awachare, C., Salutgi, U., Sharma, B., Shilpa P. and Marathe, R. A. 2022. Healthy Saplings – Key to Sustainable Pomegranate Production. Biological Forum – An International Journal.14(4): 1188-1194.
17.	Singh, N.V., Sharma, J., Patil, P.G., Babu, K.D., Shilpa P., Sharma, A., and Marathe, R.A. 2022. Pomegranate cultivation in dry land regions of India – a success story. Krishi Science. 4(2): 44-48.
18.	Pinky Raigond 2022. Physiological disorders in pomegranate: impact of use of plant growth-promoting hormones for quality pomegranate production. E-training manual on 'Recent advanced practices for export quality pomegranate production and value addition from June 6-10, 2022'. ICAR-NRCP, Solapur. Pp 33-36.
19.	Maity, A., Ghosh, D., Adhikary, P.P., and Shinde, Y. 2022. SONAAR - A Novel Potassium Solubilizing Bio-Formulation for Quality Pomegranate Production. Biotica Research Today 4(11):741-744
20.	Maity, A., Ghosh, D., Shinde, Y. 2022. Dalimba baget biomineral khatacha santulit bapar (Marathi). Sakal Agrowan, 27-28 December, 2022, page 12.
21.	Maity, A., Ghosh, D., Adhikary, P.P. and Shinde, Y. 2022. Biomineral fertilizer can substantially supplement phosphate and potassium requirement of pomegranate tree. Sabujeema, 2(11):32-39.
22.	Rahul Devidas Damale, Marahte R A, Gajanan Fuke, Dinkar Chaudhari, Dinesh K Babu (6 July 2022), Pomegranate phytochemicals and importance in human health & diet. Krushi Sahkar newspaper.
23.	Vasundhara More, Raviraj Shinde, Rahul Devidas Damale (28 July 2022), Agricultural Chemicals: problems and solution, Krushi Sahkar newspaper.
24.	Rahul Devidas Damale, Marahte R A, Gajanan Fuke, Dinkar Chaudhari, Dinesh K Babu (7 July 2022), Pomegranate fruit and its importance in Ayurveda. Krushi Sahkar newspaper.
25.	Rahul Devidas Damale, R A Marathe, Gajanan Fuke, (August 2022) Importance of healthy pomegranate, Agrowan newspaper.

S.No.	POPULAR ARTICLES/ TECHNICAL ARTICLE
26.	Mallikarjun, Rajiv Marathe and Dinkar Chaudhary 2022. Dalimb Pikaavaril Khod Keed (Bhungera) Vyavstapan. Quarterly magazine, Dalimbvrut, January- March-2022. Page. No.42-44.
27.	Somnath Pokhare, Manjunatha, N., Mallikarjun and Jyotsana Sharma 2022. Dalimbaalitl sutrakrumichae ektmik Vyavstapan. Maharshtra Rajya panan mandal Pune, vibhagiya kaaryalaya, Pune. June-July 2022. Page No. 29-36.
28.	Mallikarjun Somnath Pokhare, Rajiv Marathe and Dinkar Chaudhary 2022. Dalimb Pikaavaril Khod Keed (Bhungera) Vyavstapan. Maharshtra Rajya panan mandal Pune, vibhagiya kaaryalaya, Pune. June-July 2022. Page No. 43-47.
29.	निलेश गायकवाड, नम्रता गिरी, दिनेश बाबू, स्वाती सूर्यवंशी आणि राजीव मराठे. 2022. फळ प्रक्रिया उद्योग: डाळिंब प्रक्रिया विशेष संदर्भ. शेतकरी, जून २०२२, 53-55.
30.	Roopa Sowjanya P, Shilpa Parashuram and RA Marathe. 2022. Rewards and Recognitions to Farming Community for Plant Genetic Resources Conservation Under PPV&FRA. In: "Awareness for Protection of Farmer's Rights in Farm Innovations, Breeding and Protection of Varieties", Workshop manual no. NRCP/Workshop/2022/01 ICAR-National Research Centre on Pomegranate, Solapur-413255 (Maharashtra), India, pp 30-39.
31.	Nilesh Gaikwad, Shilpa Parashuram and RA Marathe. 2022. Intellectual Property Rights with respect to Farm Innovations. In: "Awareness for Protection of Farmer's Rights in Farm Innovations, Breeding and Protection of Varieties", Workshop manual no. NRCP/Workshop/2022/01 ICAR-National Research Centre on Pomegranate, Solapur-413255 (Maharashtra), India, pp. 8-19.
32.	Mallikarjun, M. H., Marathe, R. A., Manjunatha, N., Somnath, S. P., 2022. Shot Hole Borer: An Emerging Pest of Pomegranate Its Diagnosis and Management. 4th International Conference on "Global Efforts on Agriculture, Forestry, Environment and Food Security (Theme: Climate Change and Its Impact) (GAFEF-2022)" organized by Agricultural and Environmental Technology Development Society (AETDS) U.S. Nagar Uttarakhand, India from September 17-19, 2022 Souvenir book Gafef Vol-2, Page No. 519. ISBN: 978-93-5659-453-1.
33.	Mallikarjun, M. H., Shilpa, P., Rahul Damale, Singh, N.V., Somnath, S. P., Marathe, R. A. 2022. A sub-plan approach for tribal development at Gadchiroli, Maharashtra. National Conference on Tribal Horticulture (hybrid mode) October 17-18, 2022, (THS1007). Organized by Dr. YSR Horticultural University Venkataramannagudem, West Godavari District, Andhra Pradesh. Souvenir cum abstract book. P No.136.

PRESENTATIONS IN CONFERENCES/ SYMPOSIA/ SEMINAR/ OTHER FORA

S.No.	ORAL PRESENTATIONS
1.	Singh, N.V. 2022. Pomegranate orchard establishment. In: Webinar on Pomegranate Orchard Management and Integrated Pests and Disease Management Organized by the Maharashtra Agriculture Department on 23.03.2022.
2.	Marathe, R.A., Sharma, J. and Singh N.V. 2022. "Current Status of the Pomegranate Industry in India: Challenges and Opportunities". Vth International Symposium on Pomegranate and Minor Mediterranean Fruits, 14-18th Feb, 2022.
3.	Raigond, P., Singh, N.V., Shilpa, P., Roopa Sowjanya, P., Babu, K.D. and Marathe, R. A. 2022. Physiological disorders of pomegranate and their management strategies. National Symposium on Novel Strategies in Plant Stress Diagnosis and Management, May 6-7, 2022.
4.	Singh, N.V. 2022. Establishment of pomegranate nurseries for production of good quality planting material. In: training programme on "Quality pomegranate production and value addition for doubling farmers' income", funded by Bayer Crop Science, 24-26th February 2022.

S.No.	ORAL PRESENTATIONS
5.	Singh, N.V. 2022. Recent advances in propagation methods, orchard establishment, canopy management and flower regulation in pomegranate. In: Training gprogramme on Good Agriculture Practices for Quality Pomegranate Production and value addition" from August 10-12, 2022 at ICAR-National Research Centre on Pomegranate funded by Fertis, Hyderabad.
6.	Singh, N.V. 2022. Orchard establishment, canopy management and impact of high-density planting in pomegranate. In: Online off-campus collaborative training programme on "Recent advanced Practices for Export Quality Pomegranate Production and value addition" from 6-10th June 2022 funded by MANAGE, Hyderabad.
7.	P. Roopa Sowjanya, Shilpa Parashuram, Vipul Sangnure, NV Singh, Ajinkya Madave and RA Marathe. 2022, Genetic mapping of genes associated with horticultural traits in pomegranate (Punica granatum L.) germplasm, In Proc: 7th International Conference On Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development, Old Goa.
8.	Pinky Raigond, N.V Singh, ShilpaParashuram, RoopaSowjanya P., Dhinesh Babu, R. A Marathe, 2022, Physiological disorders of pomegranate and their management strategies, In Proc: National Symposium on "Novel Strategies in Plant Stress Diagnosis and Management" May 6-7, 2022.
9.	Namrata Ankush Giri*, Nilesh N. Gaikwad, Ashis Maity, Manjunatha N. and R.A.Marathe.2022. "Utilization of pomegranate by-product for oxidative and microbial stability of muffins". In "International conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022)" 22-24 August, 2022 at UAS, Bangalore.
10.	Namrata Ankush Giri*, Nilesh N. Gaikwad, Prasad Gaikwad and R. A. Marathe. 2022. "Physico-Chemical Properties of Pomegranate Peel Powder and Its Utilization as Natural Preservative in Muffins". In "7th International Conference on Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022)" 29-31 October, 2022 at Don Bosco College of Agriculture, Old Goa.
11.	Shilpa Parashuram, Roopa Sowjanya P and RA Marathe. 2022. DUS Characterization and Protection of Farmer Variety in Pomegranate. In: Workshop programme on "Awareness for Protection of Farmer's Rights in Farm Innovations, Breeding and Protection of Varieties", organized by ICAR-NRCP, Solapur on June 03, 2022. pp. 20-29.
12.	Shilpa Parashuram, 2022. 'Important Commercial Varieties of Pomegranate. In: One-day "Awareness cum Training Program on Pomegranate cultivation" to SC farmers from Kalburgi, Karnataka on 19.9.2022 organized by ICAR-NRCP, Solapur.
13.	Maity, A., Marathe, R.A., and Babu K.D. 2022. Conjunctive use of microbial and seaweed extract-based bio-stimulants improved soil fertility, fruit yield, quality and net returns in pomegranate (Punica granatum L.)" In abstract of International conference on 'Advances in Agriculture and Food System towards Sustainable Development Goals' held on 22-24th August, 2022 at University of Agricultural Sciences, Bangalore, pp. 292
14.	Maity, A., Marathe, R.A., and Babu, K.D. 2022. Bio-integration of Rock Materials can Revamp Rhizospheric Activity and Supplement P and K Requirement of Pomegranate Tree (Punica granatum L.). In Souvenir cum Abstract of National Seminar on "Managing soils in a changing climate" held on March, 24-26, 2022 organized by Indian Society of Soil Survey & Land Use Planning (ISSLUP), Nagpur, pp. 195.
15.	Mallikarjun, M. H., Shilpa, P., Rahul Damale, Singh, N.V., Somnath, S. P., Marathe, R. A. 2022. A Sub-Plan Approach for Tribal Development at Gadchiroli. National Conference On Tribal Horticulture (Hybrid mode) 17th & 18th October, 2022. Souvenir Cum Abstract Book. Page No. 35.
16.	Nilesh N. Gaikwad, Namrata Ankush Giri, Swati K. Suryavanshi and R.A.Marathe 2022. "Osmotic assisted tray drying of pomegranate arils. In "International conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022)" 22-24 August, 2022 at UAS, Bangalore.

S.No.	POSTERS
1.	Shilpa, P., Singh, N. V., Raigond, P., Roopa Sowjanya, P., Awachare, C., Babu, K. D., Girme, A. R. and Marathe, R. A. 2022. Genetic variability, heritability and correlations for fruit cracking in pomegranate. In: 1st National conference on Plant Genetic Resources Management (NCPGRM 2022) organized by Indian Society of Plant Genetic Resources, New Delhi during 22-24 November 2022.pp. 97.
2.	Dr. K. Dhinesh Babu, N.V. Singh, R Chandra, A Maity, J Sharma, VT Jadhav, RK Pal, RA Marathe, Shilpa P, N Gaikwad, P.G. Patil, R Damale, SH Jalikop, BNS Murthy, PS Kumar and PL Saroj 2022. ICAR-NRC on Pomegranate, Solapur have been conferred Best Poster Paper Award for the research paper entitled .Solapur Lal : A bio-fortified, HYV of pomegranate for nutrition & livelihood. Fruits and Vegetables for Health and Nutrition.
3.	Mallikarjun, M. H., Marathe, R. A., Manjunatha, N., Somnath, S. P., 2022. Shot Hole Borer: An Emerging Pest of Pomegranate Its Diagnosis and Management. 4th International Conference on "Global Efforts on Agriculture, Forestry, Environment and Food Security (Theme: Climate Change and Its Impact) (GAFEF-2022)" held from August September 17-19, 2022 Souvenir book Gafef Vol-2, Page no. 519. ISBN: 978-93-5659-453-1.
4.	Shilpa P., Roopa Sowjanya, P., Babu, K.D., Singh, N.V., Gaikwad, N.N., Sharma, J., Mallikarjun, M.H., Patil, P.G., Chandra, R. and Marathe, R.A. 2022. DUS Catalogue of pomegranate cultivars (Part I). Technical Bulletin No.NRCP/2022/2, ICAR-National Research Centre on Pomegranate, Solapur P. 55.

S.No.	PATENTS
1	Gaikwad Nilesh N. and Pal Ram Krishna 2022. "A Process of Extraction of Virgin Pomegranate Seed Oil with retention of bioactive compounds" Patent Filed Application No. 201611011366 E-2/528/2017/DEL.
2.	Ashis Maity, R.K.Pal, J.Sharma 2022. Bio-formulation for potassium fertilizer supplement in pomegranate and process of preparation thereof Patent No. 403302 Date of grant - August 10, 2022.
3.	Tanbir Ahmad, Nilesh N. Gaikwad and Yogesh Kumar. 2022. An innovative poultry processing table. CBR No. 9785 APP. No. 3172/DEL/2012.

S.No.	MANUAL / COMPENDIUM/ OTHERS/SCIENTIFIC/ TEACHING REVIEWS
1	Singh, N.V., Awachare, C., Salutgi, U., Salunkhe, O., Patil, P.G. and Marathe, R.A. 2022. Micro-propagation and bio-priming in pomegranate - imperative for quality planting material. Mod. Concep. Dev. Agrono. 11(1) DOI: 10.31031/MCDA.2022.11.000753. (mini review)
2	Shilpa, P., Roopa Sowjanya, P., Gaikwad, NN and Marathe RA. Compendium of lectures for Workshop Programme on "Awareness for Protection of Farmer's Right in Farm Innovations, Breeding and Protection of Varieties", June 03, 2022 at ICAR – NRCP, Solapur, MS, India.pp-39.
3.	Mallikarjun M. H., Manjunatha N., Somnath S. Pokhare and Venkatesh Rao B. 'E-Training manual on "Recent advanced Practices for Export Quality Pomegranate Production and value addition from June 6-10, 2022, at ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra, India. Technical E-Training Manual No. NRCP/2022-1. p 118.
4.	Mallikarjun M. H., 'E-Training manual on "Good Agriculture Practices for Quality Pomegranate Production and value addition from August 10-12, 2022" at ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra, India. Technical E-Training Manual No. NRCP/2022-1. Page 119.
5.	Jyotsana Sharma, Mallikarjun M. H., Parameshwar S. Shirgure, N.V. Singh, Ashish Maity, Somnath S. Pokhare, and Manjunatha, N. Course compendium of lectures for a training programme on Shot hole borer and disease management in a pomegranate" for the extension officers of state Department of Agriculture, Maharashtra from 05-07, 2022 at ICAR-National Research Center on Pomegranate, Solapur, Maharashtra, India. Technical training manual No. NRCP/2022-23/1. Page 105.

S.No.	TECHNICAL BULLETIN
1.	Shilpa P., Roopa Sowjanya, P., Babu, K. D., Singh N.V., Gaikwad, N. N., Sharma, J., Mallikarjun M. H., Patil, P. G., Chandra, R. and Marathe R. A. 2022. DUS catalogue of pomegranate cultivars (Part-I). Technical Bulletin No. NRCP/2022/2, ICAR-National Research Centre on Pomegranate, Solapur, p.55.
2.	Patil, P.G., Singh, N.V., Roopa Sowjanya, P., Shilpa, P., Babu, K.D. and Marathe, R.A. 2022. Genomics enabled Pomegranate Improvement, Technical Bulletin No. NRCP/2021/1 ICAR-National Research Centre on Pomegranate, Solapur p. 26.
3.	Singh, N.V., Shilpa, P., Roopa Sowjanya, P., Sharma, J., Mallikarjun, M.H., Maity, A., Gaikwad, N.N., Babu, K.D., Pokhare, S., Manjunatha, N. and Marathe, R.A. 2022. Promotion of ICAR-NRCP technologies under SCSP programme. Technical Bulletin No. NRCP/2022/1, ICAR-National Research Centre on Pomegranate, Solapur, p. 36.
FOLDERS	
4.	Raigond, P., Singh, N.V., Shilpa, P., Awachare, C., Roopa Sowjanya, P., Marathe, R.A. 2022. Physiological disorders in pomegranate & their management. ICAR-National Research Centre on Pomegranate, Solapur 4p.
5.	पिंकी रायगोंड, नृपेन्द्र वी. सिंह, शिल्पा परशुराम, चंद्रकांत अवचारे, रुपा सौजन्या, राजीव अ. मराठे, 2022. अनार में अजैविक विकार व प्रबंधन. भ. कृ. अनु. प - राष्ट्रीय अनार अनुसन्धान केंद्र, सोलापूर, महाराष्ट्र, 4प.
6.	Shilpa, P., Awachare, C., Roopa Sowjanya, P., Patil, P.G., Singh, N.V., Manjunatha, N., Pokhare, S., Giri, N., Damale, R., Gaikwad, N.N., Mallikarjun, M.H., Maity, A., Babu, K.D., Shirgure, P.S., Raigond, P., Sharma, J., Marathe, R.A. 2022. Proceedings of the international webinar jointly organized by SARP, ICAR-NRCP and ICAR-CIAH, released on 20/05/2022, 8p.
7.	Shilpa Parashuram, Chandrakant Awachare, Roopa Sowjanya P., P.G. Patil, N.V. Singh, Manjunatha N., Somnath Pokhare, Namrata Giri, Rahul Damale, N.N. Gaikwad, Mallikarjun M.H., Ashis Maity, K.D. Babu, P.S. Shirgure, Pinky Ralgond, Jyotsana Sharma, R.A. Marathe, 2022, Proceedings of the International webinar, 25-27 Aug, 2021, SARP, ICAR-NRCP, Solapur.
8.	Pokhare, S. S., Sharma, J., Manjunatha, N., and Marathe. R. A. 2022. Nematode management in Pomegranate. ICAR-NRCP/EXTN/2022/2
9.	डॉ. सोमनाथ पोखरे, डॉ. ज्योत्स्ना शर्मा, डॉ. मंजूनाथा एन., आणि डॉ. राजीव मराठे (२०२२). डाळिंबातील सूत्रकृमींचे एकात्मिक व्यवस्थापन. विस्तार पत्रिका क्र. २०२२/२.
10.	Sharma, J., Manjunatha, N., Pokhare, S. S. and Marathe. R. A. 2022. Stem Solarization to Control Bacterial Blight Disease (Eco-friendly, Economical and Effective Technology) Extension Bulletin No.4/NRCP/2022 ICAR - National Research Centre on Pomegranate, Solapur, (MS), India, 12 p.
11.	Mallikarjun M. H., Manjunatha N., Jyotsana Sharma and Somnath S. P. and Marathe R.A. 2022. Current Status, Diagnosis and Management of Pomegranate Shot Hole Borer. 2022. Extension Bulletin/NRCP/2022/4. ICAR-National Research Centre on Pomegranate, Solapur, p.10.
12.	Mallikarjun H. Jyotsana Sharma Somnath S. Pokhare Manjunatha, N. Rajiv Marathe 2022. Pomegranate Shot hole borer Management. ICAR-NRCP/EXTN/2022/1. Published under CROPSAP.
13.	Mallikarjun H. Jyotsana Sharma Somnath S. Pokhare Manjunatha, N. Rajiv Marathe 2022. Dalimb pikaavaril khod keed (Bhungera vyavstapan. ICAR-NRCP/EXTN/2022/1. Published under CROPSAP.

S.No.	VIDEOS TELECAST (ETV programs for Farmers)
1.	Mallikarjun MH. 2022. Sequenced *Euwallacea fornicatus* isolate MH-SPR-001 cytochrome c oxidase subunit causing pomegranate wilting submitted to NCBI database on 24.06.2022 with accession numbers (ON063908- ON063909).

S.No.	VIDEOS TELECAST (ETV programs for Farmers)
2.	Mallikarjun MH. 2022. Sequenced Uncultured Fusarium isolate E-8 2B-1 ITS Sequence subunit symbiotic fungi associated pomegranate shot hole borer submitted to NCBI database on 24.06.2022 with accession numbers (MG462858.1).
3.	Mallikarjun MH. 2022. Sequenced Colletotrichum Gloeosporioides isolate E-9 1D ITS Sequence of symbiotic fungi associated pomegranate shot hole borer submitted to NCBI database on 24.06.2022 with accession numbers (OM913143.1).

S.No.	NCBI data base
1.	Mallikarjun MH. 2022. Sequenced *Euwallacea fornicatus* isolate MH-SPR-001 cytochrome c oxidase subunit causing pomegranate wilting submitted to NCBI database on 24.06.2022 with accession numbers (ON063908- ON063909).
2.	Mallikarjun MH. 2022. Sequenced Uncultured Fusarium isolate E-8 2B-1 ITS Sequence subunit symbiotic fungi associated pomegranate shot hole borer submitted to NCBI database on 24.06.2022 with accession numbers (MG462858.1).
3.	Mallikarjun MH. 2022. Sequenced Colletotrichum Gloeosporioides isolate E-9 1D ITS Sequence of symbiotic fungi associated pomegranate shot hole borer submitted to NCBI database on 24.06.2022 with accession numbers (OM913143.1).

S.No.	E-NEWSLETTER / E-PUBLICATIONS/ CROP ADVISORY
1.	Namrata Giri. 2022. Nutritional importance and health benefits of pomegranate in functional foods. In E-book on "High-tech Pomegranate Production Practices for Export Quality Pomegranate Production and value addition". (Ed. Marathe R.A. et al.). Hyderabad: National Institute of Agricultural Extension Management (MANAGE) & ICAR- National Research Centre for Grapes. ISBN: 978-93-91668-12-9. 99-104.
2.	Mallikarjun M. H., Manjunatha N., Jyotsana Sharma., Somnath S. P. and Marathe R.A. (October-2022) Advisory on Current Status, Diagnosis and Management of Pomegranate Shot Hole Borer.1-7pp.
3.	Jyotsana Sharma, Mallikarjun, KD Babu, Somnath S. Pokhare, Manjunatha N. and Debi Sharma. ADHOC list of agrochemicals with EU MRL and PHI for pomegranate production (https://nrcpomegranate.icar.gov.in/files/Advisory/91.pdf).
4.	Mallikarjun, H., Somnath S. Pokhare, Manjunatha N. and Jyotsana Sharma. Trade/ Brand/ Commercial names of agro-chemicals. (https://nrcpomegranate.icar.gov.in/files/Advisory/90.pdf).
5.	Wilt management in Pomegranate, Six step management strategy for bacterial blight management in pomegranate.
6.	Advisory for the management of pomegranate diseases (bi monthly) in Marathi and English.
7.	Jyotsana Sharma, Somnath S. Pokhare, Manjunatha, N. and Mallikarun, H. Pomegranate wilt: Identification and management.
8.	डॉ. सोमनाथ पोखरे, डॉ. मंजूंनाथा एन., डॉ. ज्योत्स्ना शर्मा व श्री. विजय लोखंडे. डाळिंबातील मर रोग: ओळख आणि व्यवस्थापन.
9.	Mallikarjun, Rajiv Marathe and Dinkar Chaudhari 2022. Advisory for the Management of fruit piercing moths-2022.p 1-2.
10.	Jyotsana sharma, Ashis Maity, N V Singh, Mallikarjun, Manjunatha N. and Somnath Pokhare, Bimonthly Pomegranate Advisory for Bearing Orchards - English (Feb - Mar 2022) (https://nrcpomegranate.icar.gov.in/files/Advisory/114.pdf).

S.No.	E-NEWSLETTER / E-PUBLICATIONS/ CROP ADVISORY
11.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - English (April- May 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/115.pdf).
12.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - Marathi (April- May 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/116.pdf).
13.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - English (June- July 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/117.pdf).
14.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - Marathi (June- July 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/118.pdf).
15.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - English (August-September 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/119.pdf).
16.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - Marathi (August-September 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/120.pdf).
17.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - English (October-November 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/123.pdf).
18.	Jyotsana sharma, Ashis Maity, N V Singh, Somnath Pokhare, Mallikarjun and Shri. Dinkar Chaudhari. Bimonthly Pomegranate Advisory for Bearing Orchards - Marathi (October-November 2022). (https://nrcpomegranate.icar.gov.in/files/Advisory/124.pdf).

Awards and Recognition

AWARDS

S.No.	Name of Scientist	Name of award	Year of award	Awarding organization
Fellowship/ Associateship/Young Scientist/ other awards				
1.	Dr. R.A Marathe (Team Leader), Dr. Jyotsana Sharma, Dr. N.V. Singh, Dr. K.D. Babu, Dr. Ashis Maity, Dr. N.N. Gaikwad	Vasant Rao Naik Award for Outstanding Research and Application in Dryland Farming Systems-2021 (ICAR-National Award for Excellence in Agricultural Research)	2022	ICAR, New Delhi
2.	Dr. N.V. Singh	Fellowship of the Indian Academy of Horticultural Sciences	2022	Indian Academy of Horticultural Sciences, New Delhi
3.	Dr. P. Roopa Sowjanya	Best Research Paper Award	2022	ICAR –NRCP, Solapur
4.	Dr. P. Roopa Sowjanya	Young Scientist Research Award	2022	DAE-BRNS, BARC, GOI, India
5.	Dr. P. Roopa Sowjanya	Vadh Vivadh (Debate) - Second Place	2022	ICAR–NRCP, Solapur
6.	Dr. Ashis Maity	NESA Young Scientist Award-2022	2022	National Environmental Science Academy, New Delhi
7.	Mr. Rahul Devidas Damale	Young scientist award	2022	Society for Scientific Development in Agriculture & Technology (SSDAT), Meerut, India (National Conference).
8.	Mallikarjun M.H	Young Entomologist Award-2022	2022	Agricultural and Environmental Technology Development Society (AETDS) U.S. Nagar Uttarakhand, India
Best oral presentation awards				
1.	Dr. P. Roopa Sowjanya	Best Oral P resentation	2022	Agro Environmental Development Society (AEDS) Majhra Ghat, Rampur, U.P, India
2.	Namrata Ankush Giri*, Nilesh N. Gaikwad, Ashis Maity, Manjunatha N. and R.A.Marathe	1st position in Best oral presentation award for presentation on "Utilization of pomegranate by-product for oxidative and microbial stability of muffins".	2022	University of Agricultural Sciences, Bangalore in "International conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022)" at UAS, Bangalore.

S.No.	Name of Scientist	Name of award	Year of award	Awarding organization
3.	Namrata Ankush Giri*, Nilesh N. Gaikwad, Prasad Gaikwad and R. A. Marathe	1st position in Best oral presentation award for presentation on "Physico-Chemical Properties of Pomegranate Peel Powder and Its Utilization as Natural Preservative in Muffins"	2022	Agro Environment Development Society, New Delhi in "7th International Conference On Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022)" at Don Bosco College of Agriculture, Goa.

Budget Estimate

Financial outlay in 2022-23

Head of account	Rupees (in lakhs)	
	2022-23	
	Govt. Grant	
	RE	**Expenditure**
(A) Recurring		
Establishment charge	532.52	532.52
T.A.	13.05	13.05
Other charges	248.95	248.20
Total A	794.52	793.77
(B) Non-recurring		
Equipment	71.15	71.01
Minor works	1.30	1.30
Library	0.00	0.00
Furniture	7.26	7.26
Information technology	11.79	11.79
Total B	91.50	91.36
(C) Loan & advances	116.00	90.47
(D) Pension	0.00	0.00
(E) Vehicles & vessels	11.50	11.50
Grand total (A+B+C+D)	**1013.52**	**987.10**

Revenue receipt in 2022-23

S. No.	Items	Amount (Rs.)
1.	Income from farm produce	1408559.00
2.	Income from royalty and publications	32691.00
3.	Income from other sources	68603.00
4.	Interest on loans and advances	36988.00
5.	Interest earned on short term deposits	255328.00
6.	Recovery of loans and advances	412381.00
7.	Training programs	261000.00
8.	Analytical testing fee	34958.00
9.	License fee/ Guest house	75862.00
	Total revenue receipt	**2586370.00**

Staff position & Personnel Joining/ Promotion/ Relieving

STAFF POSITION

Category	Sanctioned during XIIIth Plan	Staff position	Vacant
RMP	1	1	0
Scientific	22	16	6
Technical	6	6	0
Administrative	11	5	6
Supporting	2	2	0
Total	42	30	12

PERSONNEL

RMP		
Dr. R.A. Marathe Director		
Scientific staff	**Technical staff**	**Administrative staff**
Dr. Jyotsana Sharma, Principal Scientist (Plant Pathology)	**Sh. D.T. Chaudhari** Technical Officer	**Sh. R.B. Rai** AO
Dr. P.S. Shirgure Principal Scientist (Land and Water Management Engg.)	**Sh. Yuvaraj Shinde** Technical Officer	**Sh. V.A. Shinde** Finance & Account Officer (FAO)
Dr. K. Dhinesh Babu Principal Scientist (Hort.-Fruit Science)	**Sh. Bhausaheb Naikwadi** Sr. Technical Assistant	**Sh. Kiran Khatmode** UDC
Dr. Ashis Maity Senior Scientist (Soil Science-Pedology)	**Sh. Mahadev Gogaon** Senior Technician	**Sh. A.S. Babar** LDC
Dr. Prakash G. Patil Senior Scientist (Plant Biotechnology)	**Sh. Govind Salunke** Senior Technician	**Sh. Vipin Dagar** LDC
Dr. N.V. Singh Senior Scientist (Fruit Science)	**Sh. Vijay Lokhande** Technical Assistant	**Supporting staff**
Dr. N.N. Gaikwad Senior Scientist (Agrl. Structures and Process Engg.)		**Sh. Shailesh Bayas** SSS
Dr. Pinky Raigond, Senior Scientist (Plant Physiology)		**Sh. Vishal Gangane** SSS
Dr. Manjunatha, Scientist (Plant Pathology)		
Dr. Somnath Pokhare, Scientist (Nematology)		
Dr. Mallikarjun Scientist (Agrl. Entomology)		
Dr. Shilpa P. Scientist (Genetics & Plant Breeding)		

Mr. Chandrakant Awachare, Scientist, (Fruit Science)		
Dr. Namrata Ankhush Giri, Scientist (Food Technology)		
Dr. Roopa Sowajanya P. Scientist (Genetics & Plant Breeding)		
Mr. Rahul Damale, Scientist (Biochemistry)		

JOINING:

PROMOTION:

RELIEVING:

- Dr. Ashish Maity, Sr. Scientist, Soil Science, relieved on 20th August, 2022 after transfer from ICAR-NRCP, Solapur to IIWM, Bhuveneshawar, Odisha.

APPENDIX I

QUINQUENNEAL REVIEW TEAM (QRT-III)

1.	Dr. K.P. Vishwanatha, Former Vice-Chancellor, MPKV, Rahuri, Maharashtra	Chairman
2.	Dr. D.P. Waskar, Director of Research, VNMKV, Parbhani, Maharashtra	Member
3.	Dr. S.D. Gorantiwar, Professor & Head, Department of Agril. Engg. MPKV, Rahuri	Member
4.	Dr. (Mrs.) Indu S. Sawant, Ex. Director (Acting) ICAR – NRCG, Pune	Member
5.	Dr. Rajesh Parbhatrao Kadam, Prof. & Head, Dept. of Extension Education VNMKV, Parbhani-431402, Maharashtra	Member
6.	Dr. C. K. Narayana, Principal Scientist, Division of PHT, ICAR – IIHR, Bengaluru-560089, Karnataka	Member
7.	Dr. Ashis Maity, Sr. Scientist, ICAR-NRCP, Solapur-413255 Maharashtra	Member Secretary

APPENDIX II

INSTITUTE MANAGEMENT COMMITTEE (IMC)

Sl. No	Name	IMC Member	
1.	Dr. R A Marathe	Director, ICAR-NRCP, Solapur	Chairman
2.	Dr. PG Patil	Vice-Chancellor MPKV, Rahuri	Member
3.	Dr. KP Mote	Director, Horticulture, Maharashtra	Member
4.	Dr. Rohita Lenka	Director, Horticulture, Odisha	Member
5.	Dr. VK Pandey	ADG (I/c), (Horticulture-I), ICAR, New Delhi	Member
6.	Dr. Ashutosh Murkute	Principal Scientist, ICAR-CCRI, Nagpur	Member
7.	Dr. Anuradha Upadhyay	Principal Scientist, ICAR-NRCG, Pune	Member
8.	Dr. DV Sudhakar Rao	Principal Scientist, ICAR-IIHR, Bengaluru	Member
9.	Dr. Jyotsana Sharma	Principal Scientist, ICAR-NRCP, Solapur	Member
10.	Sh. Shrinavas Rao	Finance & Account Officer, ICAR-IIRR, Hyderabad	Member
11.	Sh. RB Rai	Administration Officer	Member Secretary

APPENDIX III

RESEARCH ADVISORY COMMITTEE (RAC)

1.	Dr. C.D. Mayee, (Former Chairman, ASRB), Nagpur	Chairman
2.	Dr. Sunil Pareek, Head, NIFTEM, Sonipat	Member
3.	Dr. Ganeshmurthy, Ex-Head, Soil Sc., IIHR	Member
4.	Dr. S.H. Jalikop, Ex-PS, IIHR, Bengaluru	Member
5.	Dr. B.P. Singh, Ex-PS, CISH, Lucknow	Member
6.	Dr. K.K. Pandey, PS, IIVR, Varanasi	Member
7.	Director, ICAR-NRCP	Member
8.	ADG (HS-II), ICAR, New Delhi	Member

9.	Shri. Rambhau Jaybhau Patil, Satana, Nashik	Member
10.	Shri. Shankar Vasant Waghmare, Mohol, Solapur	Member
11.	Dr. K.Dhinesh Babu, MS, ICAR-NRCP	Member Secretary

APPENDIX IV

INSTITUTE RESEARCH COUNCIL (IRC)

	Chairman IRC	**9**	Dr. Somnath Pokhare, Scientist (Nematology), ICAR-NRCP
1	Dr. R. A. Marathe, Director, ICAR-NRCP, Solapur (MS)	**10.**	Dr. Shilpa Parashuram, Scientist (Plant Breeding), ICAR-NRCP
	Members	**11.**	Dr. Namrata Giri, Scientist (Food Technology), ICAR-NRCP
2	Dr. Jyotsana Sharma, Pr. Scientist (Plant Pathology), ICAR-NRCP	**12.**	Dr. Chandrakant Awachare, Scientist (Hort.-Fruit Sc.,), ICAR-NRCP
3	Dr. P. S. Shirgure, Pr. Scientist (L&W Mg.Engg), ICAR-NRCP	**13.**	Dr. Mallikarjun Harsur, Scientist (Entomology), ICAR-NRCP
4	Dr. N.V. Singh, Sr. Scientist (Hort.-Fruit Sc.), ICAR-NRCP	**14.**	Dr. Roopa Sowjanya P, Scientist (Plant Breeding), ICAR-NRCP
5	Dr. Prakash G. Patil, Sr. Scientist (Plant Biotech.), ICAR-NRCP	**15.**	Mr. Rahul Damale, Scientist (Plant Biochemistry), ICAR-NRCP
6	Dr. Nilesh N. Gaikwad, Sr. Scientist (AS & PE), ICAR-NRCP		**I/c Member Secretary**
7	Dr. Pinky Raigond, Sr. Scientist (Plant Physiology), ICAR-NRCP	**16.**	Dr. K.Dhinesh Babu, Pr. Scientist (Hort.-Fruit Sc.), ICAR-NRCP
8	Dr. Manjunatha N, Scientist (Plant Pathology), ICAR-NRCP		

APPENDIX V

Institute Joint Staff Council of ICAR-NRCP

	Chairperson		
1.	Dr. R.A. Marathe, Director		
2.	**Member (Official side)**		**Member (Staff side)**
3.	Dr. K. D. Babu	8.	Sh. B.V.Naikwadi, Member (CJSC) Senior Tech. Asst.,
4.	Dr. P. G. Patil	9.	Sh. D.T. Chaudhari, Secretary (IJSC) Tech. Officer.,
5.	Dr. Roopa Sowjanya	10.	Sh. A.S.Babar, LDC,
6.	Officer I/c Accounts, NRCP	11.	Sh. V.S. Gangane, SSS,
7.	Officer I/c Administration, NRCP		

APPENDIX VI

Scientific staff	Technical staff	Administrative staff
Dr. Jyotsana Sharma, Principal Scientist (Plant Pathology)	Sh. D.T. Chaudhari Technical Officer	Sh. V.A. Shinde Finance & Account Officer (FAO)
Dr. P.S. Shirgure Principal Scientist (Land and Water Management Engg.)	Sh. Yuvaraj Shinde Technical Officer	Sh. R.B. Rai AO
Dr. K. Dhinesh Babu Principal Scientist (Hort.-Fruit Science)	Sh. Bhausaheb Naikwadi Sr.Technical Assistant	Sh. Kiran Khatmode UDC
Dr. Ashis Maity Senior Scientist (Soil Science-Pedology)	Sh. Vijay Lokhande Technical Assistant	Sh. A.S. Babar LDC
Dr. Prakash G. Patil Senior Scientist (Plant Biotechnology)	Sh. Mahadev Gogaon Senior Technician	Sh. Vipin Dagar LDC
Dr. N.V. Singh Senior Scientist (Fruit Science)	Sh. Govind Salunke Senior Technician	**Supporting staff**
Dr. N.N. Gaikwad Senior Scientist (Agrl. Structures and Process Engg.)		Sh. Shailesh Bayas SSS
Dr. Pinky Raigond, Senior Scientist (Plant Physiology)		Sh. Vishal Gangane SSS
Dr. Manjunatha, Scientist (Plant Pathology)		
Dr. Somnath Pokhare, Scientist (Nematology)		
Dr. Namrata Ankhush Giri, Scientist (Food Technology)		
Mr. Chandrakant Awachare, Scientist, (Fruit Science)		
Dr. Shilpa P. Scientist (Genetics & Plant Breeding)		
Dr. Mallikarjun Scientist (Agrl. Entomology)		
Dr. Roopa Sowajanya P. Scientist (Genetics & Plant Breeding)		
Mr. Rahul Damale, Scientist (Biochemistry)		

Monthly weather data at NRCP Meteorological Observatory (January to December 2022)

Month	T (max) ^{0}C	T (min) ^{0}C	Rh (max) %	Rh (min) %	WS kmph	SS hrs	Eva mm	Rainfall mm	Soil temp.-5 ^{0}C		Soil temp.-10 ^{0}C		Soil temp.-20 ^{0}C	
									min	max	min	max	min	max
January	30.07	13.88	79.03	36.19	3.73	7.92	4.26	0.00	20.69	38.87	23.12	29.90	27.03	27.94
February	33.58	15.98	60.07	28.75	4.27	8.95	6.25	0.00	22.79	44.52	25.39	34.55	29.38	30.00
March	37.75	20.34	47.65	19.94	4.66	6.94	8.75	0.00	27.15	45.28	29.70	38.22	33.27	33.76
April	40.81	22.87	60.26	21.65	5.68	6.68	9.45	4.60	30.74	48.29	33.66	41.65	36.64	37.27
May	39.22	22.79	67.32	31.48	7.55	6.19	8.25	45.20	30.05	43.05	32.81	38.84	35.45	36.77
June	35.26	21.36	76.57	43.80	7.01	6.76	6.55	34.20	28.57	40.78	30.80	37.90	34.52	35.74
July	30.76	20.39	87.73	63.59	5.70	3.34	3.60	214.20	24.77	31.18	26.11	30.79	29.29	29.95
August	30.46	20.05	89.77	66.39	4.89	4.25	2.90	189.40	25.04	31.07	26.06	30.32	28.69	29.08
September	30.77	19.63	91.30	64.27	4.32	4.63	3.04	105.70	25.40	32.77	26.56	31.25	29.23	29.95
October	30.71	18.36	86.42	53.77	4.06	6.92	3.66	177.20	23.90	33.15	25.30	30.71	28.49	29.03
November	31.35	14.95	67.67	34.90	3.84	8.08	4.01	0.00	22.50	37.58	25.15	31.55	28.92	29.22
December	31.60	14.82	76.26	38.87	3.76	7.92	3.59	7.10	22.15	37.90	25.10	31.91	29.01	29.13
AVG	33.53	18.78	74.17	41.97	4.95	6.55	5.36	777.60	25.31	38.70	27.48	33.97	30.83	31.49
Max	40.81	22.87	91.30	66.39	7.55	8.95	9.45		30.74	48.29	33.66	41.65	36.64	37.27
Min	30.07	13.88	47.65	19.94	3.73	3.34	2.90		20.69	31.07	23.12	29.90	27.03	27.94

T (max) –Maximum temperature, T (min) –Minimum temperature, Rh – Relative Humidity, WS- Wind Speed, SS-Sunshine, Eva-Evaporation

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

भा.कृ.अनु.प. – राष्ट्रीय अनार अनुसंधान केंद्र

ICAR – National Research Centre on Pomegranate

एनएच-65, सोलापुर-पुणे राजमार्ग, केगांव, सोलापुर-413255, महाराष्ट्र
NH-65, Solapur-Pune Highway, Kegaon, Solapur-413255, Maharashtra
T-(0217) 2354330, 2350074; Fax (0217) 2353533
Email- nrcpomegranate@gmail.com, nrcpomegranate.icar.gov.in