वार्षिक प्रतिवेदन

ANNUAL REPORT

2012-13

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ICAR

केन्द्रीय शीतोष्ण बागवानी संस्थान

श्रीनगर, जम्मू एवं कश्मीर

Central Institute of Temperate Horticulture

Srinagar, Jammu and Kashmir

वार्षिक प्रतिवेदन
Annual Report

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(भारतीय कृषि अनुसंधान परिषद)
ओल्ड एयर फील्ड, पो.–रंगरेट, श्रीनगर 190 007
जम्मू एवं कश्मीर, भारत

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Correct Citation:
CITH - Annual Report 2012-13
Central Institute of Temperate Horticulture
Old Air Field, P.O.-Rangreth-190007, Srinagar (J&K)
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Word Processing:
Syed Mubeena
S.A.Haji

Cover Page:
Promising genotypes of Apricot, Saffron, Apple, Walnut and Cherry

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Printed by:
M/s Royal Offset Printers,
A-89/1, Naraina Industrial Area, Phase-I, New Delhi-110028

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कार्यकारी सारांश

शीतोष्ण बागवानी फसलें, जम्मू एवं काश्मीर, हिमाचल प्रदेश, उत्तराखण्ड व उत्तर–पूर्वी राज्यों के कुछ भागों में जीविका का प्रमुख स्त्रोत हैं। परन्तु इन फसलों की उत्पादकता अन्य विकसीत देशों की तुलना में बहुत कम हैं। इस समस्या के समाधान के लिये, के.शी.बा.सं. के मुख्य परिसर व क्षेत्रीय अनुसंधान केन्द्र, मुक्तेश्वर में उत्पादन व उत्पादकता बढ़ाने के लिये विभिन्न शोध किये गये जिनका सारांश इस प्रकार है।

फसल सुधार एवं जैव प्रौद्योगिकी

केन्द्रीय शीतोष्ण बागवानी संस्थान कई वर्षों के प्रयास से महत्वपूर्ण शीतोष्ण बागवानी फसलों के जन्द्रव्यों (2226) का एक प्रमुख संग्रहालय बन गया है और यह कार्य राष्ट्रीय जन्द्रव्य सम्पदा को बढ़ाने व संरक्षित करने के लिये अनवरत चालू है जो कि भविष्य के पादप प्रजनन सम्बन्धित अनुसंधानों के लिये मुख्य आधार है। सेब के जनद्रव्यों को बढ़ाने के लिये, दो नये प्रारूप सी आई टी एच सेब 29 व 30 का चयन स्थानीय अम्वरी किस्म से किया गया है एवं इनके मूल्यांकन के लिए सी आई टी एच में इनका प्रवर्धन किया गया। अन्य सेब की किस्मों के मूल्यांकन में मौलीश डीलिसीयस, वीस्ता बेला, वांश डीलिसीयस प्राइमा, स्टारकिंग डिलिसीयस, वरमौंड स्पर, कूपर 4, स्काइलाइन सूपरीम और रैडस्पर आशाजनक पाई गई। चैरी में उत्पादन की दृष्टि से स्टैला (11.30 कि.ग्रा./पेड़), सी आई टी एच चैरी 6 (13. 68 कि.ग्रा./पेड़), सी आई टी एच चैरी 5 (11.23 कि.ग्रा./ पेड़) और सी आई टी एच चैरी 9 (10.01 कि.ग्रा./पेड़) किस्मे आशाजनक पाई गई। नाशपाती में काश्मीरी नाख से एक नया भिन्न प्रारूप सी आई टी एच पी 21 के रूप में किया गया। खुवानी में सी आई टी एच 1 किस्म में सबसे अधिक उत्पादकता (40.94 टन/हे.) व सी आई टी एच 15 में सबसे ज्यादा कुल घुलनशील पदार्थ (33.06^0 ब) पाई गयी। आलु बुखारा की किस्मों के मूल्यांकन में सबसे ज्यादा फलभार ग्रांड ड्यूक में व उत्पादकता ब्यूटी व सेन्टारोजा में दर्ज की गई। बादाम में 31 जनद्रव्यों के मूल्यांकन में सी आई टी एच बादाम 9 और 21, नट एवं गिरी के वांछित गुणों के आधार पर सबसे अच्छे पाये गये जबकी अखरोट में नट व गिरी के गुणों के आधार पर सी आई टी एच अखरोट 1 (27.98 ग्राम), सी आई टी एच अखरोट 10, (24.48 ग्राम), सी आई टी एच अखरोट 7 (24.72 ग्राम), सी आई टी एच अखरोट 6 (23.99 ग्राम) और सी आई टी एच अखरोट 8 (20.35 ग्राम) अन्य प्रारूपों की तुलना में अच्छे पाये गये। आड़ू में फैंटासिया, क्रेस्ट हेवन, रेट ग्लोब, ग्लो हैवन व निमला विभिन्न लक्षणों की दृष्टि से आशाजनक पाये गये। जैतून में मैसेनीस, कोराटिना, वीआनकोलीओ उत्पादन व कोराटीना एवं पैडोलिनो तेल प्रतिशतता की दृष्टि से अच्छी साबित हुई। शीतोष्ण फसलों में विविधिकरण हेतू फाइसेलिस की प्रजातियां फाइसेलिस इक्सोकारपा, फाइसेलिस प्रूनिओसा एवं फाइसेलिस पैरू वियाना उप्युक्त सिद्ध हुए।

सेब में संकरण द्वारा नई श्रेष्ठ किस्में विकसित करने हेतू 25 संकरण संयोजन किये गये जिनमें से कुछ संकरण ों जैसे कि रेडस्पर x प्राइमा और एम फ्लोरीबंडा x समर रेड में क्रमशः 60 और 56.66 प्रतिशत फल जमाव हुआ। इन सफल संकरो के बीजों को आगे अध्यन के लिए संकर ब्लॉक में बोया गया। जैतून में परागण व परागण संगतता के आधार पर विभिन्न किस्मों के लिये सबसे अच्छे परागकण दाता की पहचान की गई। सेब के सूक्ष्म प्रर्वधन में, 6 सप्ताह पुरानी, सूक्ष्म कलम कार्यकी की दृष्टि से अच्छी पाई गई जबकी एसकोर्बिक एसिड, हुमिक एसिड जड़ बनने व अन्य लक्षणों के सुधार में अच्छे पाये गये। अखरोट में 85, किस्मों के फूल अध्ययन में 18 प्रारूप प्रोटोगाइनस एवं 45 प्रारूपों में 7 से 17 दिनों का मिलाप समय एक जैसा पाया गया जो अच्छे परागण में सहायक सिद्ध हुए। केसर में 32 प्रविष्टियों का मूल्यांकन किया गया जिनमें 15 प्रविष्टियां बहुत अच्छी पायी गयी जिनकी उत्पादकता तीसरे वर्ष में 4.26 से 4.86 कि.ग्रा./हे. दर्ज की गई।

चैरी के मूलवृत के तीव्र प्रवर्धन में एम.एस.माध्यम + बी. ए.पी. 2 मिग्रा./लीटर + आई.बी.ए. 1 मिग्रा./लीटर की दर से युक्त प्रोटोकॉल में अधिक सफलता तथा हार्डनिंग माध्यम में ज्यादा उत्तरजीविता प्राप्त हुई। सेब के मूलवृन्त 106

के सुक्ष्म प्रवर्धन में एम.एस. माध्यम बी.ए. + काइनेटीन @ 0.5 मिग्रा./ली से युक्त माध्यम में तना प्रजनन देखा गया; जबकी सबसे अच्छी जड़े एम.एस. माध्यम + 2 मिग्रा./ली. आई.बी.ए. में प्राप्त हुई।

प्याज में वांछित लक्षणों के आधार पर 10 नये प्रारूपों का चयन किया गया। सबसे ज्यादा प्याज उत्पादकता (625. 89 एवं 623.86 क्वि./हे.) क्रमशः किस्म ए.ओ.ए.डी.आर.बी. 09–016 तथा एओएलडीआरबी 09–03 में अंकित की गई। इसी तरह लहसुन में 11 नये प्रारूप चुने गये। वांछित लक्षणों के आधार पर सी आई टी एच 4–12 में सबसे ज्यादा उत्पादकता (847.55 क्वि./हे.) एवं बल्ब भार (127.13 ग्राम) प्राप्त हुआ। एच्छिक लक्षणों के आधार पर मिर्च में 10 व शिमला मिर्च में 10 व बैंगन में 5 लाइन क्रमशः 270, 48 व 10 प्रारूपों के मूल्यांकन के बाद आशाजनक पाई गई।

पॉलीहाऊस में विभिन्न फूलों के मूल्यांकन में रोसीटा, टाईरा, प्लुटो, अलादीन व सीरीना एलस्ट्रोमेरीया में, ईस्कोलानो, केबडेजल, समुर, बेस्ट सेलर, प्रैटो व रोयाल ट्रीनीटी लीलीयम में और आर्मर्स्टडम, व्हाईट प्रोसपेरीटी, फेडीलियो मयूर, यूरोविजन, पीटर पीयरस किस्में ग्लेडीयोलस में आशाजनक पाई गई।

फसल उत्पादन व पादप प्रवन्धन

विभिन्न पेबन्द पद्धितियों में श्रीनगर व मुक्तेश्वर में अन्य पद्धितियों की तुलना में दोनो परिस्थितियों में स्टोन व पोम फलो में चीप पेबन्द बहुत अच्छी पायी गई जबकी अखरोट में वेज पेबन्द में जब 15–20 मि. मी. सायन का 25–30 मिमी. मूलवृंत पर रोपण किया गया तो मार्च महीने में पोलीहाऊस परिस्थिति में 93 प्रतिशत सफलता प्राप्त हुई। इसके आलावा अच्छे गुणों वाले उत्तम, विकसित किस्मों के पेबन्द, कलमी पौधों, मूल वृन्तो, कलीकायुक्त तनो व बीजो का बहुत अधिक मात्रा में उत्पादन कर किसानों व सरकारी विभागों में वितरित किया।

सेब

सेब की किस्मों के भिन्न–भिन्न पौध सधनता के मूल्यांकन में स्टार क्रिमसन किस्म में सबसे ज्यादा उत्पादकता (36.44 एवं 34.05 टन/हे.) 2 x 3 व 2.5 x 2.5 मी. दूरी पर पौधरोपण से क्रमशः एम–9 व एम–एम 106 मूल्वृन्तों पर प्राप्त हुई। मोलिस डिलिशियस किस्म में सर्वाधिक उत्पादकता (49.65 टन/हे.) 3 x 3 मी. दूरी के पौध रोपण से प्राप्त की गई। इसी तरह किस्म स्टार क्रिमसन ओर रेड स्पर में एम एम 106 मूलवृन्त पर क्रमशः 3.5 x 3.5 व 4 x 4 मी. दुरी पर पोधरोपण से सबसे ज्यादा उत्पादकता (28.32 व 52.05 टन/हे.) प्राप्त हुई। सेब के पादप वास्तुकला अभियात्रिकी में एम–9 मूलवृन्त पर रेड फ्यूजी किस्म में सबसे ज्यादा उत्पादकता (95.36 टन/हे. व 93.82 टन/हे.) क्रमशः इस्पेलियर व वर्टीकल एक्सीस प्राणालियों में प्राप्त हुई जबकि हेड व स्प्रेड, मोडीफाइड सेट्रल लीडर व स्पींडल बुश प्रणालियों में सबसे ज्यादा उत्पादकता मोलिश डिलिशियस किस्म में क्रमशः 126. 33, 108.33 व 92.00 टन/हे. प्राप्त हुई।

सेब में वर्षा जलसंचय पद्धितियों में सबसे ज्यादा उत्पादकता (18.29 टन/हे.) व मृदा आद्रता अवयव (15.10प्रतिशत) पूर्ण चाँद प्राणाली में प्राप्त हुआ। उत्तराखण्ड में एकीकृत पोषण प्रबन्धन के प्रयोग में एफवाईएम + केचुआ खाद + जैविक खाद + अकार्बनिक पदार्थों का प्रयोग बहुत अच्छा पाया गया। एक अन्य प्रयोग में, सेब में मेथी, प्याज, लेन्टील, लहसुन, धनीया, मटर, लहसुन रेड क्लोवर, स्वीस चार्ड तथा सरसो के साथ सघन खेती में सबसे ज्यादा लागतः लाभ अनुपात मेथी के बाद स्वीस चार्ड की सघन खेती में प्राप्त हुआ। सेब में मृदा के एकीकृत पोषण प्रबंधन में जैविक खाद व कार्बनिक खाद ने मृदा के गुणों में सुधार किया।

बादाम

विभिन्न पौधरोपण सघनताओ (2.5 x 2.5, 3 x 3, 3.5 x 3.5 मी) तथा विभिन्न किस्मों में सबसे ज्यादा उत्पादकता (3.11 टन/हे.) वारीस में 2.5 x 2.5 मी. दूरी पर पौधरोपण में पायी गई जबकि किस्म प्रानयाज (3.07 टन/हे.) 4 x 4 मी. दूरी पर पौधरोपण में अन्य आठ किस्मों कि अपेक्षा में सबसे अच्छी पाई गई। जल संचयन पद्धतियों में पूर्ण चाँद जल संचयन पद्धिति (3.47 टन/हे. व 15.25 प्रतिशत) तथा प्लास्टिक मल्च (2.80 टन /हे. व 15.11 प्रतिशत) क्रमशः उत्पादकता व आद्रता अवयव में आशाजनक पाई गई।

एकीकृत पोषण प्रबन्धन में सबसे ज्यादा नट उत्पादकता (3.85 टन /हे.) 4 टन एफवाईएम प्रति हेक्टेयर के साथ एन पी के अवयव क्रमशः 345.3, 9.8, 270.8 किग्रा./हे. में प्राप्त हुई जबकि फर्टीगेशन में सबसे जयादा नट उपज (4. 44 किग्रा./पेड़), 75 प्रतिशत आर डी एफ फर्टीगेशन (2/3 नत्रजन 1/3 के नट जमाव से नट विकास की अवस्था तथा 1/3 नत्रजन 2/3 के गिरी विकास से पकाव की अवस्था) के उपयोग से मिली। सबसे ज्यादा एन.पी. के

अवयव 100 प्रतिशत आरडीएफ के उपयोग से प्राप्त हुए। बादाम के पुराने व बूढ़े बगीचों को उत्पादन योग्य बनाने हेतू जीर्णोद्धार पद्धति का मानकीकरण किया गया तथा टापवर्किंग वारिस किस्म से की गयी तथा साथ में 50 किग्रा. एफवाईएम, नत्रजन 500 ग्रा. फॉस्फोरस 250 ग्रा. पोटाश 750 ग्राम प्रति पेड़ और पूर्ण मून जल संचय पद्धति व मध्यम से ज्यादा छटाई करने पर से 3.53 किग्रा./पेड़ उपज दर्ज की गई और इसके परिणाम काफी आशाजनक पाये गए।

अखरोट

अखरोट में विभिन्न सधाई प्रणालीयों में सबसे ज्यादा नट क्षमता नटभार एवं गिरी भार क्रमशः मल्टी लीडर, मोडीफाइड लीडर एवं ओपन सेन्टर में पाया गया। विभिन्न कटाई छंटाई स्तरों में 10 प्रतिशत छंटाई, 20 प्रतिशत हेडींग बेक तथा 20 प्रतिशत छंटाई + 20 प्रतिशत हेडींग बेक द्वारा नट क्षमता में वृद्धि पायी गई। भिन्न–भिन्न सधाई एवं कांट–छांट प्रणालीयों का नट व गिरी गुणों पर भी प्रभाव देखा गया।

आड़ू

अधिक सघनता व मध्यम सघनता में ग्लोहेवन व रेड ग्लोब सबसे अच्छी पायी गयी। किस्म ग्लोहेवन में सर्वाधिक उपज 25.05 व 22.85 टन/हे. क्रमशः 2.5 x 2.5 व 3 x 3 मी. पौध रोपण दूरी में प्राप्त हुई। विभिन्न सधाई प्रणालियों व पौध रोपण सघनता में टटुरा ट्रेलिस प्रणाली में उपज 23.6 से 34.78 टन प्रति हे. 2.5 x 2.5 मी. दूरी पर पौध रोपण से प्राप्त हुई जबकि 3 x 3 मी पौध रोपण सघनता में भिन्न सिध ाई प्रणालियों में विभिन्न किस्मों ने अलग–अलग प्रदर्शन किया। फेन्टेसिया नेकटरिन में फल रजटिंग को कम करने की दुष्टि से जिंक सल्फेट 200 पी पी म व जिबरेलिक अम्ल 50 पी पी एम व टटुरा ट्रैलिस प्रणाली उपज की दृष्टि से उत्तम पायी गयी।

स्ट्रॉबैरी

स्ट्रॉबैरी में विभिन्न उत्पादन अवस्थाओं में फल की उपलब्धता अवधि 38 दिनों तक बढ़ाई गयी व इन्ही अवस्थाओं के लिए ज्यादा पैदावार वाली किस्मों का चयन किया गया।

केसर

केसर में विभिन्न पौध सघनताओं, रोपण विधियों तथा सिंचाई पद्धतियों की तुलना में सबसे ज्यादा पैदावार 7.5 किग्रा./हे., 10 लाख कंद/हे. उभरी हुई क्यारियों में लगाने व बूंद–बूंद सिंचाई पद्धति में प्राप्त हुई। जैविक केसर उत्पादन में सबसे ज्यादा पैदावार 3.8 किग्रा./है 1/3 गोबर की खाद + 1/3 केचुआ खाद + 1/3 मुर्गी खाद से प्राप्त हुई।

सब्जियाँ

हरितगृह में ऊर्जा एवं जगह के दोहन की दृष्टि से टमाटर में सबसे ज्यादा पैदावार 934.23 क्विंटल/हे. सी आई टी एच टी एच 1 को 75 x 50 से. मी. की रोपण अन्तराल व दो तना सिधाई पद्धति से प्राप्त हुई जबकि शिमला मिर्च में सबसे ज्यादा उपज (1095.56 कि./हे.) एस एच–एस पी एच 2 में 20 x 50 से. मी. रोपण अन्तराल व दो तना सिधाई प्रक्रिया से प्राप्त हुई। इसी तरह खीरा में सबसे ज्यादा पैदावार (950.58 कि./हे.) एसएचसीएच 1 किस्म को 125 x 60 सेमी. पौध रोपण अन्तराल व दो तना सिधाई पद्धति से प्राप्त हुई।

प्याज के एकीकृत मापक में सबसे ज्यादा बल्व उपज (99.24 टन/हे.) स्थानीय सिफारिश के साथ जैविक खाद के प्रयोग से प्राप्त हुई। सबसे ज्यादा खरपतवार रोक क्षमता, पैंडामैथालीन का प्रयोग फसल लगाने से पहले व क्वीजालोफोप इथायल का प्रयोग फसल लगाने के तीस दिन बाद करने से प्राप्त हुई। विविधकरण व बेमौसमी खेती के लिये उच्च मूल्य सब्जियों की फसलों व इनकी किस्मों की पहचान की गई तथा इन्हें लोकप्रिय बनाने हेतू इनके प्रदर्शन लगाये गये।

पुष्प विज्ञान

हरित गृह में जरबेरा को उगाने के लिये, इसकी कृषि तकनीक मानकीकृत की गई तथा किस्में ड्यून, दाना एलन और फाइरेला में प्रति पौधा सबसे ज्यादा पुष्प प्राप्त हुए। हरित गृह व खुले क्षेत्र में सबसे ज्यादा फूल क्रमशः 53.82 व 43.26/प्रति पौधा किस्म ड्यून में आंके गये।

मृदा विज्ञान

सी आई टी एच के बगीचों में 64 स्थानों से मृदा नमूने इकट्ठे करके इनका विश्लेषण तथा तुलनामत्क मृदा गुणवत्ता सूचकांक का मूल्यांकन किया गया। चैरी व सेब की मृदा आर एस क्यू आई मान क्रमशः 90 और 86 के साथ सबसे उपयुक्त पाई गई जबकी अखरोट व बादाम में यह मान क्रमशः 77 और 76 पाया गया।

पादप स्वास्थ्य प्रवंधन

मिर्च के ग्लानि रोग के प्रवंधन में सबसे ज्यादा रोग शमन 65.9 प्रतिशत, टी वीरडी से वीज प्राइमिंग, कार्बेडिजिंम में

मूल डुबोकर तथा सफेद प्लास्टिक से मृदा सोलेराइजेशन में प्राप्त हुआ। केसर के घनकंद विगलन रोग की रोकथाम के लिये कार्बन्डाजिम (0.21 प्रतिशत) से अधिकतम पादप स्टेंड 80.83 प्रतिशत पाया गया। बादाम में सबसे ज्यादा गमोसिस रोग (8.49 प्रतिशत) 4–5 बूंदो तथा 31.42 प्रतिशत फलों में एक बूंद के साथ मरसीड किस्म में मापा गया जबकि सी आई टी एच बादाम–14 में सबसे कम गोंद स्राव पाया गया। विषाणु सर्वेक्षण के दौरान ए पी एम वी का संक्रमण पाँच सेब उगाने वाले क्षेत्रों में 2.08 से 16.20 प्रतिशत तथा ए सी एल एस वी का संक्रमण 2.83 से 19.64 प्रतिशत तक पाया गया।

कीट आबादी गतिकी में सबसे ज्यादा युरोपीयन रेड माइट का संक्रमण अमरीकन एपीरोग तथा सीरीन सेब में, जबकि बादाम में केलीफोर्निया पेपर सेल किस्म में पाया गया। एफिड का सबसे ज्यादा संक्रमण अकबर किस्म तथा सबसे कम फिरदोस किस्म में पाया गया। खुबानी, बादाम और सेब में फ्ली बीटल एक उभरता हुआ कीट पाया गया जिसकी पहचान अलटीका हीमेन्सीस के रूप में की गई। हेलीसीटीडी परिवार परागण कीट की दृष्टि से प्रभुत्व वाला परिवार पाया गया। इसके अलावा परभक्षी कोक्सीनेलीडस की 14 वर्गों की 17 प्रजातियों को भी दर्ज किया। हरित गृह वातावरण में टमाटर, खीरा व शिमला मिर्च में एकीकृत रोग व कीट प्रबन्धन मापांक को मानकीकृत किया गया। मधुमक्खीयों को वेस्प प्रजाति से बचाने के लिए अलग–अलग ट्रेप व खाद्य पदार्थों का परीक्षण किया गया तथा एक संशोधित बेट ट्रेप प्रभावशाली साबित हुआ।

उत्तराखण्ड में सेब में केंकर रोग (3.26–52.21 प्रतिशत), पर्णीया रोग (31.97–50.92 प्रतिशत), विषाणु रोग (1.92–3. 92) तथा फल रोग (2.35–39.95 प्रतिशत) का प्रकोप पाया गया। सफेद मूल सड़न रोग फाइटोफ्थोरा सड़न रोग की तुलना में पौधशाला व बगीचों में ज्यादा हानिकारक पाया गया। पौधशाला में मृदा जनित रोगों का संक्रमण अधिक पाया गया और एक स्थानीय मूलवृन्त ''पेरोन'' में इस बीमारी के लिए प्रतिरोधक क्षमता दिखाई।

पच्छ तुड़ाई प्रबन्धन

तुड़ाई उपरान्त नुकशान को कम करने के लिए मूल्यवर्धन एक महत्वपूर्ण घटक है। रोडोडेन्ड्रोन (15 प्रतिशत) + गलगल (5 प्रतिशत) + अदरक (5 प्रतिशत) तथा माल्टा (20 प्रतिशत) + अदरक (5 प्रतिशत) से बनाई गई स्केवश विभिन्न गुणों में अच्छी पायी गयी। सेब व आलु बुखारा में भंडारण समय बढ़ाने के लिए कैल्शियम (0.4 प्रतिशत) तथा नाशपाती के लिए सेलिसिलिक अम्ल 200 पी पी एम से अच्छे परिणाम मिले। स्ट्रॉबैरी में चीटोसीन (1.5 प्रतिशत) भंडारण समय 35–40 दिन तक बढ़ाने में उपयुक्त साबित हुआ।

सेब के निर्जलीकरण के लिए 2 मिमी. मोटाई के टुकड़े तथा सुखाने से पूर्व एक प्रतिशत एसकोरबीक अम्ल + 1 प्रतिशत सीट्रीक अम्ल से उपचारित करने पर सुखाने के लिए सबसे कम समय लगा तथा सबसे ज्यादा रंग व गुणवत्ता प्राप्त हुई। सेब की विभिन्न किस्मों में बैलस्पर, ग्रेनीस्मिथ, ऑरेगन स्पर व रेडचीफ साधारण वातावरण में भंडारण क्षमता की दृष्टि से उपयुक्त पायी गयी। आलुबुखारा व केपगुजबेरी के बार बनाने की तकनीक विकसित की। चैरी व खुमानी के ऑस्मोडिहाइड्रेसन के साथ केसर को सुखाने की तकनीक भी मानकीकृत की गई। ट्युलीप की पुष्पावधि बढ़ाने हेतू जिबरेलिक अम्ल 200 पी पी एम पूर्वपुष्पन के लिए जबकि साइकोसील व मेलिकहाइड्राजाइड पुष्प विलम्बन व पुष्पावधि बढ़ाने के लिए कारगर साबित हुआ। ट्यूलिप की भंडारण क्षमता 8 एच क्यू एस 300 पी पी एम से बढ़ाई गई।

प्रसार गतिविधियां

अनुसंधान के अलावा सी आई टी एच किसानो तक विभिन्न माध्यमों, प्रर्दशनों, प्रशिक्षणों, खेत दिवस, दौरा तथा जन प्रसारण माध्यमों से पहुंच रहा है। इस वर्ष 2012–13 में लगभग 4500 किसान विभिन्न भ्रमणों व प्रशिक्षणों से लाभान्वित हुए और लगभग 13 तकनीकों पर किसानो के खेतों पर 181 प्रक्षेत्र प्रदर्शन लगाए गए। लगभग 31 एक दिवसीय शिविर (परिसर में व परिसर के बाहर), विभिन्न राज्यों के बागवानी अधिकारियों के लिए एक आठ दिवसीय आदर्श प्रशिक्षण पाठ्यक्रम, पाँच दिवसीय प्रशिक्षण कार्यक्रम हिमाचल के प्रगतिशील किसानों के लिए, 3 प्रशिक्षण कार्यक्रम अरूणाचल, कारगिल व लेह के जनजातीय किसानों के लिए आयोजित किये गये। इसके आलावा तकनीको के तुरन्त स्थानांतरण के लिए मीडिया मीट, बादाम दिवस, केसर दिवस व इन्नोवेटर दिवस का भी आयोजन किया।

प्रकाशन

संस्थान के वैज्ञानिकों ने इस बार 46 शोध पत्र, 3 पुस्तक, 3 पुस्तक अध्याय, 13 लोकप्रिय लेख तथा 9 प्रसार बुलेटिन/प्रसार फोल्डर्स प्रकाशित किए।

Executive Summary

Temperate horticultural crops are the major source of livelihood in the states of Jammu & Kashmir, Himachal Pradesh, Uttrakhand and some parts of North Eastern states. But the productivity of these crops is very less as compared to other advanced countries. To overcome this bottle neck various research programmes were undertaken in temperate horticultural crops at CITH main campus and Regional Station Mukteshwar to enhance production and productivity whose results are summarized below:

Crop Improvement and Biotechnology

Central Institute of Temperate Horticulture over the years has become a major repository of germplasm having more than 2200 lines of various temperate horticultural crops and this work is continuously going on to build and preserve national wealth which is vital for future breeding programmes. To enrich the apple germplasm, 2 genotypes viz. CITH-Apple-29 and CITH-Apple-30 were selected from local germplasm of Ambri and propagated at CITH for further evaluation. From evaluation of various apple cultivars, Mollies Delicious, Vista Bella, Vance Delicious, Prima, Starking Delicious, Vermount Spur, Cooper IV, Skyline Supreme and Red Spur were found promising. On the basis of yield performance of various cherry genotypes, cultivar Stella (11.38 kg/tree), CITH- Cherry-6 (13.68 kg/tree), CITH- Cherry-5 (11.23 kg/tree) and CITH- Cherry-9 (10.01 kg/tree) were found promising. In pear, one variant i.e. CITH -P-21 was selected from *Kashmiri Nakh* population for further evaluation. In apricot, CITH- A-1 was found to be higher yielder (40.94 t/ha.) while CITH-A-15 produced fruits having very high TSS of 33.06^{0}B. In evaluation of plum genotypes, highest fruit weight was recorded in cultivar Grand Duke and fruit yield in cultivar Beauty and Santa Rosa. Among 31 almond genotypes, CITH Almond-9 and 21 were found best on the basis of desirable nut and kernel characters while in walnut, based on nut and kernel characters the genotypes, CITH-W-1(27.98 g), CITH-W-10 (24.48 g), CITH-W-7 (24.72 g), CITH-W-6 (23.99g) and CITH-W-8 (20.35g) yielded heaviest nuts as compared to other genotypes. In peach, cultivars Fantasia, Crest Heaven, Red Globe, Glo Heaven and Nimla were found promising for various yield traits while in olive, cultivar Messsenese, Coratina and Biancollio were found best in terms of fruit traits while Coratina and Pendolino for oil recovery. Under diversification, new *Physalis* species like *Physalis ixocarpa, P. pruinosa* and *P. peruviana* were found suitable for growing in temperate climate.

For development of superior apple cultivars, through hybridization, the results indicated that among twenty five inter varietal crosses, Red Spur x Prima and *M. floribunda* x Summer Red gave highest fruit set of 60 and 56.66 % respectively and found most compatible. The seeds of all the successful crosses were sown for further studies. In olive, pollination and cross compatibility studies were carried out and best pollen donors were identified for different cultivars for higher fruit set and yield. In micro propagation of apple, 6 weeks old micro-cuttings were found physiologically better while the ascorbic acid & humic acid were found beneficial for improving percentage rooting and other traits. In floral biology study of 85 walnut genotypes, 18 genotypes were found protogynous and 45 genotypes showed 7-17 days floral overlapping period leading to synchronization and better pollination. In saffron, 32 elite clones were evaluated and 15 clones were identified to be best having yield range of 4.26 to 4.86 kg/ ha in 3rd year of planting.

For rapid multiplication of cherry rootstock, protocol containing MS basal medium + BAP @ 2mg/l+IBA @ 1ml/l gave better success and showed high survival in hardening media. In micro-propagation of apple rootstock MM106, shoot multiplication was observed in MS media supplemented with BA+Kinetin @0.5mg/l while MS media +2mg/l IBA was found to be best for rooting.

In onion, 10 new genotypes were selected on the basis of desirable traits. Highest onion yield of 625.89 q/ha and 623.86 q/ha was recorded in AOLD-RB 09-016 and AOLD-RB-09-3 respectively. Similarly in garlic, 11 new genotypes were selected. Based on various traits, CITH-G-12 excelled all genotypes for yield (847.55q/ha) and bulb weight (127.13g). Based on economic traits, 10 advance lines each in chilli and capsicum as well as 5 lines in brinjal were found promising after evaluation of 270, 48 and 19 genotypes respectively.

In evaluation of various cut flowers in polyhouse conditions, cultivars Rosita, Tiara, Pluto, Alladin, Sereena in alstroemeria; Ercolano, Ceb Dazzle, Samur, Best seller, Prato and Royal Trinity in lilium and Amsterdam, White Prosperity, Fiedelio, Mayur, Eurovision, Peter Pears in gladiolus were found promising.

Crop Production and Plant Propagation

Among various budding methods, chip budding was found to be the best method at Srinagar as well as at Muktehwar for pome and stone fruits as compared to others while in walnut the wedge grafting done under poly house during early March gave higher success (93%) when 15-20 mm scion grafted on 25-30 mm root stock. Besides the large quantity of quality planting material i.e. grafted plants, rootstocks, scion wood and seeds of elite varieties and hybrids were produced and supplied to farmers as well as to line departments.

Apple

In evaluation of apple cultivars on different densities and rootstocks, the cultivar Starkrimson gave highest yield (36.44 t/ha) at 2.0x3.0 m and (34.05 t/ha.) at 2.5x2.5 m spacing on M9 and MM106 rootstocks while Mollies Delicious (49.65 t/ha) excelled other cultivars at 3.0x3.0 m spacing. Similarly Starkrimson and Red Spur on MM106 rootstocks planted at 3.5x3.5 and 4.0x4.0 m spacing gave highest yield (28.32 and 52.05 t/ha), respectively. In plant architectural engineering the cv. Co Red Fuji on M9 rootstock, gave highest yield (95.36 t/ha and 93.82 t/ha) with espalier and vertical axis systems while under head and spread, modified central leader and spindle bush system cultivar Mollies Delicious gave 126.33, 108.33 and 92.00t/ha, respectively.

In rain water harvesting, highest yield (18.29t/ha) and moisture content in soil (15.10%) were recorded with full moon water harvesting system and plastic mulch in apple cultivar Red Delicious. In an experiment at Uttarakhand, an integration of FYM+vermicompost +bio-fertilizer+inorganics were found best while in an another intercroping experiment in apple with methi, onion, lentil, garlic, coriander, pea, lucern, red clover, swiss chard and mustard; the maximum cost benefit ratio was recorded with inter cropping of methi followed by swiss chard at Srinagar. In another INM experiment, the application of biofertilizers and organic manures improved the quality of soil of medium and high density orchards of apple.

Almond

In evaluation of different planting densities (2.5x2.5, 3.0x3.0, 3.5x3.5 m) and different cultivars, highest productivity (3.11 t/ha) was recorded in Waris planted at 2.5x2.5m spacing while the cultivar Pranyaj (3.07t/ha) was found superior to other eight cultivars at 4x4m spacing. In water harvesting experiment, full moon water harvesting system and plastic mulching were found promising for increasing yield (3.47t/ha and 2.80 t/ha) and moisture content (15.25% and 15.11%) respectively.

In INM, 40 tonns of FYM/ha resulted in maximum nut yield (3.85t/ha) with maximum NPK content of 345.3, 9.8 and 270.8 kg/ha, respectively while in fertigation, maximum nut yield (4.44kg/tree)

was harvested by application of 75% RDF through fertigation (2/3N:1/3 K at nut set to nut development stage and 1/3 N: 2/3K at kernel development to maturation stage). The maximum soil NPK content were estimated in 100% recommended dose of fertilizers. To make the old and senile orchards of almond productive, the rejuvenation technique has been standardized by severe to moderate pruning, top working with cultivar Waris+fertilizer (50 kg FYM+500g N+250g P+750g K/tree) with full moon water harvesting system which yielded 3.53 kg yield/ tree after 3rd year of rejuvenation.

Walnut

Among different training systems in walnut, maximum nut efficiency, nut weight and kernel weight were recorded in multileader, modified leader and open center systems, respectively. Among various pruning levels, 10% thinning, 20% heading back and 20% thinning +20% heading back were found to increase the nut efficiency. Effect of different training and pruning systems was also observed on nut and kernel characters.

Peach

The cultivar Gloheaven and Red Globe were found best for high and medium high density plantations. The cultivar Gloheaven was found best for various traits planted at 2.5x2.5m and 3x3 m spacing with a yield potential of 25.05 and 22.85 t/ha., respectively. In different training systems and densities, Tatura Trellies system excelled in all varieties at 2.5x2.5m spacing with yield ranging from 23.6 to 34.78 t/ha while at 3x3m density, different varieties behaved differently under different systems. In Fantasia Nectarine, application of $ZnSO_4$ (200 ppm) + GA_3 (50 ppm) treatment in tatura trallies system, reduced fruit russeting and increased fruit yield.

Strawberry

The period of availability of strawberry was enhanced upto 38 days by planting under different growing conditions besides identifying high yielding varieties for different growing conditions.

Saffron

The planting density of 10 lakh corms/ha on raised bed with drip irrigation system gave maximum yield of 7.51kg/ha as compared to other densities, planting methods and irrigation systems. In organic saffron production, application of 1/3rd FYM+1/3rd vermicompost+1/3rd poultry manure was found effective to increase yield up to 3.84 kg/ha.

Vegetables

In space and energy harvest of various crops under poly house conditions, CITH-TH-1 gave maximum yield of 934.23 q/ha when trained to double stem and planted at 75x50 cm spacing in tomato while in capsicum, SH-SPH-2 gave highest yield of 1095.56 q/ha planted at 20x50 cm spacing and trained to double stem system. In cucumber, highest yield i.e. 950.58 q/ha was recorded in SH-CH-1 when planted at 120x60 cm and trained to double stem system.

In an integrated module for onion, highest blub yield of 99.24 t/ha was recorded in local recommendation with bio-fertilizers. The highest weed control efficiency was recorded with the application of pendimethalin application before planting+ quizalofop ethyl after 30 days of planting. Under diversification and off season cultivation, crops and varieties of high value vegetables were identified and demonstrations were laid out for their popularization.

Floriculture

The agro-techniques for gerbera production under polyhouse conditions have been standardized and cultivars Dune, Dana Ellen, Sunway and Fiorella were found best for maximum flowers per plant. The cultivar Dune yielded maximum flowers (53.82 & 43.26) per plant under poly house and open conditions, respectively.

Soil Science

The soil samples collected from 64 locations of CITH orchards were analyzed and Relative Soil Quality Index was also evaluated. The soils of cherry

and apple were highly suitable with RSQI value of 90 & 86 while in walnut and almond it was 77 and 76, respectively.

Plant Health Management

In chilli wilt management, maximum disease mitigation of 65.9% was achieved with the *T.viride* seed priming, carbendazim root dip and soil solarization with transparent polythene. For the management of corm rot in saffron, carbendazim (0.2%) was found most effective with maximum plant stand of 80.83%. In almond maximum gummosis (8.49%) with 4 to 5 droplets and 31.42% fruits with one droplet was recorded in cultivar Merced, while CITH Almond-14 exhibited minimum gum exudation.In survey of viruses, incidence of APMV in 5 apple growing areas ranged from 2.08 to 16.20% and mean infection of ACLSV ranged from 2.83 to 19.64 per cent.

In insect population dynamics, maximum European red mite infestation on apple was recorded in cv. American Apirogue and Shireen while in almond, maximum infestation was recorded in cv. California Paper Shell. The aphid infestation was maximum in Akbar while minimum in Firdous. The flee beetle was found to be emerging pest in apricot, almond and apple which was identified as *Altika himensis*. The family Halicitidae was the dominating family as far as insect pollinators are concerned. Beside this 17 species belonging to 14 genera of predatory coccinellids were also recorded. The IDPM module for tomato, cucumber and capsicum cultivation has been standardized under protected conditions. For the management of honey bee colonies from the attack of *Vespa* species, different traps as well as food baits were tried and one modified bait trap attracted more number of wasps and found very effective.

In Uttrarakhand, the incidence of various cankers in apple ranged from 3.26-52.21%, foliar diseases 31.97-50.92%, viruses attack 1.92-3.92% and fruit diseases from 2.35-39.95%. The white root rot disease was recorded to be more severe as compared to phytopthora root rot in nurseries and orchards. The white root rot of apple was found to be more destructive in orchards and the incidence of soil borne diseases were more in nurseries. One rootstock locally called as *Paron* showed resistance against this disease.

Post Harvest Management

The value addition is important component in post harvest management. Among the squashes prepared from various wild fruits, the squash prepared from rhododendrons (15%)+galgal (5%) ginger (5%) and from malta (20%) + ginger (5%) were found best for various traits. For enhancement of shelf life, calcium (0.4%) was found effective in apple and plum while salycilic acid (200ppm)+ calcium (0.4%) gave better response in pear. The application of chitosan coating (1.5%) was found to be beneficial in extending shelf life of strawberry from 35-40 days at low temperature and high humidity.

For dehydration of apple, slices of 2mm thickness and pre-drying treatment with 1% ascorbic acid +1% citric acid took minimum time for drying with maximum colour and quality retention. Under room condition, among various cultivars tested for post harvest life, cultivars Well Spur, Granny Smith, Oregon Spur and Red Chief were found to have better shelf life. Technology has also been developed for preparation of plum and cape gooseberry bar; osmo-dehydration of cherry and apricot as well as for drying of saffron. For enhancing blooming period in tulip, GA_3 @200 ppm found most effective by inducing earliness while CCC & MH induced late flowering and increased flowering duration. The shelf life of tulip was enhanced by application of 8HQS @ 300ppm.

Extension Activities

Besides research, CITH is reaching to the farmers through various demonstrations, trainings, field days, media and diagnostic visits. In the year 2012-13, about 4500 farmers were benefited through various visits/ trainings etc and about 181 demonstrations on 13 technologies were laid out at farmer's field. Thirty one on-campus and off campus

one day training; one eight day model training course for the officers of various states; five days training programme for progressive farmers of H.P; three days training programmes for the tribal farmers of Arunachal Pradesh, Kargil and Leh were organized besides media meet, processors meet, almond day, saffron day and innovators days for immediate transfer of technologies.

Publications

The scientists of the Institute published about 46 research papers, 3 books, 3 book chapters, 13 popular articles and 9 extension bulletins/folders during the year.

Introduction

The horticultural industry in India is progressing very fast during last two decades and has attained second position in the production of fruits and vegetables in the world. Like other regions, the temperate hill states with diversified congenial agro-climatic conditions have also shown some economic prosperity but it is still deprived of the modern technologies to boost the production. Presently the temperate fruits and vegetables in the country are yet to meet the normal dietary requirements and country is still spending a lot of hard earned foreign exchange to import many temperate fruits and nuts. Although tremendous increase in area has occurred during last two decades but the productivity of temperate horticultural crops is much lower than the developed countries. Although few technologies have been generated during past to enhance the productivity but their impact in farmer's field is yet to be realized. Considering the enormous wealth of natural resources and keeping in view the low productivity and quality of different crops as compared to advanced countries, lot of technological interventions and varieties suited to the region need to be developed to boost production and productivity of crops. To overcome the production constraints the research on temperate horticultural crops is being concentrated at Central Institute of Temperate Horticulture, Srinagar and at its Regional Station, Mukteshwar (Uttarakhand) with the following mandate and objectives

Mandate

- To act as national repository of germplasm & scientific information on temperate horticultural crops.
- To undertake basic, strategic and applied research on temperate horticultural crops in collaboration with national and international agencies to enhance productivity and quality.
- To serve as centre of training for human resource development & transfer of technology.

Objectives

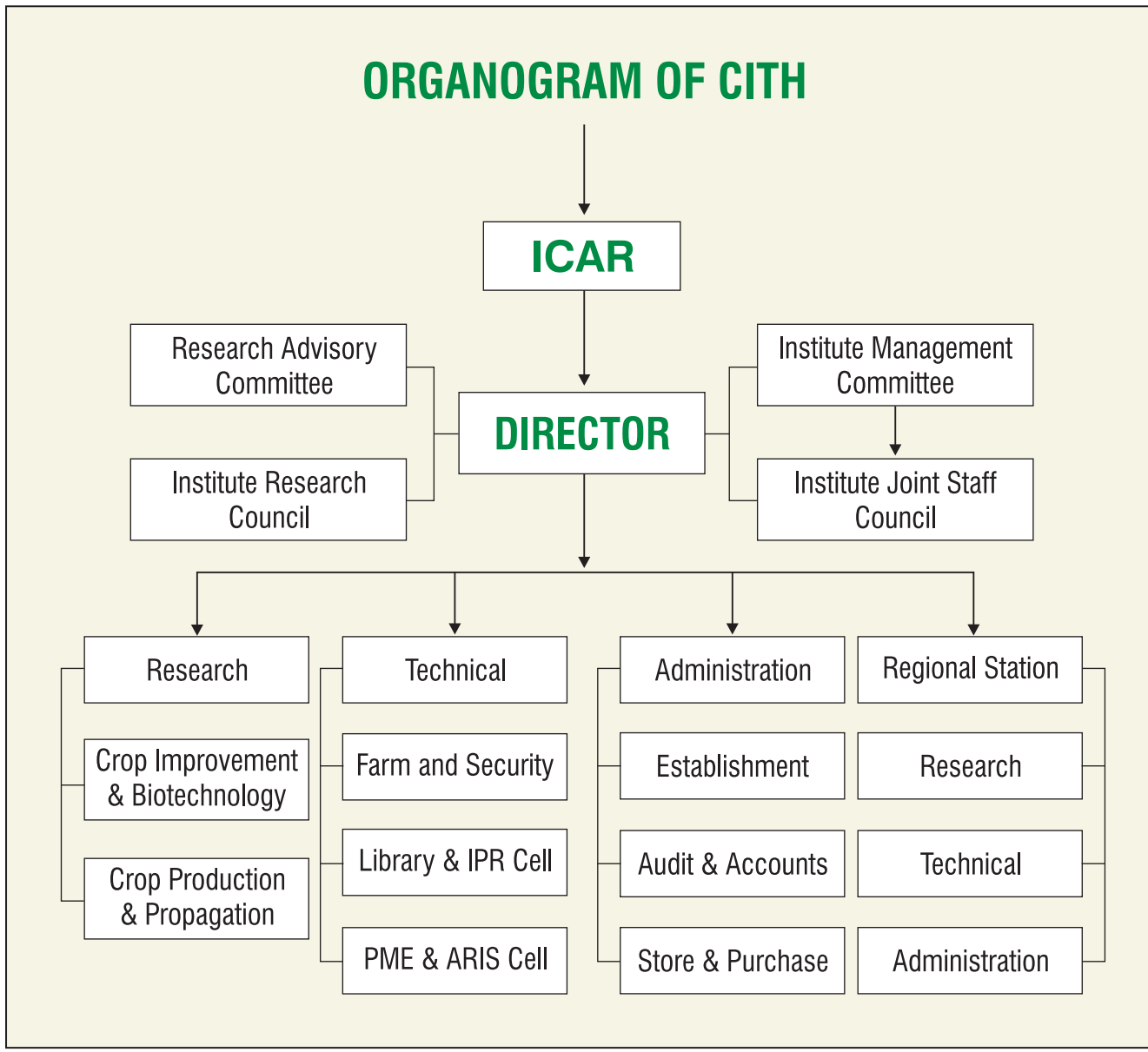
- Establishment of field gene bank and management of genetic resources and scientific data base of temperate horticultural crops.
- Genetic improvement of temperate horticultural crops for yield, maturity, quality, resistance to biotic and abiotic stresses through conventional breeding methods and use of biotechnological tools.
- Standardization of nursery management and high tech propagation techniques of temperate horticultural crops.
- To device efficient and cost effective production technologies and cropping systems for increasing productivity and improving quality of temperate horticultural crops.
- To develop eco-friendly integrated disease/pest management modules and diagnostics.
- Post harvest value addition, product diversification and waste utilization for increasing availability and returns.
- To work out economics of production and impact assessment of technologies.
- Commercialization and transfer of technologies and skilled manpower development.

Staff Position (2012-13)

Category	Sanctioned	Filled	Vacant
Scientific	22+1 RMP	16+1 RMP	06
Administrative	15	11	04
Technical including driver	14	13	01
Supporting	15	9	06
Total	**66+1RMP**	**49+1RMP**	**17**

Financial Statement (2012-13)

S. No.	Sub-Head	Plan (In lakhs)	Non-Plan (In lakhs)
1	Establishment Charges	0.00	282.01
2	T.A	7.00	2.99
3	HRD	0.55	0.50
4	Contingency	139.47	95.04
5	Equipment	38.00	2.00
6	I.T	6.00	0.00
7	Works	131.46	0.00
8	Library	22.52	0.00
9	Furniture and Fixture	0.00	0.00
10	Network project	50.00	0.00
11	Pension	------	1.96
12	Loans and advances	-----	4.00
13	**Total**	**395.00**	**388.50**


ORGANOGRAM OF CITH
ICAR
Research Advisory Committee
Institute Research Council
DIRECTOR
Institute Management Committee
Institute Joint Staff Council
Research
Crop Improvement & Biotechnology
Crop Production & Propagation
Technical
Farm and Security
Library & IPR Cell
PME & ARIS Cell
Administration
Establishment
Audit & Accounts
Store & Purchase
Regional Station
Research
Technical
Administration

I. Crop Improvement and Biotechnology

The crop improvement through conventional as well as non conventional approaches is a component of paramount importance in horticulture. In temperate horticultural crops, especially in perennial fruit crops less systematic work has been carried out except introduction and selection. But the position is different in case of temperate vegetables where a good source of earning to hill farmers coming through off season production and hybrid technology. The introgression of all desirable traits in fruit crops is somewhat difficult as compared to annual crops. The research undertaken for enhancement and genetic up gradation at CITH is presented below:

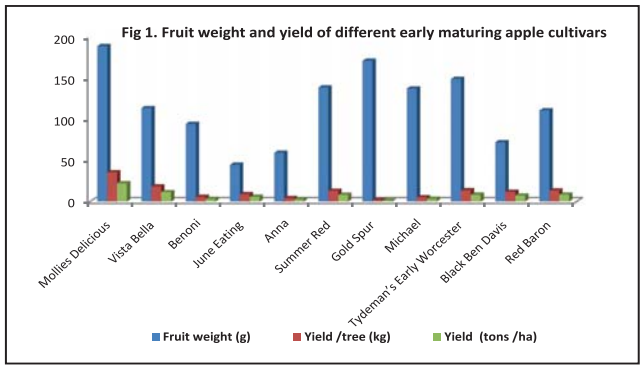
Survey, collection, evaluation, characterization and documentation of temperate horticultural crops.

The Western Himalayas and Trans-Himalayan region of country is one of the mega centers of diversity for many crops where introgression of traits from wild germplasm into cultivated variety is going on. The future prospects of any improvement in crop depends upon its richness in germplasm for further genetic enhancement. The Central Institute of Temperate Horticulture in this direction is constantly enriching its gene bank and has conserved more than 2226 germplasm lines of diverse traits of temperate horticulture crops as in Table 1 and most have been evaluated for various horticultural traits.

Table 1. Germplasm resources at CITH.

S. No.	Crop/Group	Total collection
1	**Fruits**	**957**
	Pome fruits	305
	Stone fruits	145
	Nuts	348
	Others	159
2	**Vegetables**	**959**
3	**Ornamental**	**285**
4	**Medicinal & Aromatic plants**	**25**
Total		**2226**

In apple, during the survey of Kashmir and Jammu Divisions, a wide variations in Ambri apple was noticed and two genotypes CITH-Apple-29 and CITH-Apple-30 were found promising based on various desirable traits. These promising genotypes have been propagated at CITH for further evaluation. In evaluation of eleven early maturing apple cultivars, Mollies Delicious (35.78 kg/tree and 22.00 t/ha) and Vista Bella (18.51 kg/tree and 11.60 t/ha) resulted in highest yield whereas highest fruit weight (188.40 g) was recorded in cultivar Mollies Delicious (Fig 1). In evaluation of recently introduced apple cultivars planted at 4x4 m spacing on seedling root stock, cultivars Vance Delicious , Oregon Spur, Starkrimson, Vermount Spur , Cooper IV, Skyline Supreme, Gold Spur, Red Spur and Well Spur resulted in highest yield with improved quality fruits (Fig 2).

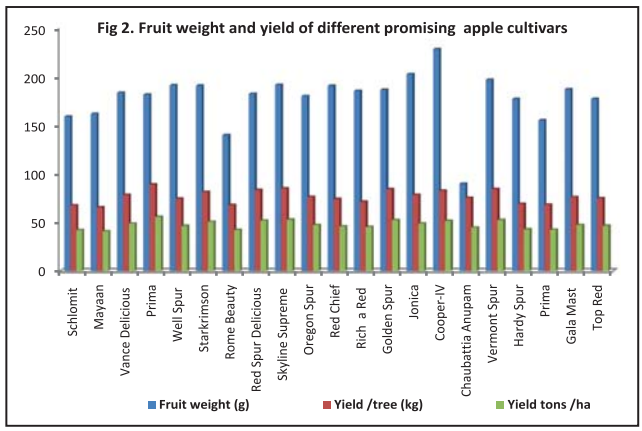


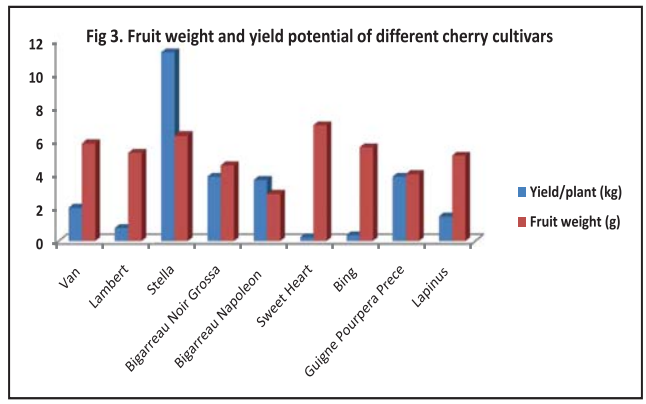
Oregon Spur Red Spur

Elite apple cultivars in fruiting at CITH, Srinagar

Fruiting in Vista Bella

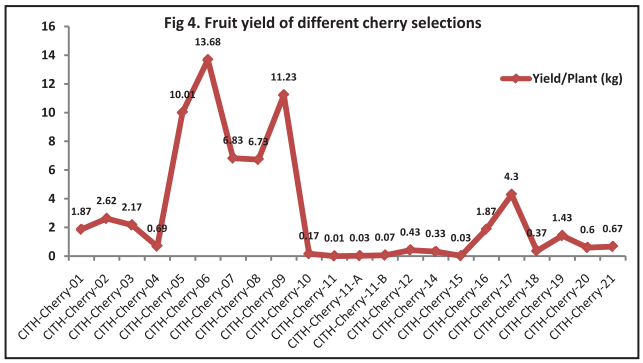
In cherry, different cultivars/elite clones selected and introduced at CITH were evaluated for various economic traits. The cultivar Stella resulted in highest yield of 11.38 kg /tree and maximum fruit weight (6.90 g) was recorded in cultivar Sweet Heart (Fig 3). While among 22 cherry selections, the yield to the tune of 13.68 kg, 11.23 kg and 10.01 kg per tree was recorded in CITH-Cherry-6,5 and 9, respectively (Fig 4).





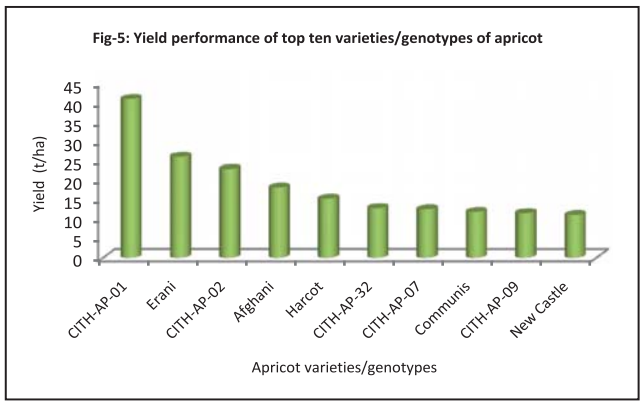
Rome Beauty Well Spur

CITH-Cherry-05 and Stella in fruiting



In pear, survey was conducted for collection of elite variants of *Kashmiri Nakh* and one promising pear selection CITH-P-21 having many improved traits was selected and planted in germplasm block.

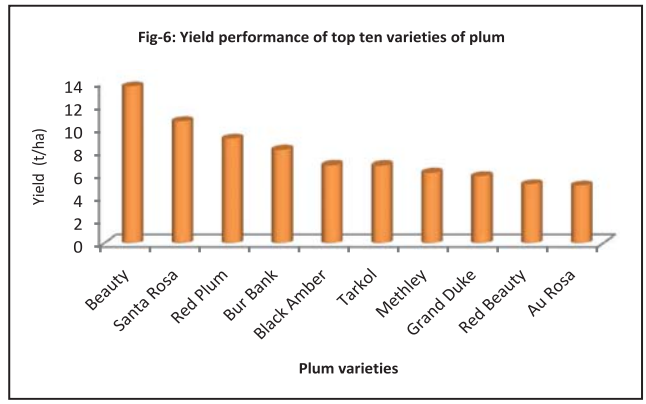
In apricot, 54 genotypes have been established and evaluated for fruit yield and quality (Fig. 5). The highest fruit yield was recorded in CITH Apricot-1 (40.94 t/ha) followed by Erani (25.95 t/ha) and CITH Apricot-2 (22.85 t/ha). The genotype CITH Apricot-15 produced fruits with very high T.S.S. (33.06^0 B) followed by CITH Apricot-37 (31.57^0 B).



CITH-Apricot-15 CITH-Apricot-37

Fruits of CITH-Apricot-15 and 37 having high TSS

In plum, 25 varieties (indigenous and exotic) have been established and 23 varieties were evaluated for growth, yield and quality. Results of the experiment indicated that highest fruit weight (81.36 g) and TSS (24.93^0 B) was recorded in Grand Duke. Maximum fruit yield (13.67 t/ha) was recorded in Beauty followed by Santa Rosa (10.62 t/ha) variety of plum (Fig. 6).



Grand Duke Santa Rosa President Plum

Fruits of high yielding plum varieties

In almond, a field gene bank of 43 varieties / genotypes have been established and out of these 31 came to flowering and fruiting. Preliminary observations indicated that two elite genotypes i.e. CITH-Almond-9 and 21 showed superior nut and kernel characteristics.

Plants and nuts of CITH-Almond-9 and 21

In evaluation of walnut genotypes, highest nut weight (27.9 g) and kernel weight (14.7 g) with good kernel recovery (52.6%), light shell colour, long trapezoidal shape and very easy removal of kernel was recorded in CITH-W-1 followed by CITH-W-10 having respective nut & kernel weight (24.4 & 13.7g), CITH-W-7 (24.72 & 12.26 g); CITH-W-6 (23.99 &12.22 g) and CITH-W-8 (20.35 & 11.01 g). A clustered line CITH-W-23 was also identified with superior nut and kernel characters.


CITH-W-1


CITH-W-6


CITH-W-7


CITH-W-8


CITH-W-10


CITH-W-23

Fruiting in different elite walnut genotypes

In peach/nectarine, a total of 33 exotic and indigenous cultivars have been collected, conserved in field gene bank and out of these 21 flowered and fruited. Among various varieties Fanatasia, Crest Heaven, Red Globe, Gloheaven and Nimla were found very promising with high yield potential (Fig. 7). In terms of TSS/acidity ratio, highest value

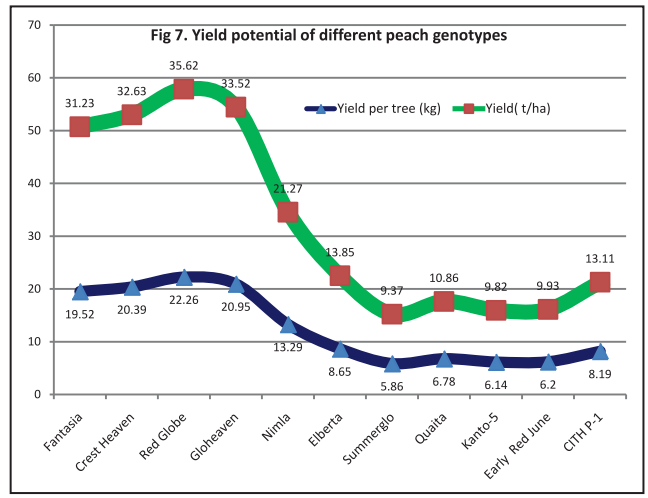

Grest Heaven


Red Globe


Fantasia


Nimla

Fruiting in different cultivars of peach/nectarines



was recorded in Snowqueen, CITH-P-1, July Elberta and Nimla.

In olive, out of 25 varieties, thirteen came in to bearing. Maximum fruit weight was recorded in Messenese, fruit length in Coratina, width in Biancollio, pulp weight in Messenese, stone weight in Biancollio and yield per plant in Coratina, Cipressino, Pendolino, Leccino and Picholine, respectively. Maximum oil recovery on fresh weight basis was estimated in Coratina followed by Pendolino while peroxide value of oil and pulp weight was recorded in Messeneses. However maximum oleic acid was found in fruits of Cipressino and Etrana (Table 2).

Table 2. Physico-chemical and yield attributes of different olive cultivars.

Varieties	Fruit wt (g)	Fruit length (mm)	Width (mm)	Pulp wt (g)	Stone wt (g)	Acidity (oleic acid %)	Oil %	Peroxides value meq O_2/kg	Yield / plant (kg)
Messenese	3.30	20.82	15.36	2.64	0.66	0.36	24.25	12.36	5.23
Pendolino	2.81	20.30	14.58	2.16	0.65	0.42	26.38	10.24	8.47
Etrana	1.81	18.10	13.95	1.29	0.52	0.89	20.30	9.68	1.34
Zatuna	2.62	22.29	15.59	2.00	0.62	0.47	20.40	12.00	0.50
Frontoio	2.45	19.06	15.06	1.83	0.62	0.86	19.24	10.34	6.36
Morolio	1.89	19.05	14.21	1.40	0.49	0.67	19.89	9.68	0.30
Biancollio	3.05	22.51	18.18	2.30	0.75	0.75	20.20	12.00	0.45
Cipressino	2.74	20.35	16.88	2.04	0.70	0.89	24.65	14.24	8.58
Cornicobra	1.80	19.07	13.44	1.32	0.48	0.35	18.96	11.35	0.34
Coratina	3.03	23.98	15.20	2.22	0.81	0.55	27.36	9.87	9.56
Carignola	1.92	19.33	14.91	1.47	0.45	0.68	21.31	8.97	0.59
Leccino	1.60	19.64	14.09	1.23	0.37	0.39	26.35	10.23	7.32
Picholine	1.90	19.38	13.44	1.25	0.65	0.52	25.68	11.36	6.50

Pendolino Frontoio Leccino

Fruiting in different promosing olive cultivars

In quince, survey was carried out in Bandipora district and fruit samples from 45 genotypes were evaluated for different fruit traits and lot of variation was observed for various morphometric traits. The fruit size varied from 39.6 g to 483.8g. Fourteen trees produced fruits having size more than 250g. Based upon desirable traits the elite genotypes have been propagated at CITH for further evaluation.

Variability for fruit size in different quince clones

Collection, maintenance and evaluation of temperate fruits at Mukteshwar

A total 103 germplasm lines of apple procured

through introduction as well as by local collection have been evaluated and maintained at the station. Among the different apple cultivars, Schlomit, Michael and Mayaan have low chilling requirement, Prima, Summer Red and Mollies Delicious apart from pollinizers like Tydeman's Early Worcester as early maturing; Oregon Spur, Well Spur, Red Chief, Starkrimson and Spur Type Red Delicious (Red Spur Delicious) as spur type and Skyline Supreme as colour strain were identified for Uttarakhand conditions. Besides these cultivars Cooper IV, Vermount Spur, Gala Must, Gloster and Bright-N-Early have also found to be promising. The various germplasm of other fruits being maintained and found promising are Red June, Red Nectarine, Flavour Top, Gloheaven, Fantasia, Ashwariya, Paradelux, Fla 1633, Florida Sun, Florida Red and Sharbati in peach; Satsuma, New Plum, First Plum, Methley, Monarch and Santa Rosa etc. in plum; Harcot, Iranian, Chaubattia Madhu, St Ambroise, CITH-A-1, 2 & 3 in apricot; Merced, Waris, IXL, American in almond; Red Bartlett, Starkrimson, Bagugosha, Zirhania Nakh, Bartlett, Max Red Bartlett and local selections in pear; Camarosa, Osograndy, Blackmore, Chandler, Gorella, Addie, Shasta, BL-13, Jeolikote Local, Corona, Ofra, and Maxima in strawberry and Sulaiman, CITH-Walnut-1, CITH-Walnut-2, CITH-Walnut-3, CITH-Walnut - 4, CITH-Walnut- 5, CITH-Walnut-6, CITH-Walnut-7, CITH-Walnut-8, CITH-Walnut-9 and CITH-Walnut-10 in walnut. Few local germplasm of chestnut have been also evaluated and one promising type (CITH Chestnut Seedling Selection-1) has been selected which has bigger nuts (30.5 -34.5 g) and high shelling percentage (80-85%) with yield potential of 80-90 kg/tree.

Diversification in temperate fruit production through introduction of new fruit crops

For diversification in temperate fruit production, four new *Physalis* species namely *Physalis ixocarpa, Physalis nicandroides, Physalis pruinosa* and *Physalis peruviana* were evaluated and all produced vegetative growth, flowering and fruiting under temperate conditions. Among them, *Physalis pruinosa* and *Physalis ixocarpa* were found to exhibit vigorous growth while days maturity was minimum in *Physalis peruviana*. Maximum average fruit weight, number of fruits/plant, size of fruit, fruit husk ratio and fruit firmness were recorded in *Physalis pruinosa*. Quality of fruit (TSS, acidity, ascorbic acid) was recorded on higher side in *Physalis peruviana*. Under temperate conditions *Physalis ixocarpa, Physalis pruinosa* and *Physalis peruviana* were found performing well for fruiting, flowering, yield and quality of fruits. Among the earlier introduced new crops, hazelnut, fig, Chinese ber, red raspberry and black berry came into flowering and have yielded sample fruits.


Fruiting in black berry


Husk tomato plant in fruiting


Hazelnut plant in fruiting


Fruiting in fig


Fruiting in Chinese ber


Fruiting in red raspberry

New introductions in temperate fruits under crop divesification

In onion, ten long day types have been selected from Chadura area of Budgam district of Kashmir valley on the basis of morphological variability and evaluated for some valuable traits. All selected accessions were having A-grade size bulbs with narrow neck and better TSS. The bulbs of these selections have been planted for seed production and will be evaluated in next year for specific characters.

In varietal evaluation of 36 entries, AOLD-RB-09-29 recorded highest plant height (79.80 cm) and number of leaves /plant where as entry AOLD-RB-09-22 recorded largest size of bulb (115.50 g) and highest gross yield (770.00 q/ha) followed by AOLD-RB-09-12 with 113.1g bulb weight and 754.00 q/ha yield. Entry AOLD-RB-09-016 and AOLD-RB-09-3 produced highest marketable bulbs (98%) with highest marketable yield i.e. 625.89 q/ha and 623.86q/ha, respectively and were at par with AOLD-RB-09-22 (616.00q/ha). However, AOLD-RB-09-18 recorded highest % of A grade bulbs (45%). In the storage trial entry AOLD-RB-09-24 recorded minimum total loss (33%) followed AOLD-RB-09-27 and AOLD-RB-09-28 with 36.50 % and 38.50% total loss, respectively

In garlic, eleven long day genotypes have been selected from of Budgam and Parimpora market of Kashmir valley. Among the genotypes evaluated for some valuable traits (Table 3). Selection CITH-G-12 recorded maximum average bulb weight (127.13g) and yield (847.55 q/ha) followed by CITH-G-13 (612.88 q/ha) and CITH-G-10 (605.26q/ha).

Bulb and cloves of elite garlic genotypes

Table 3. Bulb, clove and yield characteristics of elite long day garlic genotypes

Genotypes	Leaf length (cm)	Leaf width (cm)	No. of leaves	Plant height (cm)	Collar thick-ness (cm)	Polar dia. (cm)	Equi. di. (cm)	Av. bulb weight (g)	No. of cloves	Av. wt. of 10 cloves (g)	Total yield (q/ha)
CITH-G-7	55.33	2.63	6.33	80.66	1.83	3.94	6.01	62.16	12.33	48.53	414.44
CITH-G-8	57.33	2.46	6.00	85.33	1.63	4.68	5.44	51.03	9.66	43.86	340.21
CITH-G-9	52.33	3.10	6.66	86.66	2.06	4.95	6.29	80.53	11.00	64.40	536.88
CITH-G-10	56.66	3.06	7.33	83.33	2.03	4.39	6.69	90.79	14.66	53.20	605.26
CITH-G-11	42.00	2.46	4.66	69.66	1.12	4.37	6.60	86.33	14.00	49.66	575.55
CITH-G-12	60.00	3.00	7.66	86.00	2.26	4.92	7.10	127.13	15.33	66.40	847.55
CITH-G-13	44.00	2.66	5.00	75.00	1.33	4.66	6.79	91.93	14.00	59.83	612.88
CITH-G-14	48.33	2.60	5.33	78.66	1.53	4.26	6.38	80.63	13.66	50.33	537.54
CITH-G-15	50.66	2.73	6.00	77.00	1.50	3.83	6.31	73.10	13.66	50.66	487.32
CITH-G-16	61.33	2.60	5.66	80.33	2.13	4.12	5.57	50.56	10.33	43.50	337.10
CITH-G-17	40.66	2.70	5.66	75.66	1.36	4.46	6.12	67.06	14.00	46.23	447.10
CD at 5%	*4.61*	*0.20*	*0.86*	*6.34*	*0.19*	*0.52*	*0.57*	*10.35*	*2.22*	*14.03*	*70.28*

In alstroemeria, under polyhouse conditions, all the cultivars came into flowering. The earliest flowering was recorded in cultivars Riana, Pluto, No. 14 and Tiara in April. Maximum length and diameter of flowering shoot were recorded as 150.3 cm and 8.32 mm in cultivar Alladin. The longest flower cavity (66.13 mm) and diameter (57.58 mm) was recorded in cultivar Tiara while flower length was found maximum (70.06 mm) in cultivar Alladin. Many cultivars continued flowering up to December. The cultivars Rosita, Alladin, Sereena, Capri, Pluto and Tiara were found promising based on different floral traits.

Flowering in different cultivars of alstroemeria under polyhouse conditions

In lilium, under polyhouse conditions, the maximum plant height (108 cm) was recorded in cultivar Best Seller while maximum plant diameter (11.81mm) was recorded in cultivar Royal Trinity. Maximum flower length (100.2mm) was found in cultivar Celesta while maximum flower diameter (195.30 mm) was measured in cultivar Pavia. Earliest flowering was observed in Polyana and Samur during May while other cultivars flowered in June. Based on number of flowers per spike, cultivar Ercolano, Ceb Dazzle, Samur, Best Seller, Prato, Pavia and Royal Trinity were found to be promising.

In evaluation of gladiolus cultivars under polyhouse conditions, most of the cultivars attained the height of more than one meter. The maximum plant height of 165.33 cm was recorded in cultivar Amsterdam while maximum spike length (113.6 cm) was recorded in cultivar Shabnam. Maximum vase life of 20-23 days was recorded in cultivar Sylvia while maximum flower length and diameter were measured in cultivar Mayur (Purple) and Red Beauty respectively. The different varieties flowered at different time and earliest flowering was observed during May in cultivar *Psithanus* hybrid. Many cultivars yielded more than one spike.

Flowering in different cultivars of lilium under polyhouse conditions

Flowering spikes of different gladiolus cultivars under polyhouse conditions

Breeding for development of superior varieties / hybrids in solanaceous crops

To develop and isolate high yielding varieties and hybrids in chilli, capsicum and brinjal suitable to temperate region were evaluated in open field conditions. In chilli, out of 270 lines tested, ten promising genotypes were identified on the basis of yield and fruit traits. The promising genotypes are CITH-HP-655-1, CITH-HP-712-1, CITH-HP-210-1, CITH-HP-1011-2 , CITH-HP-699-1, CITH-HP-1016, CITH-HP-773, CITH-HP-260-2 and CITH-HP-612-1. In capsicum, out of 48 lines tested, ten promising genotypes were identified with a high yield potential. The identified genotypes are SH-SP-603, CITH-SP-1, CITH-SP-2, CITH-SP-5, CITH-SP-9, SH-SP-706, CITH-SP-3, CITH-SP-4, CITH-SP-6 and CITH-SP-10. In brinjal, 19 lines were evaluated in open field conditions. Based on yield and desirable fruit traits, the best genotypes identified are CITH-B-1, CITH-B(L)-6, CITH-B(O)-4-11-1, CITH-B(O)-4-6-1 and CITH-B(O)-4-5.

Floral biology and pollination studies in walnut

A detailed floral biology of 85 genotypes of walnut was studied for synchronization period for pollination among the different genotypes. Out of 85 genotypes, 38 were protogynous and rest were protoandrous while 45 genotypes showed 7-17 days of male and female bloom overlapping by indicating synchronized flowering in most of the genotypes for successful pollination. Genotype PTS-11 and Cheinova showed maximum synchronizing period of 17 days followed by genotype SKUA-0023, GG-7 and BRTS-1 having 16 days synchronization. While genotypes CITH-W-4, CITH-W-7, Hamdan, Opex Culcherry, WU-1, WU-8, BRTS-4, and PB-3 showed non-synchronization with respect to male & female blooming period indicating need of pollinizers. The details of compatible and non compatible genotypes are presented below on the basis of synchronized flowering (Table 4).

Table 4. Compatibile pollinizers for newly released ten walnut genotypes

New Genotypes	Compatible pollinizers
CITH-W-1	CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W- 6 CITH-W-7. CITH-W-8 CITH-W-9, CITH-W10, Hamdan, Sulaiman, Opex Culcherry ,Nugget,Cheinova,Tutle
CITH-W-2	CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-6 CITH-W-7. CITH-W-8, CITH-W-9, CITH-W-10, CITH-W-11, CITHW12, CITH-W-13, CITH-W-14
CITH-W-3	CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-6, CITH-W-7, CITH-W-8,CITH-W-9, CITH-W10, Hamdan, Sulaiman, Opex Culcherry, Nugget, Cheinova, Tutle
CITH-W-4	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6, CITH-W-7, CITH-W-8, CITH-W-9, CITH-W-11, CITH-W-2, CITH-W-14, CITH16, CITH-W-17, CITH-W-18, CITH-W-23, CITH-W-24, Hamdan, Sulaiman, Opex Culcherry, Nugget, Cheinova, Tutle
CITH-W-5	CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-7, CITH-W-7 CITH-W-8, CITH-W10, CITH-W-11, CITH-W-12, CITH-W-13, CITH-W-14, CITH-W-18, CITH-W-19, CITH-W-23, CITH-W-24, CITH-W-25, Hamdan, Sulaiman, Opex Culcherry, Nugget Cheinova, Tutle, Franquette
CITH-W-6	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6, CITH-W-7, CITH-W-8, CITH-W-9, CITH-W10, CITHW11, CITHW12, CITH-W-13, CITH-W-14, CITH16, CITH-W-17, CITH-W-18, CITH-W-19
CITH-W-7	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-6, CITH-W-7, CITH-W-8, CITH-W-9, CITH-W-11, CITH-W12, CITH-W-13, CITH16, CITH-W-17, CITH-W-18, CITH-W19, CITH-W-23
CITH-W-8	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 ,CITH-W-6, CITH-W-7, CITH-W-8, CITH-W-9, CITH-W-11, CITH-W12, CITH-W-13, CITH16, CITH-W-17, CITH-W-18, CITH-W 19, CITH-W-23
CITH-W-9	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6, CITH-W-7. CITH-W-8, CITH-W-9, CITH-W10, CITHW11, CITHW12, CITH-W-13, CITH-W-14, CITH16, CITH-W-17, CITH-W-18, CITH-W-19, CITH-W-23, CITH-W-25, CITH-W-26, CITH-W-27, CITH-W-31
CITH-W-10	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6, CITH-W-7, CITH-W-8, CITH-W-9, CITH-W10, CITHW11, CITHW12, CITH-W-13, CITH-W-14, CITH16, CITH-W-17, CITH-W-18

Saffron improvement

Under saffron improvement programme, a total of 32 elite saffron clones were evaluated for economic traits such as fresh weight of pistil, dry weight of pistil, stigma/style length and weight. Based on performance, a total of fifteen best clones having high saffron yield/hectare were identified. They include CITH-125 (4.86 kg/ha), CITH-123 (4.92 kg/ha), CITH-124 (4.74 kg/ha), CITH-122 (4.74 kg/ha), CITH-12 (4.86 kg/ha), CITH-121 (4.29 kg/ha), CITH-107 (4.34 kg/ha), CITH-120 (4.68 kg/ha), CITH-104 (4.56 kg/ha), CITH-117 (4.12 kg/ha), CITH-112 (4.62 kg/ha), CITH-113 (4.56 kg/ha), CITH-106 (4.44 kg/ha), CITH-101 (4.26 kg/ha) and CITH-3 (4.26 kg/ha), having higher saffron yield in their initial planting year. All the clones are maintained in field and are being multiplied for further utilization. During survey of saffron growing areas of valley, eight more clones were identified based on number of flowers per plant, stigma/pistil length, weight, corm multiplication rate and planted in field for further evaluation.

Development of superior cultivars/hybrids in temperate fruits through conventional and non conventional methods

Evaluation of F1 seedlings and hybridization in apple

The hybrid progeny of F1 seedlings were evaluated on the basis of morphological and chemical composition. Hybrid seedlings of Ambri x Snow Drift, Golden Delicious x Silver Spur, Ambri x Granny Smith and Golden Delicious x Top Red have very low stomata density (Table 5). During the year hybridization was carried out on 25 different cross combinations and few combinations like Red Spur x Prima and *M. floribunda* x Summer Red resulted in high fruit percentage of 60 & 56.66, respectively (Table 6).

Table 5. Evaluation of hybrid seedlings of apple for various traits

Cross combination	Leaf pH value	Stomata count	Tree habit	Tree vigour	Leaf pubescence
Starkrimson x Gold Spur	5.20	16.0	Spreading	Vigrous	Present
Golden Delicious x Oregon Spur	5.66	20.0	Upright	Intermediate	Present
Ambri x Top Red	5.74	24.0	Spreading	Intermediate	Present
Ambri x Mollies Delicious	5.99	24.0	Upright	Extremely vigrous	Present
Golden Delicious x Mollies Delicious	5.71	18.6	Spreading	Vigrous	Present
Red Delicious x Mollies Delicious	5.71	21.3	Upright	Vigrous	Absent
Red Delicious x Granny Smith	5.46	22.0	Upright	Weak	Present
Jonica x Oregon Spur	5.70	16.6	Spreading	Weak	Absent
Golden Delicious xTop Red	5.99	14.0	Extremely Upright	Intermediate	Present
Golden Delicious x Gala Mast	5.48	19.0	Upright	Weak	Absent
Golden Delicious x Cooper IV	5.91	24.0	Extremely Upright	Vigrous	Absent
Ambri x Maharaji	5.91	20.0	Spreading	Extremely Vigrous	Present
Golden Delicious x Granny Smith	4.70	16.5	Upright	Extremely Vigrous	Present
Ambri x Snow Drift	5.12	14.7	Extremely upright	Vigrous	Present

Cross combination	Leaf pH value	Stomata count	Tree habit	Tree vigour	Leaf pubescence
Red Delicious x Gala Mast	5.55	24.3	Spreading	Vigrous	Absent
Ambri x Coe Red Fuji	5.57	25.0	Upright	Intermediate	Present
Golden Delicious x Red Fuji	5.56	20.0	Spreading	Vigrous	Present
Golden Delicious x Silver Spur	5.65	12.0	Upright	Vigrous	Present
Ambri x Granny Smith	5.76	15.0	Spreading	Vigrous	Absent
Golden Delicious x Gala Must	5.48	22.0	Upright	Weak	Present
Red Delicious x Silver Spur	5.77	17.0	Upright	Vigrous	Present

Table 6. Fruit set percentage in different intervarietal crosses in apple.

Cross Combination	Fruit set (%)	Cross Combination	Fruit set (%)
Ambri X Summer Red	45.45	American Apirouge X Vista Bella	21.73
American Apirouge X *M. floribunda*	33.33	Ambri X Red Spur	53.33
M. floribunda X Prima	26.66	Ambri X Vista Bella	29.41
M. floribunda X Vista Bella	7.5	Ambri X *M. floribunda*	19.04
M. floribunda X Well Spur	12.72	Mollies Delicious X Prima	10.71
Red Spur X *M. floribunda*	20.00	*M. floribunda* X Summer Red	56.66
Red Spur X Prima	60.0	Mollies Delicious X Americian Apirouge	5.00
Red Spur X Summer Red	16.66	*M. floribunda* X American Apirouge	43.75
Red Spur X Vista Bella	13.33	Mollies Delicious X *M. Flori bunda*	30.00
Well Spur X *M. floribunda*	2.22	Mollies Delicious X Summer Red	34.61
Well Spur X Prima	28.00	Mollies Delicious X Well Spur	28.00
Well Spur X Summer Red	8.33	Ambri X Prima	52.94
Well Spur X Vista Bella	15.38		

Cross compatibility studies in olive

In olive, cross compatibility studies were were carried out to determine the pollen donors for six major olive cultivars besides blooming period, pollen viability, types of flowers, self pollination and open pollination studies. Among different cross combinations highest fruit set were recorded in combinations as Frontoio x Picholine, Frontoio X Leccino, Cipressino X Leccino, Leccino X Picholine, Coratina X Frontoio, Coratina X Picholine, Coratina X Messenese, Picholine X Leccino and Pendolino X Coratina. In open pollination conditions, maximum fruit set was recorded in Pendolino however in self pollination Picholine showed highest fruit set. Maximum fresh pollen viability was recorded in Frontoio and hermaphrodite flowers in Coratina. In all cultivars, blooming period also overlapped indicating chances of cross pollination with compatible cultivars.

Cross pollination operation in olive

Rooting of MM-111 as affected by bio-regulators and physiological maturity under *in vitro* condition

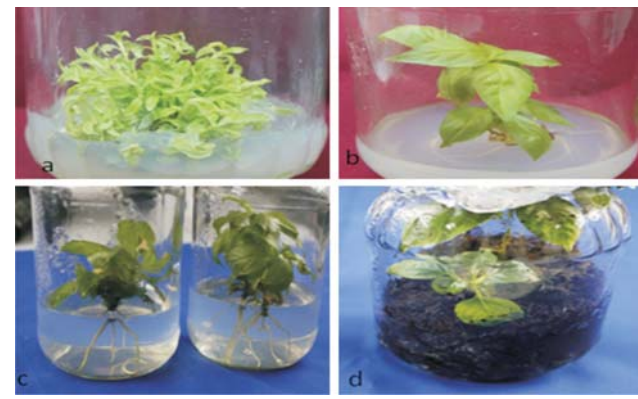
In this study explant of MM 111 was collected from forced shoots under culture room environment and established in MS media supplemented with BAP (0.5 mg/L) + IBA (0.1 mg/L). After establishment of the explants, elongation and subsequent proliferation was achieved in MS media supplemented with BAP (0.5 mg/L) + IBA (0.1 mg/L) + Kinetin (0.5 mg/L) for production of micro-shoots. Micro-cuttings were collected from proliferated micro-shoot culture at different intervals 3, 6 and 9 weeks after the date of inoculation of the elongated shoots in the proliferation media. The initial observation showed that the higher concentration of IBA (6 mg/L) alone or in combination with NAA (1 or 2 mg/L) induced early and more callus and poor rooting. Micro-cuttings taken after 6 weeks growth stage were found to be physiologically better responsive to rooting in comparison to 9 and 3 week growth stage. Plantlet length, leaf number and leaf area were better in combination treatment of 6 week old micro cuttings subjected to 3 mg/L IBA or 3 mg/L IBA + 1 mg/L NAA.

To study the effect of antioxidants namely ascorbic acid, Dithiothreitol (DTT) and humic acid on root initiation and successive root and plant let growth was examined. Ascorbic acid at the concentration of 0.25 or 0.25mM/L induced early rooting, however, callus intensity was comparatively higher (1.8-2.5 score) than the other treatments. Though, percent rooting (90.5-96.4%), number of roots/shoot (8.3-8.6) and root length (6.0-6.4 cm) were satisfactory. DTT at 0.25 concentration was very much effective in minimizing callus intensity (1.0 score), percent rooting (96.7%), number of root/shoot (10.5) and root length (7.8 cm). Humic acid at concentration of 1.0 mg/L was beneficial for percentage of rooting (95.0%), root length (8.0 cm), plant let length (6.0 cm), number of leaves (23.0) and leaf area (5.5 cm^2). Performance of plants which were subjected to bio regulator treatments was improved in terms of plant height, leaf area and % survival.

Effect of different concentration of auxins on rooting behaviour

Development of fast and efficient micro-propagation protocol in cherry root stocks

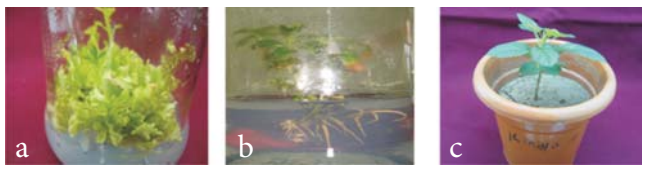
Cherry root stock Mazzard was used for development of fast and efficient micropropagation protocol. Shoot tips and meristem were used as an initial explants and the sterilized plant material was transferred on the MS basal medium, supplemented with different concentrations of BAP+ IBA, BAP + GA_3 and IBA + NAA. Medium containing BAP @ 2mg/l + IBA @1mg/l proved to be best medium for initial establishment. Maximum number of shoot (32) and length of shoots (10 cm) was observed on MS media supplemented with BAP (2 mg/l) + GA_3. Maximum number of roots and highest length of roots was obtained on MS media containing NAA + GA_3. Rooted plants showed very good survival rate on hardening media i.e. cocopeat. Humidity during hardening was maintained by low cost poly cover. Low temperature and low light intensity was also maintained during hardening to improve survival of the plants. Plants will be transferred after step wise exposure to high temperature, high light intensity and low humidity.



Micro-propagation of cherry clonal root stock Mazzard. (a)Shoot multiplication (b) elongation (c) rooting and (d) hardening

In-vitro shoot multiplication and hardening of apple root stock MM-106

Apple clonal root stock MM-106 was used for development of an efficient shoot multiplication and hardening protocol. Shoot multiplication was done on MS media supplemented with BA and kinetin @ 0.5 mg/l. Elongation was done on same media with modifications in salt concentrations. Elongated shoots were rooted on MS media supplemented with 2 mg/l IBA. Hardening of rooted plants is in progress. Hardening is being done on cocopeat, vermiculite, perlite, sand and soil combinations. However promising results were observed on cocopeat supplemented with ¼ strength of MS liquid culture.



Shoot multiplication (a), rooting (b) and hardening (c) of apple root stock MM-106

Apocarotenoid gene expression in *in-vitro* developed stigma like structures in *Crocus sativus* L.

Stigma Like Structures (SLS) were produced under *in-vitro* conditions. Highest response was observed with half ovaries on G-5 media supplemented with different combinations of phytohormones. The relative quantification through real time PCR for expression of apocarotenoid genes like *CsBCH* and *CsGT*-2 revealed that there is increase in expression from callus to SLS development. Expression pattern of *CsBCH* and *CsGT*-2 was also studies in different flower parts and highest expression was found in stigma followed by SLS, style and tepal (Fig. 8). Expression of the regulatory genes responsible for biosynthesis of apocarotenoids viz crocin, picrocrocin and safranal is getting upregulated in SLS in saffron hence revealing that these structures are developmentally closely related to natural stigma. Callus tissue was used as negative control and it does not show any expression of apocarotenoid biosynthesis gene. The biosynthesis of apocarotenoids by quantifying crocin, safranal and picrocrcin through HPLC analysis was observed and SLS showed significantly higher levels of apocarotenoid content than callus, style and petals. Thus the study revealed that these structures have higher potential for apocarotenoid biosynthesis and can have great industrial application.

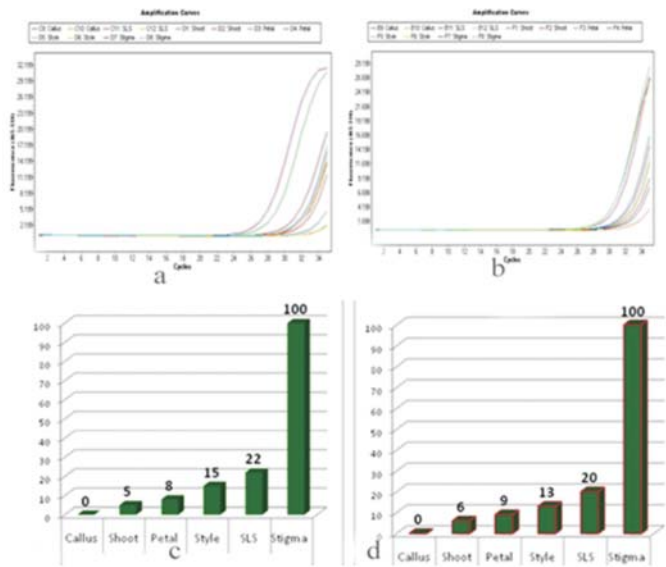


Fig 8: Real Time PCR analysis showing amplification curves of *CsBCH* (a) and *CsGT2* (b) in callus, shoot, petal, style, SLS and stigma tissues. Relative gene expression for *CsBCH* (c) and *CsGT2* (d) between callus, shoot, petal, style, SLS and stigma tissues.

II. Crop Production and Propagation

Large scale multiplication of quality planting material and seeds of temperate horticultural crops

For enhancing the availability of elite germplasm of fruit crops to the farmers about 7.0 lakh bud wood of elite varieties of apple, pear, peach, plum, cherry, walnut, almond, apricot were produced for distribution while a total of 64692 clonal root stock of apple, pear, cherry and seedling root stocks of almond, apricot and walnut were produced for multiplication of elite clones of temperate fruits. About 61236 grafted plants of elite varieties of apple, strawberry, pear, peach, plum, almond, apricot and cherry etc were produced and distributed to farmers and Govt. agencies. In vegetables, a total quantity of 650 kg breeder seed, 4.58 kg hybrid seeds and 1.28 lakh vegetable seedlings were produced and supplied to farmers, seed growers and line departments.

Low cost polyhouse propagation of walnut

Influence of budding methods, environment and budding dates on walnut propagation.

Different budding methods (chip, patch and annular) were compared under controlled and field conditions using different timing in walnut. Bud take percentage was affected by different methods of budding and timings under both the conditions with different timings. The highest bud take of 91.10, 73.33 and 71.10% was recorded under controlled conditions through patch budding on 15th of July, annular budding on 15th June and chip budding on 15th May respectively. Similarly chip budding on 15th May, patch and annular budding on 15th July gave maximum bud take under open conditions. However highest budding success (51%) was recorded with patch budding on 15th July under net house conditions (Table 7). The result indicates that controlled temperature (25-28^{0}C) and optimum humidity (80-85%) in net house improves the budding success. However the high light intensity and day time temperatures and low humidity during May and June caused poor budding success in the field experiment.

Grafted plants of cherry

Almond seedlings ready for budding

Grafted plants of apple

Table 7: Influence of budding methods under two environmental conditions with different dates in walnut.

Treatments	Bud take (%)	Budding success (%)	Plant height (cm)
Chip Budding X Open field X15th May	66.66	39.99	137.33
Chip Budding X Open field X15th June	59.99	37.77	104.66
Chip Budding X Open field X15th July	53.33	28.88	136.33
Chip Budding X Open field X15th Aug	53.33	26.66	146.33
Chip Budding X Net House X15th May	71.10	33.33	131.33
Chip Budding X Net House X 15th June	62.21	35.55	137.33
Chip Budding X Net House X15th July	59.99	35.55	173.00
Chip Budding X Net House X15th Aug	55.10	33.33	172.33
Patch Budding X Open field X15th May	75.55	33.33	121.33
Patch Budding X Open field X15th June	66.66	35.55	126.33
Patch Budding X Open field X15th July	86.66	44.44	192.66
Patch Budding X Open field X15th Aug	57.77	39.99	129.66
Patch Budding X Net House X15th May	62.22	43.44	134.66
Patch Budding X Net House X 15th June	73.33	39.99	147.66
Patch Budding X Net House X15th July	91.10	51.10	151.33
Patch Budding X Net House X15th Aug	73.33	48.88	145.00
Annular Budding X Open field X15th May	51.10	15.22	140.00
Annular Budding X Open field X15th June	53.33	19.66	150.33
Annular Budding X Open field X15th July	62.22	33.33	141.66
Annular Budding X Open field X15th Aug	51.10	24.44	99.00
Annular Budding X Net House X15th May	55.55	26.66	144.00
Annular Budding X Net House X 15th June	73.33	24.44	157.33
Annular Budding X Net House X15th July	62.22	22.9	105.33
Annular Budding X Net House X15th Aug	44.44	21.55	151.00
CD at 5%	*8.87*	*9.11*	*12.54*

Effect of grafting methods, time and varieties on grafting success and plant growth in walnut

To standardize the efficient propagation techniques in walnut, two grafting techniques i.e. wedge and tongue grafting were evaluated with three different dates i.e. 15th Feb, 1st March and 15th March on five different varieties (CITH-Walnut-1, CITH-Walnut-2, CITH-Walnut-3, Sulaiman and Opex Culcherry). Wedge grafting on 15th March with CITH-Walnut-1 (Table 8) recorded highest sprouting (96.67%) with grafting success of 86.67% indicating that the success of graft take is genotype dependent. The better maturity and quality of the scion, which contain higher soluble sugars, starch and C:N ratio also lead to higher grafting survival percentage.

Table 8: Effect of grafting methods, time and varieties on sprouting graft success and plant growth.

Treatments	Sprouting %	Grafting success (%)	Plant height (cm)
Wedge Graftingx15th Feb x CITH-W-1	50.00	46.67	139.33
Wedge Graftingx15th Feb x CITH-W-2	63.33	56.70	125.33
Wedge Graftingx15th Feb x CITH-W-3	53.33	50.00	133.00
Wedge Graftingx15th Feb x Sulaiman	53.33	40.00	158.66
Wedge Graftingx15th Feb x Opex Culcherry	26.67	23.33	127.66
Wedge Graftingx 1st March x CITH-W-1	66.67	56.67	168.33
Wedge Graftingx 1st March x CITH-W-2	73.33	63.33	158.33
Wedge Graftingx 1st March x CITH-W-3	76.67	60.00	148.33
Wedge Graftingx 1st March x Sulaiman	40.00	36.70	172.66
Wedge Graftingx 1st March x Opex Culcherry	66.67	60.00	111.33
Wedge Graftingx 15th March x CITH-W-1	96.6	86.67	174.66
Wedge Graftingx 15th March x CITH-W-2	93.33	83.33	171.00
Wedge Graftingx 15th March x CITH-W-3	90.00	76.70	163.00
Wedge Graftingx 15th March x Sulaiman	60.00	53.33	147.66
Wedge Graftingx 15th March x Opex Culcherry	90.00	73.33	99.66
Tongue Graftingx15th Feb x CITH-W-1	63.33	53.33	133.00
Tongue Graftingx15th Feb x CITH-W-2	73.33	70.00	108.66
Tongue Graftingx15th Feb x CITH-W-3	53.33	46.70	149.33
Tongue Graftingx15th Feb x Sulaiman	60.00	46.70	150.00
Tongue Graftingx15th Feb x Opex Culcherry	33.33	30.00	131.66
Tongue Graftingx1st March x CITH-W-1	73.33	56.67	171.00
Tongue Graftingx1st March x CITH-W-2	80.00	63.33	141.00
Tongue Graftingx1st March x CITH-W-3	70.00	56.70	158.00
Tongue Graftingx1st March x Sulaiman	43.33	43.33	122.00
Tongue Graftingx1st March x Opex Culcherry	76.67	50.00	115.33
Tongue Graftingx15th March x CITH-W-1	80.00	63.33	151.33
Tongue Graftingx15th March x CITH-W-2	83.33	66.70	146.33
Tongue Graftingx15th March x CITH-W-3	73.33	66.70	140.00
Tongue Graftingx15th March x Sulaiman	73.33	53.33	141.33
Tongue Graftingx15th March x Opex Culcherry	53.33	30.00	115.33
CD at 5%	*1.16*	*1.22*	*14.08*

Effect of rootstock and scion girth on grafting success of walnut under controlled conditions.

To standardize the most suitable root stock and scion girth, an experiment was carried out with 3 different root stock girths i.e. 25-30 mm, 20-25 mm and 15-20 mm and three different scion girths i.e. 15-20 mm, 10-15 mm, 5-10 mm. Among the root stock and scion girths, A1B1 recorded the highest graft success (93.3%) and plant height (150.3 cm) followed by A1B2 (83.3%). However, the minimum graft success was recorded in A3B2 (44.4%). The

results indicated that use of healthy strong stocks (25-30 mm)and fully developed plump scions (15.20 mm) are best and key to higher grafting success and further plant growth in walnut (Table 9).

Table 9: Effect of rootstock and scion girth on grafting success and plant height of walnut under controlled conditions

Treatment Combinations	Sprouting %	Grafting success %	Plant height (cm)
(T1) A1B1	96.7	93. 3	150.33
(T2) A1B2	90.0	83. 3	136.66
(T3) A1B3	83.3	76. 7	147.00
(T4) A2B1	83. 3	83. 3	135.00
(T5) A2B2	93. 3	73. 3	119.00
(T6) A2B3	93. 3	70. 0	113.00
(T7) A3B1	66. 7	55. 2	142.33
(T8) A3B2	50. 0	44. 4	118.66
(T9) A3B3	66. 7	50. 0	116.66
CD at 5%	*3.91*	*4.12*	*4.912*

I) Rootstock Girth
A_1 = 25 – 30 mm
A_2 = 20 – 25 mm
A_3 = 15 – 20 mm

II) Scion Girth
B_1 = 15 – 20 mm
B_2 = 10 – 15 mm
B_3 = 05 – 10 mm

Walnut propagation under controlled conditions

Standardization of efficient propagation techniques in pome and stone fruits

To standardize propagation techniques for higher percentage success, chip budding technique was practised in apple and pear at 15 days interval. The results revealed that in apple 54.75% budding success was recorded and more than 74% plants were available for sale during 3rd week of March when chip budded in third week of March. Similarly, chip budding in stone fruit also had significant effect on different budding success. Highest budding success was noted in peach (59.0%) with maximum proportion of saleable plants when budding was done in 3rd week of March.

Response of different clonal rootstock cuttings and IBA on rooting in apple

Rooting response was studied in cuttings of clonal rootstocks. The cuttings having 6-8 buds resulted in highest rooting. Type of rootstock, bud numbers and IBA concentration also had significant effect. M-26 clonal root stock with 8 buds/ cutting in 2000 ppm IBA concentration resulted in highest rooting percentage (68%) with best root quality followed by MM 111 (64.80%).

Profuse rooting in MM-111 at 2000 ppm IBA

Chip budding time and height as determining factors for bud take and successive plant growth under Uttarakhand conditions

Chip budding of cv. Starkrimson on crab apple seedling gave higher percentage of success in the month of February-March, July-August and

September-October (81.2 -95.3%) irrespective of grafting/budding height, whereas, tongue grafting and wedge grafting gave 82.6 and 86.0% during February-March. The T-Budding gave 79.6% during June-July at 8-10 cm grafting/budding height. Chip budding on apple clonal rootstock M 9 gave 95.9, 91.2 and 94.8% success in February-March, June-July and September-October, respectively at budding height of 8-10 cm. Wedge grafting in February-March also gave higher graft (88.7%), followed by tongue grafting (84.1%) during February-March and T-budding (81.3%) during June-July. Apple plant height ranged from 81.5-144.9 cm on seedling rootstock and 71.6-120.3 cm on M9 (dwarf) rootstock. Chip budding resulted in higher success with respective values of 93.6, 91.7 and 91.5% in pear 94.2, 93.1 and 90.6% in peach during February-March, June-July and September-October respectively at 8-10 cm height. Plant height of pear and peach was in the range of 77.4-139.9 cm and 94.1-138.7 cm respectively. Chip budding in apricot gave 90.4, 86.9 and 85.9% graft/bud success in February-March, July-August and September-October, respectively; with a plant height range of 73.4-142.8 cm. Similarly in case of almond, chip budding during February-March, June-July and September-October gave 89.6, 84.3% and 82.2% respectively at 8-10 cm budding height. Whereas, chip budding on walnut seedling gave higher success only during February-March with bud take of 83.1 and 77.9% at 8-10 cm and 13-15 cm budding height respectively. Tongue grafting gave (73.2 and 68.4%) and wedge grafting (77.8 and 74.8%) during February-March at 8-10 cm and 13-15 cm budding height. Patch budding in walnut during July-August gave only 28.2% success. Grafted/budded almond plants attained plant height of 77.3-135.8cm, whereas, walnut plant attained plant height in the range of 40.3-118.4 cm. Plant diameter at graft/bud union, below graft/bud union and above graft/bud union was also better particularly in the grafting/budding season which resulted in better graft/bud take and plant growth under polyhouse conditions.

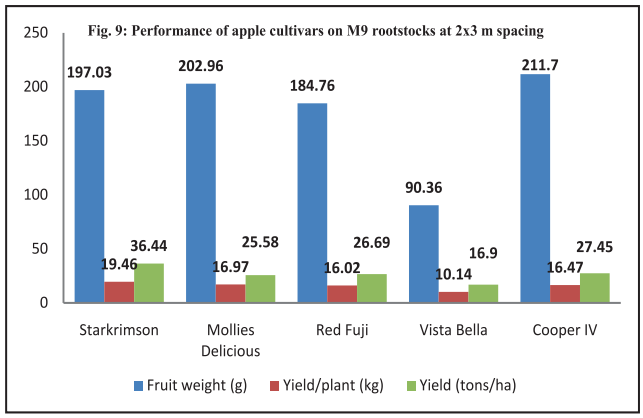
Chip budding in peach

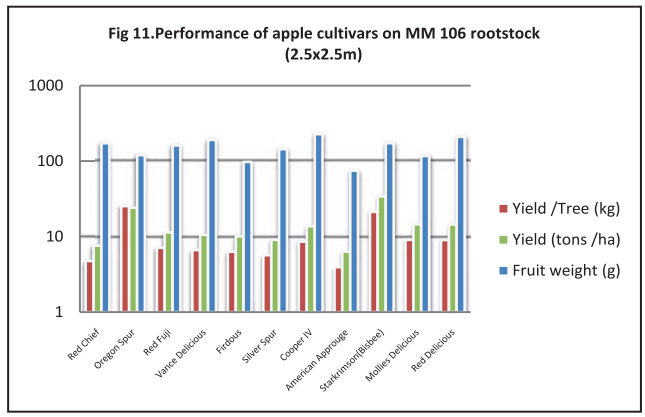
Chip budding in walnut

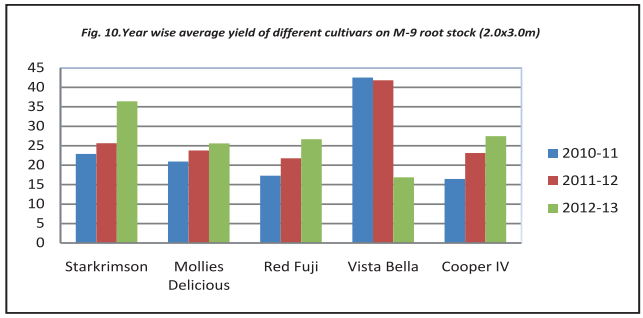
Standardization of medium, medium-high and high density orcharding in temperate fruits

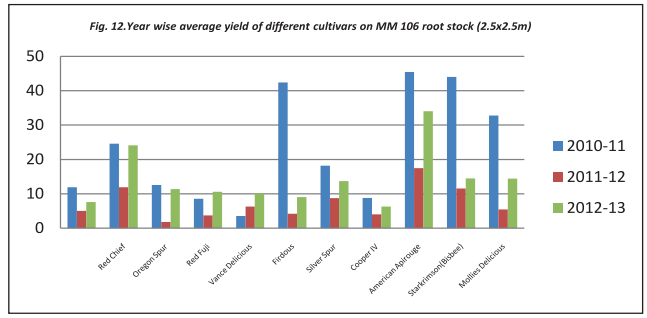
Standardization of medium, medium-high and high density orcharding in apple

In evaluation of 5 cultivars on M9 root stock planted at 2.0x3.0 m spacing, maximum yield (36.44 t/ha) was recorded in Starkrimson while minimum (16.90 t/ha) in Vista Bella (Fig 9). Highest yield efficiency of 0.42 kg/cm^2 was recorded in cultivar Cooper IV followed by 0.3kg/cm^2 in cultivar Starkrimson and Mollies Delicious. The cumulative yield of previous three years (Fig. 10) however indicate that cultivar Vista Bella surpassed all the cultivars with average yield of 33.75 t/ha followed by Starkrimson (28.32t/ha).









Similarly the results of 11 apple cultivars planted at MM106 root stock at a spacing of 2.5x2.5 m, the maximum yield was recorded in cultivar Starkrimson (34.05t/ha) followed by Oregon Spur (24.12t/ha) while minimum yield (6.30t/ha) was recorded in American Apirogue (Fig.11). In cumulative yield of previous three years, maximum yield was recorded in cultivar Starkrimson (32.34 t/ha) followed by Oregon Spur and minimum in cultivar American Apirogue (Fig. 12)

In another study of eight apple cultivars on MM 106 planted at 2.5x3.5 m spacing, the cultivar Starking Delicious (67.73 t/ha) surpassed other cultivars followed by Red Chief and Starkrimson and minimum yield of 11.90 t/ha was recorded in cultivar Lal Ambri (Table 10). Similar trend was observed in the cumulative yield of three years and Starking Delicious was found best.

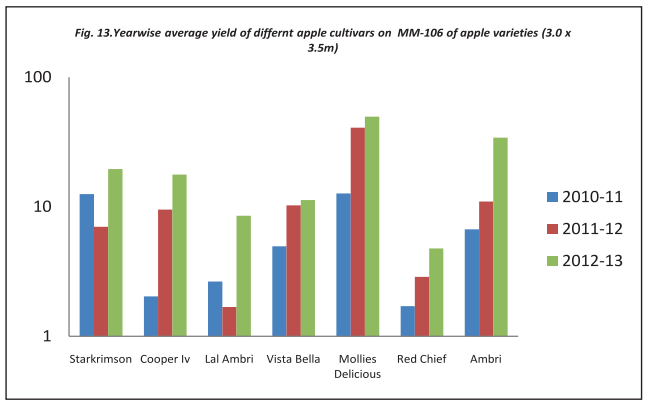
Table 10: Yield and quality attributes of apple cultivars on MM-106 (2.5 x 3.5m)

Variety	Fruit weight (g)	Yield /Tree (kg)	Yield (t/ha)	Trunk circum-ference (cm)	TCA (cm^2)	Yield efficiency (kg/cm^2)
Starkrimson	136.93	50.85	46.69	28.66	67.30	0.57
Mollies Delicious	113.76	19.65	18.63	38.33	117.81	0.13
Cooper IV	228.10	29.25	33.43	25.00	49.87	0.58
Lal Ambri	198.73	11.08	11.90	25.33	51.81	0.20
Vista Bella	50.33	15.34	17.53	31.33	78.22	0.19
Red Chief	173.27	49.99	50.66	26.33	58.20	0.84
Starking Delicious (Royal Delicious)	157.86	59.26	67.73	29.33	69.73	0.92
Ambri	187.46	23.05	26.35	30.66	75.36	0.31
CD at 5%	*28.40*	*16.75*	*20.56*	*7.61*	*36.67*	*0.31*

In another spacing of 3.0x3.5 m, cultivar Mollies Delicious yielded 49.65 t/ha while lowest yield of 4.76t/ha was recorded in Ambri (Table 11). The cumulative maximum average yield of 34.34 t/ha was recorded in Mollies Delicious and minimum (4.28 t/ha) in Lal Ambri (Fig. 13).

Table 11: Yield and yield related characters of apple cultivars after 9-10 years on MM-106 (3.0 x 3.5m).

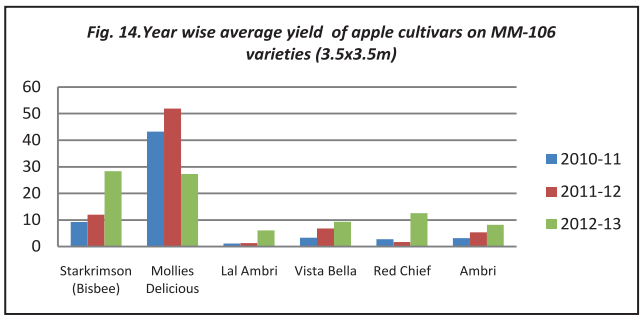
Variety	Fruit weight (g)	Yield /Tree (kg)	Yield (t/ha)	Trunk circum-ference (cm)	TCA (cm^2)	Yield efficiency (kg/cm^2)
Starkrimson	116.63	20.58	19.56	29.66	70.45	0.29
Cooper Iv	227.93	18.59	17.70	27.33	59.92	0.32
Lal Ambri	217.43	8.98	8.52	29.33	68.73	0.13
Vista Bella	50.33	11.86	11.27	38.00	115.10	0.09
Mollies Delicious	183.76	52.15	49.65	31.33	78.97	0.71
Red Chief	173.26	35.83	34.11	28.00	62.57	0.57
Ambri	124.30	5.01	4.76	34.66	96.68	0.05
CD at 5%	*23.54*	*11.28*	*10.74*	*5.83*	*29.31*	*0.27*



In another study of six cultivars on MM 106 planted at 3.5x3.5 m spacing, the cultivar Starkrimson surpassed other cultivars with the yield of 28.32 t/ha followed by Mollies Delicious (27.30 t/ha) and minimum yield (6.10t/ha) was recorded in cultivar Ambri (Table 12). Similar trend was observed in the cumulative yield of three years and Mollies Delicious was found to be best with the yield of 40.82 t/ha (Fig. 14).

Table 12: Yield and quality attributes of apple cultivars on MM-106 (3.5x3.5m)

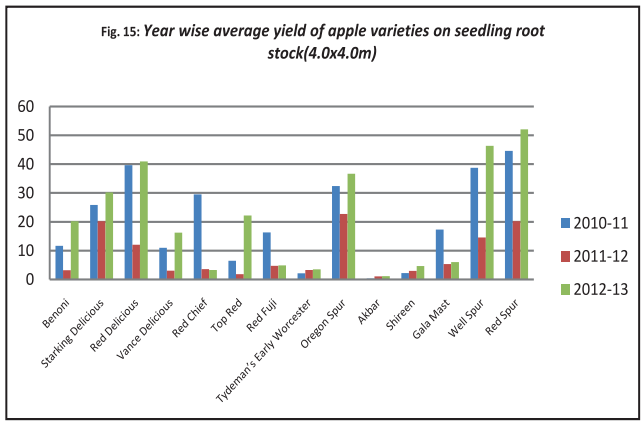
Variety	Fruit weight (g)	Yield /Tree (kg)	Yield tons/ha	Trunk Girth (cm)	TCA (cm^2)	Yield efficiency (kg/cm^2)
Starkrimson (Bisbee)	173.13	22.46	28.32	20.66	34.31	0.72
Mollies Delicious	117.10	33.45	27.30	36.33	105.56	0.34
Lal Ambri	216.60	7.56	6.10	26.66	56.58	0.13
Vista Bella	50.33	8.86	9.29	32.66	85.54	0.08
Red Chief	173.27	15.43	12.58	22.00	38.66	0.39
Ambri	185.23	8.82	8.14	32.00	83.11	0.07
CD at 5%	*36.93*	*9.41*	*8.17*	*5.54*	*27.98*	*0.16*



The results of different apple cultivars planted at 4.0x4.0 m spacing on seedling rootstock revealed that maximum yield of 52.05 t/ha was recorded in Red Spur followed by Well Spur, Red Delicious and Oregon Spur while minimum(1.14t/ha) in Akbar (Table 13). In cumulative yield of three years, Red Spur surpassed other 11 cultivars by yielding average yield of 38.96 t/ha (Fig 15)

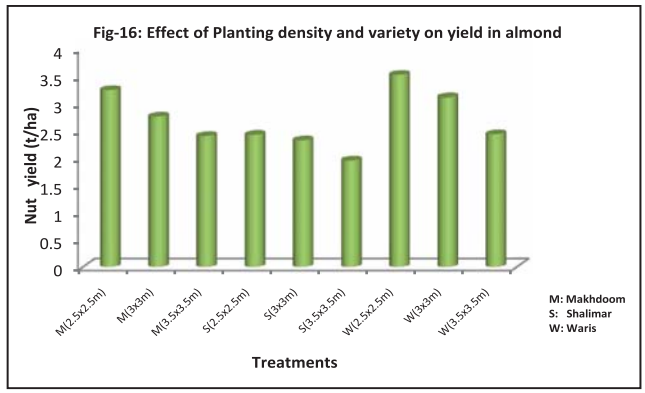
Table 13: Yield and quality attributes of apple cultivars on seedling root stock (4.0x4.0m).

Variety	Fruit weight (g)	Yield /Tree (kg)	Yield (t/ha)	TCA (cm^2)	Yield efficiency (kg/cm^2)
Benoni	46.00	2.04	20.23	138.13	0.01
Starking Delicious (Royal Delicious)	157.80	40.34	25.21	88.88	0.46
Red Delicious	200.30	73.53	45.95	115.30	0.62
Vance Delicious	191.57	20.53	16.22	99.59	0.21
Red Chief	162.13	5.29	3.30	117.12	0.04
Top Red	115.39	35.57	22.20	111.10	0.31
Red Fuji	46.00	7.84	4.89	115.56	0.06
Tydeman's Early Worcester	105.70	5.66	3.53	103.78	0.06
Oregon Spur	157.80	58.72	36.70	68.51	0.87
Akbar	200.30	1.63	1.14	63.05	0.00
Shireen	191.57	7.50	4.68	78.75	0.09
Gala Mast	162.13	9.81	6.02	70.40	0.14
Red Spur	153.00	11.87	52.05	110.69	0.37
Well Spur	126.80	12.97	46.38	113.09	0.39
CD at 5%	*19.39*	*12.59*	*12.79*	*36.12*	*0.09*



Oregon Spur at 2.5 x 2.5 m planting density

Oregon Spur at 4 x 4 m planting density



Starkrimson at 2.5 x 3.5 m planting density

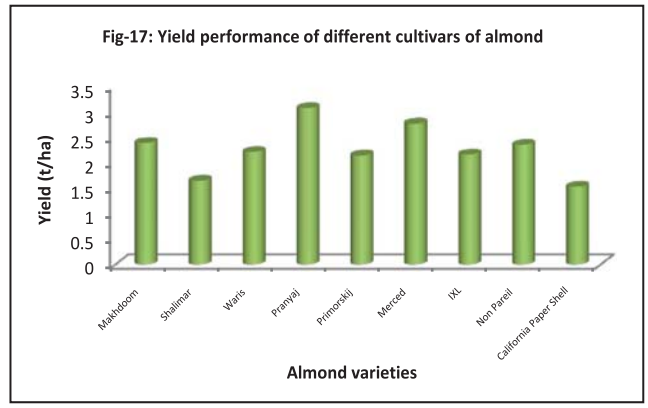
Medium high density almond plantation at 3.5x3.5 m spacing

Standardization of medium high and high density orcharding in almond on seedling rootstock

Three almond varieties (Makhdoom, Shalimar and Waris) budded on seedling root stock, planted at three densities 2.5 x 2.5m (1600 plant/ha), 3 x 3m (1111 plant/ha) and 3.5 x 3.5m (816 plant/ha) respectively were evaluated. Results of the experiment clearly indicated that mean maximum nut yield (3.24 kg/tree) was recorded in cultivar Waris at 3.5 x 3.5 m spacing. However, mean yield (3.11 t/ha) was recorded in cultivar Waris at 2.5 x 2.5 m spacing (Fig. 16) which may be due to accommodation of more plants per unit area.

Standardization of medium density orcharding in almond

Nine varieties of almond (Makhdoom, Shalimar, Waris, Non Pareil, IXL, Pranyaj, Primorskij, Merced and California Paper Shell) were evaluated at 4 x 4m spacing. Results revealed that mean maximum nut yield (3.07 t/ha) was recorded in cultivar Pranyaj (Fig. 17) followed by Merced (2.77 t/ha), Makhdoom (2.39 t/ha), Non Pareil (2.35 t/ha), Waris (2.21 t/ha) and IXL (2.16 t/ha).



Standardization of medium high and high density orcharding in peach

In high density (2.5x2.5m) plantations of peach, maximum fruit weight was recorded in cv. Gloheaven (80.19g) followed by Red Globe (72.39g), Crest Heaven (70.12g) and Fantasia (65.14g). Similarly the yield per tree (Table 14) was recorded maximum in cv. Gloheaven (22.85 kg) followed by Red Globe 18.09kg), Crest Heaven (16.82kg) and Fantasia (16.93 kg). However, under medium high density (3x3 m), maximum fruit weight and yield was recorded in cv. Gloheaven followed by Crest Heaven, Red Globe and Fantasia (Table 15). On the basis of overall performance and fruit quality of peach/nectarine genotypes having age of five years cultivars Gloheaven and Red Globe were found promising for high and medium high density plantation.

Energy harvest through plant architectural engineering for increasing source and sink relationship in apple

To harness the natural resources, different canopy management systems were tried at different spacings on M-9 root stock (Table 16). Among three cultivars trained on espalier training system resulted highest yield /plant and per hectare in cultivar Red Fuji (42.88 kg and 95.36 t/ha), whereas cultivar Granny Smith yielded fruits of bigger size (160.06 g). In Single axis and cordon training systems, cultivar Coe Red Fuji trained on single axis resulted highest yield (93.82 t/ha) followed by Granny Smith (62.66 t/ha) on single axis training system (Table17). In head and spread, modified central leader and spindle bush training system, cultivar Mollies Delicious resulted in yield of 126.33, 108.33 and 92 tons/ha respectively (Table 18).

Table.14: Evaluation of peach/nectarine varieties for higher fruit yield and better quality under high density (2.5m x 2.5 m spacing)

No. of Genotype Density 2.5x2.5m	Trunk girth (mm)	No. of fruit/ plant	Fruit wt. (g)	TSS (^{O}B)	Ascorbic acid (mg/100 g)	Yield per tree (Kg)	Yield (t/ha)
Fantasia	50.35	260	65.14	14.16	7.19	16.93	27.08
Crest Heaven	54.43	240	70.12	16.59	6.89	16.82	26.91
Red Globe	57.77	250	72.39	15.90	7.59	18.09	28.94
Gloheaven	76.06	285	80.19	16.70	6.80	22.85	36.56
CD at 5%	*4.56*	*20.36*	*11.64*	*1.34*	*0.80*	*2.68*	*1.36*

Table.15: Evaluation of peach/nectarine varieties for higher fruit yield and better quality under medium density (3m x 3 m spacing)

No. of Genotype Density 2.5x2.5m	Trunk girth (mm)	No. of fruit/ plant	Fruit wt. (g)	TSS (^{O}B)	Ascorbic acid (mg/100 g)	Yield per tree (Kg)	Yield (t/ha)
Fantasia	53.65	262	65.20	15.23	7.20	17.08	27.32
Crest Heaven	55.35	232	78.29	16.16	7.80	18.16	29.05
Red Globe	56.93	290	71.90	17.99	6.8	20.85	33.36
Gloheaven	70.22	310	80.92	16.18	6.1	25.05	40.08
CD at 5%	*4.56*	*20.36*	*11.64*	*1.34*	*0.80*	*2.68*	*3.69*

View of Espalier Training System in apple during dormancy

Coe Red Fuji in flowering on Espalier Training System

Row wise view of Coe Red Fuji laden with fruits

bearing in Oregon Spur apple after 3 years of planting in Cordon Training System

Table 16. Yield and quality attributes of apple cultivars with Espalier plant architecture system on M-9 rootstock spacing (1.5 x 3.0 m).

Cultivars	Fruit weight (g)	Yield/ plant (kg)	Yield (t/ha)	Trunk Circumference (cm)	TCA (cm^2)	Yield efficiency (kg/cm^2)	Color Intensity				
							L	a	b	hue	chroma
Coe Red Fuji	145.80	42.88	95.36	20.33	33.22	1.35	55.28	16.01	20.78	51.08	26.47
Granny Smith	160.06	19.33	43.63	15.33	18.82	0.70	61.64	-8.46	26.35	-72.16	27.64
Spartan	95.40	10.03	22.36	16.66	22.21	0.47	50.58	17.52	13.39	52.45	21.36
CD at 5%	*16.49*	*2.53*	*6.19*	*N.S.*	*N.S.*	*0.54*	*4.80*	*3.49*	*2.57*	*3.24*	*2.28*

Table 17: Yield and quality attributes of apple cultivars on different training system (0.75 X 1.5 m)

Cultivars	Fruit weight (g)	Yield/ tree (kg)	Yield (t/ha)	Trunk Circumference (cm)	TCA (cm^2)	Yield efficiency (kg/cm^2)	Color Intensity/ Kind of Colour				
							L	a	b	hue	chroma
Main effect of variety											
Coe Red Fuji (V1)	144.13	5.59	49.59	15.83	20.57	0.24	56.52	13.70	20.91	57.97	25.62
Granny Smith (V2)	149.63	4.92	43.77	13.66	15.10	0.31	63.96	-7.45	27.46	-74.1	28.65
Spartan (V3)	103.66	1.69	5.09	13.66	15.07	0.1	42.62	16.75	12.00	69.60	20.46
CD at 5%	*10.28*	*0.92*	*5.60*	*1.38*	*3.61*	*0.07*	*1.22*	*1.13*	*1.07*	*5.58*	*0.29*
Main effect of training system											
Vertical Axis (T1)	134.66	6.91	54.54	16.22	21.23	0.33	54.43	9.68	19.75	24.22	25.65
Cordon (T2)	130.28	1.22	11.09	12.55	12.59	0.10	54.31	5.65	20.49	11.40	24.17
CD at 5%	*8.39*	*0.75*	*4.57*	*1.12*	*2.95*	*0.06*	*1.00*	*0.92*	*0.87*	*4.56*	*0.23*
Interaction effect of variety and training system											
V1XT1	150.63	10.57	93.82	18.33	26.86	0.44	56.7	20.16	19.27	43.61	27.71
V1XT2	137.63	0.60	5.36	13.33	14.29	0.04	56.35	7.25	22.56	72.34	23.53
V2XT1	149.7	7.12	62.66	15.33	18.82	0.38	62.81	-7.33	28.44	-74.60	29.61
V2XT2	149.56	2.73	24.88	12.00	11.38	0.24	65.11	-7.58	26.48	-73.68	27.69
V3XT1	103.66	3.04	7.14	15.00	18.02	0.17	43.78	16.22	11.56	103.66	19.62
V3XT2	103.66	0.34	3.04	12.33	12.11	0.02	41.46	17.29	12.44	35.55	21.31
CD at 5%	*14.54*	*1.31*	*7.92*	*1.95*	*5.11*	*0.10*	*1.73*	*1.60*	*1.52*	*7.90*	*0.41*

Table 18: Evaluation of different canopy model on yield and yield associating characters in apple

Cultivars	Fruit weight	Yield/ tree (kg)	Yield (t/ha)	Trunk Circumference (cm)	TCA (cm^2)	Yield efficiency	Color Intensity				
							L	a	b	hue	chroma
Color Intensity											
Starkrimson *(V1)*	151.778	19.77	44.00	22.88	43.07	0.50	47.56	14.21	10.81	40.79	18.82
Mollies Delicious *(V2)*	151.778	48.77	108.88	24.66	49.09	1.06	41.97	24.28	18.66	36.85	30.69
Vista Bella *(V3)*	61.3333	8.00	18.44	26.11	65.71	0.39	39.59	17.58	7.78	25.93	19.15
Red Fuji *(V4)*	180.444	6.88	17.77	25.00	51.68	0.15	45.88	21.46	9.52	24.23	23.54
CD at 5%	*17.22*	*3.44*	*6.44*	*4.49*	*17.22*	*0.29*	*0.28*	*1.70*	*0.39*	*6.84*	*0.48*

Cultivars	Fruit weight	Yield/ tree (kg)	Yield (t/ha)	Trunk Circumference (cm)	TCA (cm^2)	Yield efficiency	Color Intensity				
							L	a	b	hue	chroma
Main effect of training system											
Head and spread (T1)	139.833	23.50	52.5	24.58	52.21	0.48	45.47	18.99	12.46	31.82	23.58
Modified central leader (T2)	136.5	21.75	50.41	25.25	52.50	0.58	43.51	19.34	11.54	34.49	22.73
Spindle bush (T3)	132.67	17.33	38.91	24.16	52.44	0.51	42.26	19.81	11.08	29.54	22.85
CD at 5%	*10.462*	*2.97*	*5.57*	*3.89*	*14.91*	*0.25*	*0.24*	*1.47*	*0.34*	*5.92*	*0.41*
Interaction effect of variety and training system											
V1XT1	150	22.33	49.00	25.00	50.83	0.47	48.25	11.32	11.17	37.02	18.43
V1XT2	151.667	21.33	48.00	23.33	45.12	0.54	47.91	13.67	10.81	52.00	17.53
V1XT3	153.667	15.66	35.00	20.33	33.26	0.49	46.51	17.65	10.46	33.34	20.51
V2XT1	166.333	56.33	126.33	25.66	52.95	1.13	45.14	25.57	20.25	36.12	32.61
V2XT2	146.667	48.66	108.33	23.00	42.55	1.23	41.00	24.61	18.54	37.07	30.84
V2XT3	142.333	41.33	92.00	25.33	51.77	0.83	39.79	22.67	17.21	37.38	28.62
V3XT1	55.3333	10.00	23.00	19.66	42.56	0.25	41.02	16.78	9.19	31.66	19.13
V3XT2	70	8.66	19.66	28.33	64.19	0.42	39.48	18.62	7.57	24.63	20.09
V3XT3	58.6667	5.33	12.66	30.33	90.37	0.50	38.28	17.35	6.57	21.51	18.25
V4XT1	187.667	5.33	11.66	28.00	62.52	0.08	47.49	22.32	9.25	22.5	24.16
V4XT2	177.667	8.33	25.66	26.33	58.15	0.13	45.67	20.48	9.24	24.27	22.46
V4XT3	176	7.00	16.00	20.66	34.38	0.23	44.48	21.6	10.08	25.93	24.02
CD at 5%	*20.92*	*5.95*	*11.15*	*7.79*	*29.83*	*0.51*	*0.48*	*2.94*	*0.68*	*11.85*	*0.83*

Energy harvest through plant architectural engineering for increasing source and sink relationship in peach.

Four varieties (Fantasia, Crest Heaven, Gloheaven and Red Globe) planted at two planting densities (2.5x2.5 m and 3x3 m) and trained on six training systems. In the fourth year maximum fruit set, fruit yield per tree, fruit yield/ha and fruit quality was recorded in Tatura trellis system of training at 2.5x2.5 m planting density in all the varieties (Table 19). Under 3x3m planting density, among all the varieties, maximum fruit set, fruit yield per tree, fruit yield/ha and fruit quality were recorded in four scaffold (Fantasia and Red Globe). However Gloheaven in modified center leader system and Crest Heaven in modified open center training systems gave better response (Table 20). Maximum light interception in the canopy at different heights was recorded in Tatura trellies training system followed by four scaffold system (Fig. 18a & b). Maximum marketable grade fruits in terms of fruit skin color (high a* value) recorded in Tatura trellies followed by four scaffold system (Fig. 19).

Table 19: Effects of six training system on fruit yield of peach/nectarine cultivars (2.5×2.5 m)

Training systems	Fantasia		Red Globe		Gloheaven		Crest Heaven	
	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)
Central leader	9.18	14.68	13.67	21.87	13.71	21.93	13.30	21.28
Modified center leader	10.3	16.48	11.20	17.92	11.02	17.64	16.14	25.83
Open leader	14.2	22.72	9.73	15.56	13.13	21.01	9.25	14.81
Tatura trelllies	15.00	24.00	14.75	23.6	21.10	33.76	21.74	34.78
Four scaflod	12.50	20.00	12.91	20.65	22.47	35.95	19.61	31.39
Modified open leader	12.40	19.84	7.17	11.47	12.70	20.32	10.25	16.40
CD at 5%	*2.56*	*3.98*	*2.76*	*3.76*	*2.78*	*3.10*	*2.99*	*3.23*

Table 20: Effects of six training system on fruit yield of peach/nectarine cultivars (3.0×3.0 m)

Training systems	Fantasia		Red Globe		Gloheaven		Crest Heaven	
	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)	Yield (kg/tree)	Yield (t/ha)
Central Leader	11.58	12.86	14.43	16.03	13.78	15.31	13.01	14.45
Modified Center leader	12.31	13.68	16.77	18.64	17.21	20.51	12.45	13.83
Open Leader	16.86	18.73	19.05	21.17	15.98	17.76	14.56	16.17
Perpendicular V System	9.45	10.50	7.13	7.92	8.21	9.12	8.82	9.80
Four Scaffold	13.96	15.51	15.69	17.44	10.23	11.37	14.73	16.36
Modified Open Leader	12.94	14.38	10.95	12.17	16.48	18.31	16.20	18.00
CD at 5%	*2.89*	*3.12*	*3,67*	*2.45*	*3.67*	*3.33*	*2.44*	*2.98*

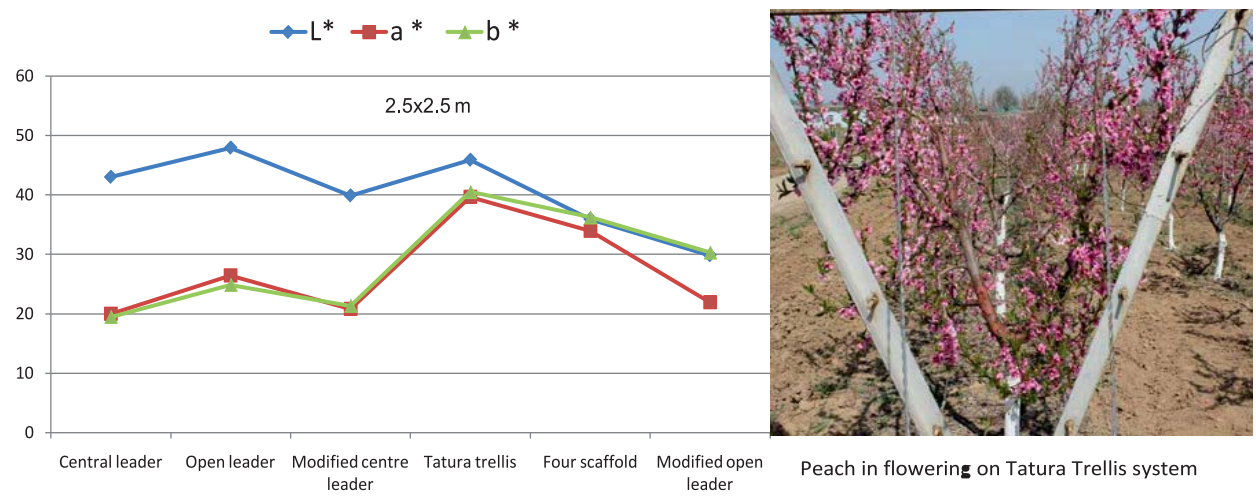


Fig. 18a. Colour intensity in different training systems

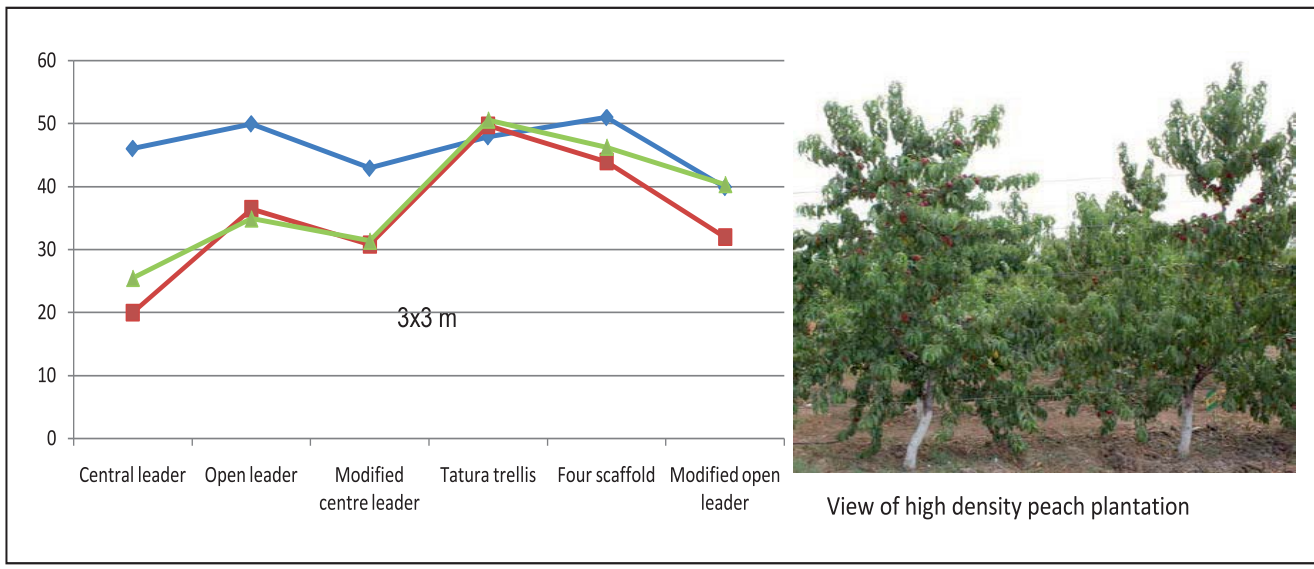


Fig. 18b. Colour intensity in different training systems

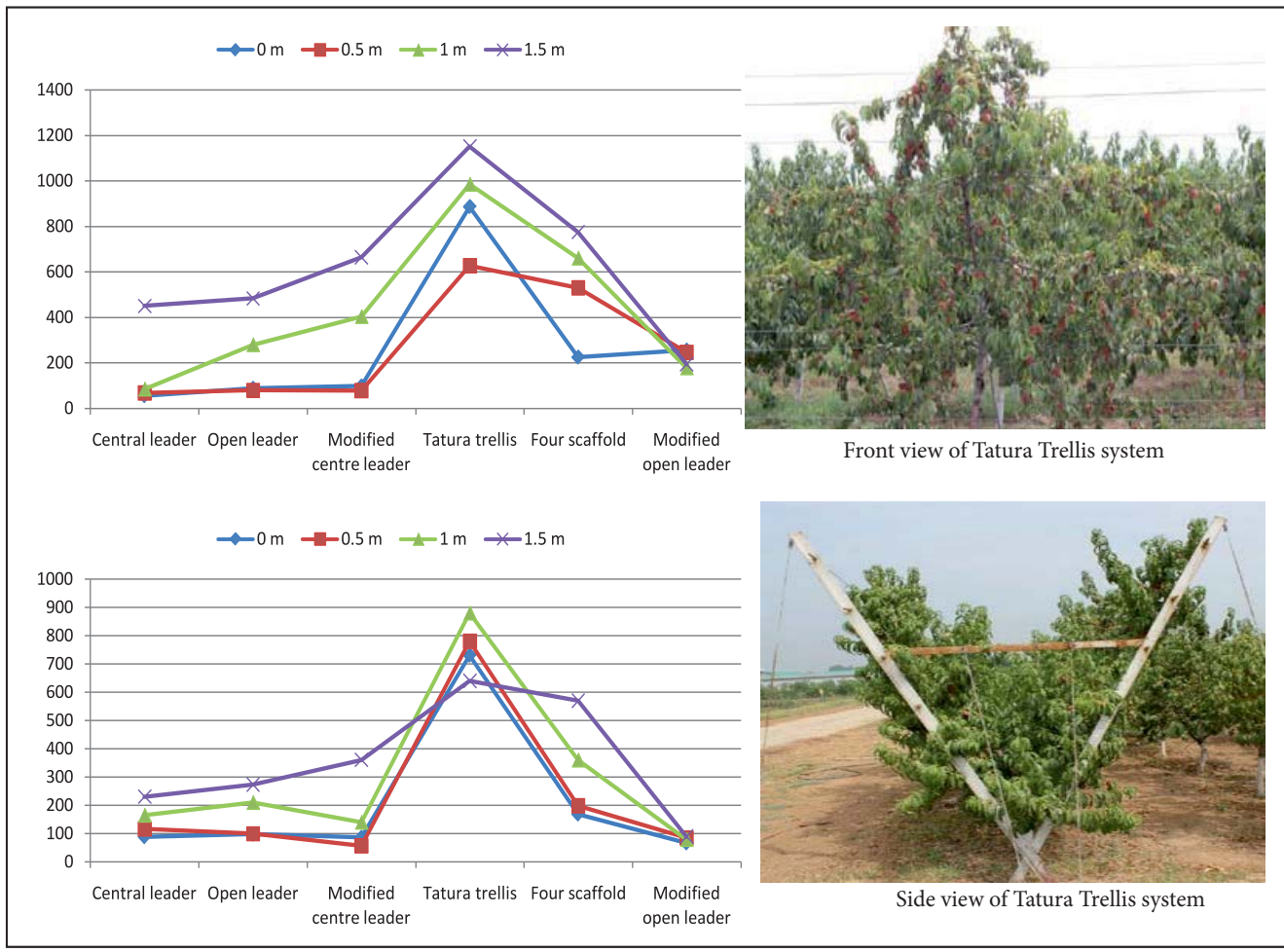
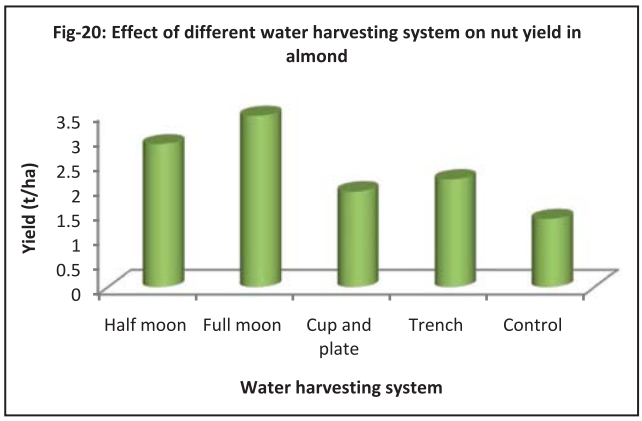


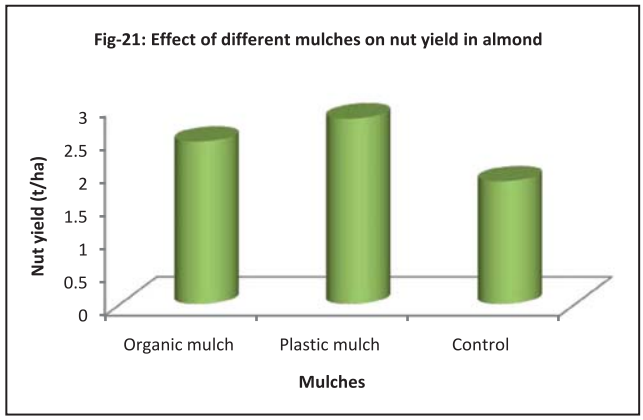
Fig. 19. Light interception and fruit color development in six planting systems in Red Globe

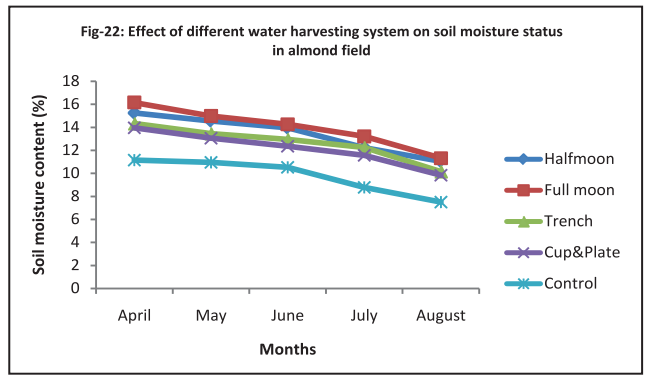
Management of frost, drought and other abiotic stresses in almond and apple in changing climate scenario

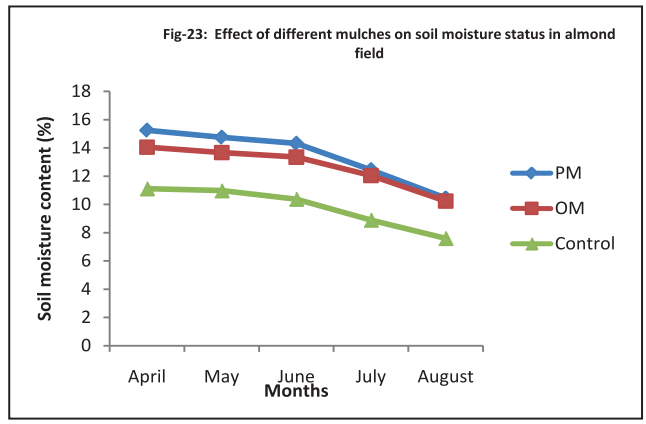
Rain water harvesting and mulching for almond production under rain fed conditions of karewa land

The experiment has been carried out for conservation and utilization of rain water under rain fed conditions for almond production. The water harvesting techniques like full moon, half moon, cup and plate and trench system alongwith different types of mulch materials were evaluated for efficient moisture conservation with control. The almond variety Non Pariel planted at a spacing of 4 m x 4 m, yielded maximum mean nut yield (3.47 t/ha) and soil moisture content (15.25 %) with full moon water harvesting system (Fig. 20 & 22). Amongst mulches, maximum nut yield (2.80 t/ha) and soil moisture content (15.11 %) were recorded in plastic mulch treated plots (Fig. 21 & 23)







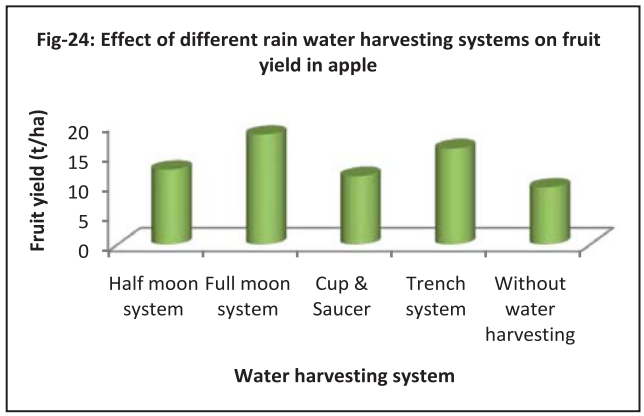


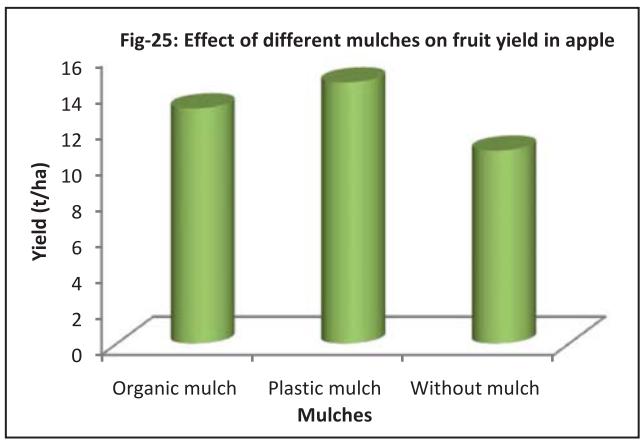
Full moon water harvesting + plastic mulch in almond

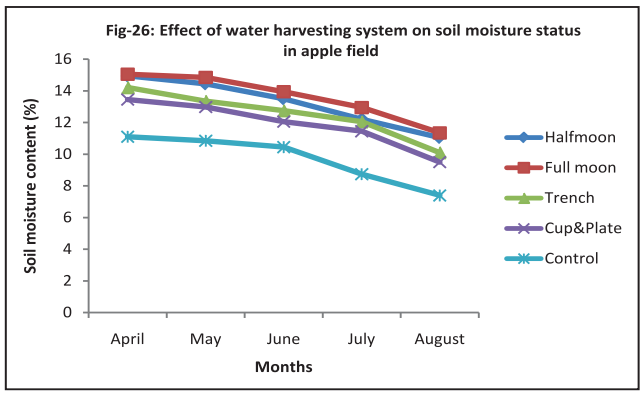
Rain water harvesting techniques in apple under rainfed condition

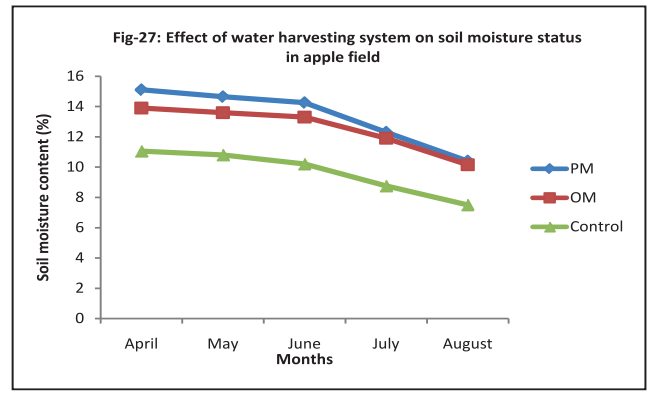
For conservation and utilization of rain water under rainfed apple production, different water harvesting techniques (full moon, half moon, cup and plate and trench system) alongwith different mulches on apple cultivar Red Chief at a spacing of 4 m x 4 m was tried. Maximum mean fruit yield

(18.29 t/ha) and soil moisture content (15.10 %) were recorded in full moon water harvesting system (Fig. 24 and 26). Amongst mulches, plastic mulch treated plots registered highest fruit yield (14.49 t/ha) and 15.05% soil moisture content (Fig. 25 and 27).





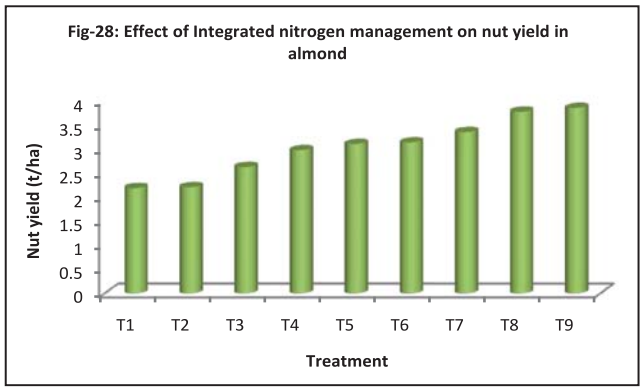


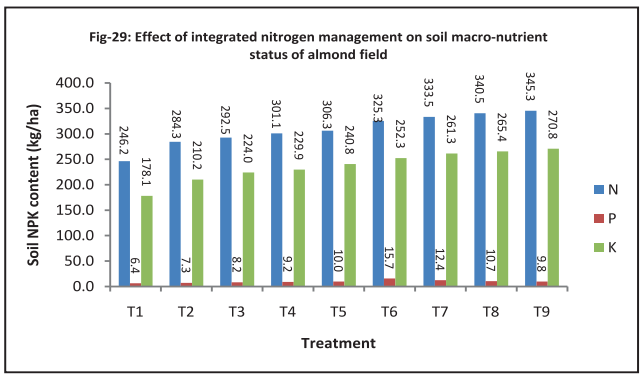


Water harvesting system in apple

Integrated nitrogen management in almond

To evaluate effect of integrated nitrogen management, fertilizers were applied as per the treatment in almond cultivar Waris. The treatment comprised of T_1-Control, T_2- 50% RDF of nitrogen, T_3- 75% RDF of nitrogen, T_4- 100 % RDF, T_5- 125% of RDF, T_6-50% RDF + 20t FYM/ha, T_7-75% RDF + 15t FYM/ha, T_8- 100% RDF + 10 t FYM/ha and 40 t FYM/ha, replicated thrice under Randomized Block Design. Maximum nut yield (3.85 t/ha) and soil NPK (Fig. 28 & 29) content (345.3 kg N, 9.8 kg P and 270.8 kg K/ha) were recorded in the treatment T9 (40 t/ha farm yard manure).

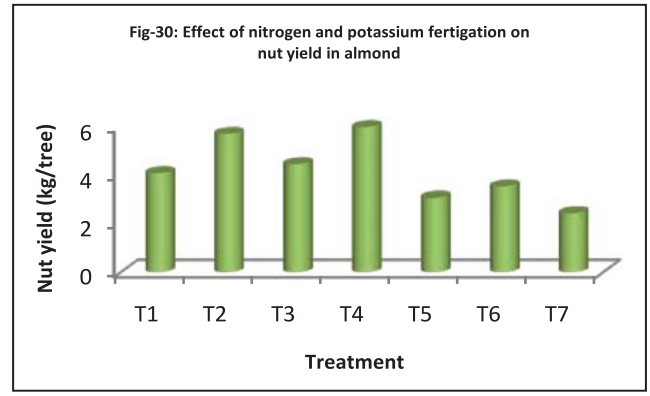




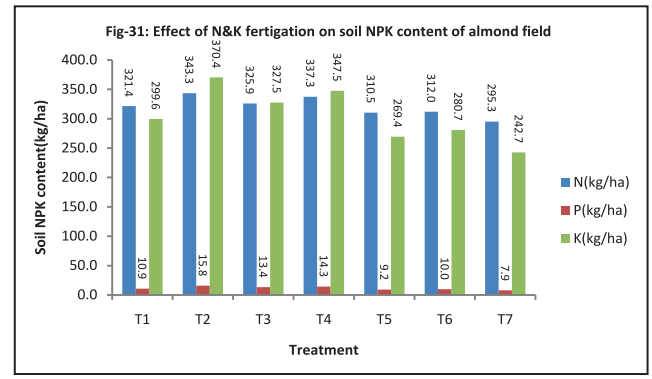
Integrated nitrogen management in almond

Fertigation studies in almond

The fertigation study was initiated during 2011 on almond cultivar Waris planted at 3m x 3m. The treatment comprised of T_1-Recommended Dose of Fertilizers (Basal application), T_2- RDF through fertigation, T_3-75% RDF through fertigation, T_4-75% RDF through fertigation (applied N:K in the ratio of 2/3 N:1/3K at nut set to nut development and 1/3 N:2/3 K at nut development to maturation stage), T_5-50% RDF through fertigation, T_6- 50% RDF through fertigation (applied N:K in the ratio of 2/3 N:1/3K at nut set to nut development and 1/3 N:2/3 K at nut development to maturation stage), T_7- Control with three replication under Randomized Block Design. The results of the experiment indicated that maximum nut yield (4.44 kg/tree) was recorded in 75% RDF through fertigation (Applied N:K in the ratio of 2/3N:1/3K at nut set to nut development stage and 1/3N: 2/3K at kernel development to maturation stage) and minimum was in control (2.43 kg/tree) plots (Fig. 30).



The soil samples were collected from experimental field at 0-30 cm depth as per the treatment for soil fertility status of almond fertigation experiment (Fig. 31) indicated that maximum soil NPK content (370.4 kg N: 15.8 kg P: 343.3 kg K/ha) were estimated in the treatment of 100 % recommended dose of fertilizers through fertigation and minimum was in control (295.3 kg N: 7.9 kg P: 242.7 kg K/ha).



Fertigation studies in almond

kernel percentage (52.80%) were recorded at 20% level of thinning.

Effect of different levels of heading back in Persian walnut

The data on various parameters after heading back revealed that maximum nut efficiency (0.094 nuts/ cm^2) was found at 20% level of heading back while branching density was improved in all levels as compared to control. The maximum nut weight

Walnut plants trained under different training systems

Effect of various training & pruning systems in Persian walnut

Effect of various training systems in Persian walnut

The results of first year trial in walnut trained on different systems revealed maximum nut efficiency (0.0594 nuts/ cm^2) and branching density (6.08/m) in multi leader system while maximum nut weight (12.35 g), kernel weight (6.54 g) and kernel recovery (58.33%) were recorded in modified central leader system, open centre and multi-leader system, respectively.

Effect of different levels of thinning in Persian walnut

Different levels of thinning responded differently for various traits in walnut. Maximum nut efficiency (0.1240 nuts/ cm^2), branching density (5.16) were recorded at 10% level of thinning while maximum nut weight (11.21 g), kernel weight (5.92 g) and (13.44g) and kernel weight (6.77g) were recorded at 20% level of heading back.

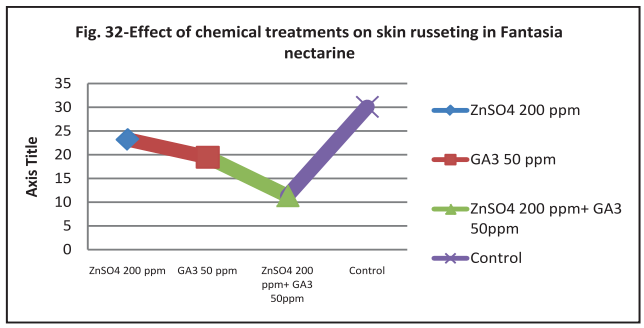
Effect of different levels of thinning + heading back in Persian walnut

The combined effect of various thinning and heading back levels on various parameters in walnut. revealed that nut efficiency was found to be reduced in all levels as compared to control while maximum branching density (6.50) was recorded at 20+20% level of thinning + heading back. Maximum nut weight (13.47g) and kernel weight (6.66g) were found at 20+20% level of thinning + heading back while maximum kernel recovery (46.30%) was reported at 30+30% level of thinning+ heading back.

Management of physiological disorders in temperate fruit crops

To minimize fruit skin russeting in Fantasia nectarine trained under various training system, pre-harvest application of chemicals and growth

regulators were tired in different combinations. Among the chemical treatments, minimum russeting percentage was recorded in treatment $ZnSO_4$ 200 ppm+ GA_3 50ppm as compared to control. However among training system minimum russeting was reported in tatura trellis system as compared to other systems. In chemical treatment and training system interaction, minimum russeting was observed in tatura trellis system with $ZnSO_4$ 200 ppm+ GA_3 50 ppm. Similarly maximum yield per plant was recorded in treatment $ZnSO_4$ 200 ppm+ GA_3 50ppm and tatura trellis system as compared to other systems. In chemical treatment and training system interaction, maximum yield per plant was observed in tatura trellis system with $ZnSO_4$ 200 ppm+ GA_3 50 ppm. (Fig. 32 & 33)



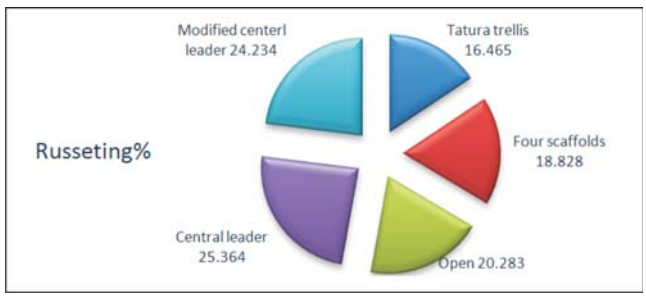


Fig. 33-Effect of various training systems on fruits russeting

Russeting in nectaring fruits

Nectarine fruits after $ZnSO_4$ 200 ppm+ GA_3 50ppm treatment

Characterization of soil and nutritional survey of temperate fruit crop

Soil fertility plays an important role in sustaining crop productivity of an area, particularly in a situation where the input of nutrient application varies and information on nutritional status of soil can go a long way to develop economically viable alternative of different nutrient management under different fruit crop. Random soil samples from different fruits and vegetable growing blocks (sixteen) of CITH were collected at 64 points with an incremental depth of 0-15, 15-30, 30-60 & 60-100 cm to know the fertility status of soil and subsequently initiated development of soil fertility map of the CITH farm with the help of the NBSS&LUP, Nagpur. Data generated on various soil properties indicated that most of the soils are mildly alkaline to moderately alkaline and non-saline in nature. Interestingly, a hard pan was observed at some places at the depth of around one meter. Direct measurement of various soil processes in relation to fertility is not frequently possible; hence it can be inferred by measuring certain soil properties which collectively can be the indicative of soil fertility/suitability. In order to illustrate the suitability of soil to abide the fruit crops, quality assessment of temperate soils under different fruit crops was carried out. Relative Soil Quality Index (RSQI) based on eight soil and physiographic parameters was evaluated. The indicator parameters used were slope, texture, pH, organic carbon, available nitrogen, phosphorus, potassium, and cation exchange capacity. It was observed that cherry and apple growing soils were in class I (highly suitable) with RSQI values of 90 and

86, respectively. Soils under walnut and Almond were having RSQI values of 77 and 76, respectively and were in suitability class II. The soils kept fallow were having a RSQI value of 78. In comparison to crop-free/fallow soils, the RSQI value of cherry and apple soils have increased whereas the same decreased in walnut and almond grown soils (Fig. 34). For the characterization of the apple growing area of India, soil samples were collected from different location of Sopore, and Kachhwari areas of district Baramulla and Budgam respectively. The preliminary depth wise soil analysis revealed that most of the soil in Sopore area are acidic in nature and a slight increasing trend in pH was observed with increasing depth of soil (Fig. 35). High organic matter content in soil were recorded but it varies with the altitude. While in Kachhwari area, surface soil pH range between 6.58 - 7.43 and electrical conductivity ranges from 144 to 173 µs/m at different locations (Fig. 36).

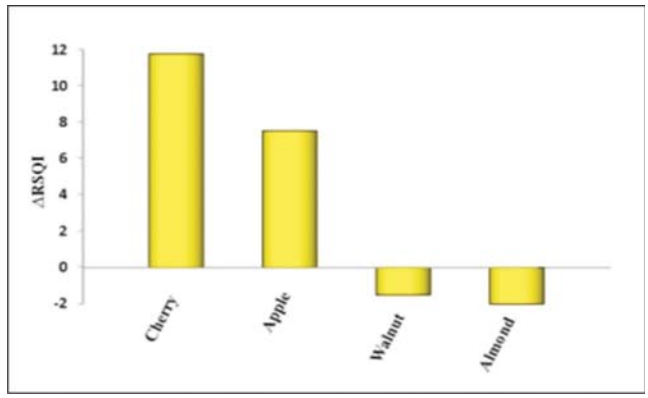


Fig. 34 :Change in Relative Soil Quality Index (ΔRSQI) in temperate soils under different fruit crops

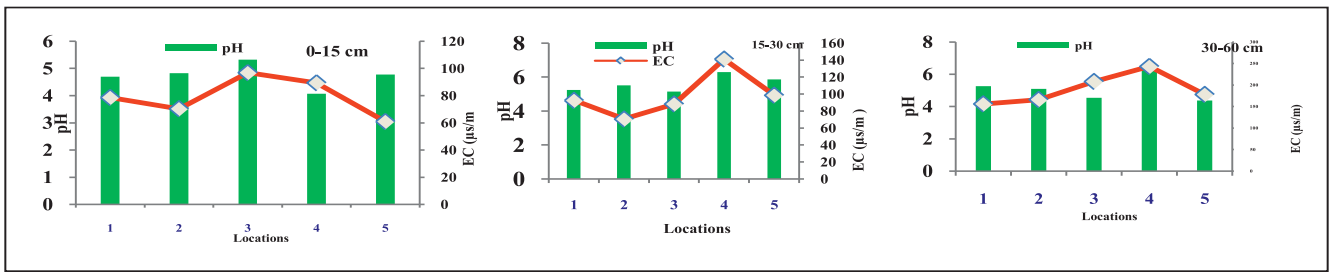


Fig. 35. Depth wise variation in soil pH and electrical conductivity (EC) in different apple growing orchard in Sopore area of Baramulla district. A. 0-15 cm, B. 15-30 cm, and C. 30-60cm

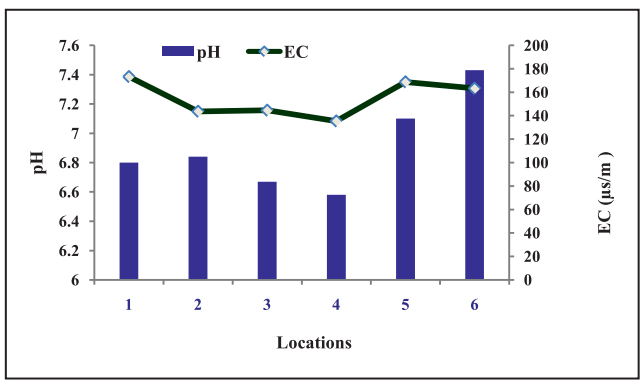
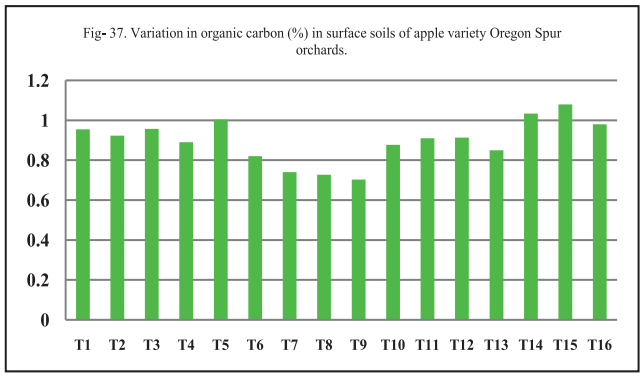


Fig. 36. Variation in soil pH and electrical conductivity (EC) in surface soil of apple growing orchards in Kachhwari area of Budgam district.

Integrated nutrient management in soil of medium and high density orchards of apple

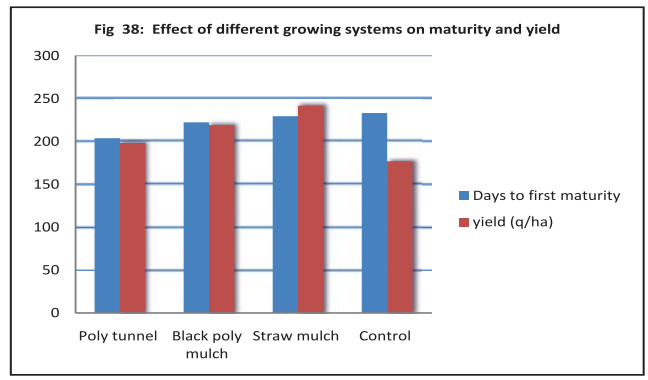
To develop an integrated nutrient management (INM) module high and medium density plantation of apple with 2.5 x 2.5 m and 4 x 4 m spacing, sixteen treatments with different nutrient combinations were applied in the field consisting of organic manures, namely vermicompost and farm yard manure (FYM), biofertilizer, namely *Azotobacter*, phosphate solublizing bacteria, *Azosprillum* & VAM, and inorganic fertilizers either alone or in combination. The treatments were control (T_1),

100% of recommended dose of NPK fertilizers (T_2), RDF+ Zn +B (T_3), 75% of RDF+ Zn +B (T_4), 75% of RDF+ Zn +B + 25% N through FYM (T_5), 75% of RDF+ Zn +B + 25% N through VC (T_6), 50% of RDF+ Zn +B + 50% N through VC (T_7), 50% of RDF + Zn +B + 25% N through FYM + 50% N through VC (T_8), 75% of RDF+ Zn +B + Zn and B +*Azotobactor* (T_9), 75% of RDF+ Zn +B +Microphos (T_{10}), 75% of RDF+ Zn +B +*Azospirllium* (T_{11}), 75% of RDF+ Zn +B + 25% N through FYM + *Azotobactor* (T_{12}), 75% of RDF+ Zn +B + 25% N through FYM + Microphos (T_{13}), 75% of RDF+ Zn +B + 25% N through VC + *Azotobactor* (T_{14}), 75% of RDF+ Zn +B + 25% N through VC+ Microphos (T_{15}), 75% of RDF+ Zn +B + 25% additional N (T_{16}). Native nutrient status was also found out for each treatment. Organic carbon content varies between 0.70 - 1.03 % in different treatments (Fig. 37). As per preliminary analysis of soil and crop data revealed that application of biofertilizer and organic manure improve the quality of soil as compared to control. But first year of experiment did not signify any significant difference in the nutrient status of soil as well as plant nutrient content among different biofertilizer and organic manure treatments.

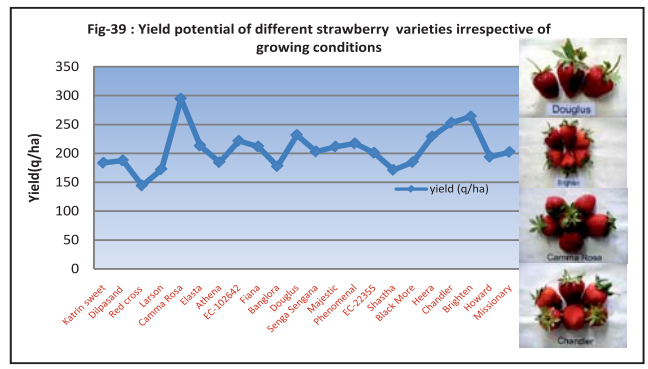


Evaluation of strawberry varieties under Kashmir conditions in different production systems

To extend the availability span with superior fruit quality and higher yield *vis a vis* higher benefits to the farmers, twenty two varieties were evaluated under 4 growing conditions i.e. poly tunnel, black polythene mulch, organic mulch and normal cultivation with three replications. The significant variations in days to first harvest ranged from 172 days to 225 days from date of transplanting i.e. 15th October. The earliest harvesting was obtained under poly tunnel (205.95days) from date of transplanting where as maximum number of days (238.31 days) taken to first harvest in control irrespective of varieties. Thus period of availability was enhanced up to 6 weeks (38) by using different growing conditions. Earliest maturing varieties under poly tunnel were Katrian Sweet , Dilpasand and Elasta (173days) which took 230 days under open conditions. Thus availability of fruits of these varieties can be extended up to 55 days under different growing conditions. The highest yield was obtained under straw mulch (242.00q/ha) irrespective of varieties which was closely followed by black polythene mulch (219.26 q /ha). The lowest yield was harvested in control 177.13 q/ha. However, variety Camma Rosa, Brighton, Chandler and Douglas were higher yielder among all tested varieties (Fig. 38 & 39).



Potential varieties of strawberry



Potential varieties of strawberry

Development of apple based cropping system with spices and condiments, vegetables, legumes, forage and oil crops.

Among the cropping sequences, treatment consisting of apple + methi recorded highest apple equivalent yield (196q/ha) followed by apple + garlic (195.88q/ha), apple + peas (162.08) and apple +swisschard (155.44q/ha). Highest apple yield was observed with apple + peas cropping system (116.08 q/ha) followed by apple + lucerne (Fig. 40). Whereas, maximum soil nitrogen gain was observed in apple + lentil cropping system (9.80kg/ha) followed by apple + methi (9.71kg/ha) and apple + lucerne (9.29kg/ha). The treatment apple + methi recorded maximum soil potassium gain followed by apple + lentil and apple+red clover (Table 21). Highest cost of production was observed with cropping sequence apple + garlic followed apple + onion due to high cost of seed and much involvement of labour, whereas maximum cost benefit ratio (Table 22) was observed with apple + methi (1:6.40) followed by apple + swiss chard (1:5.34).

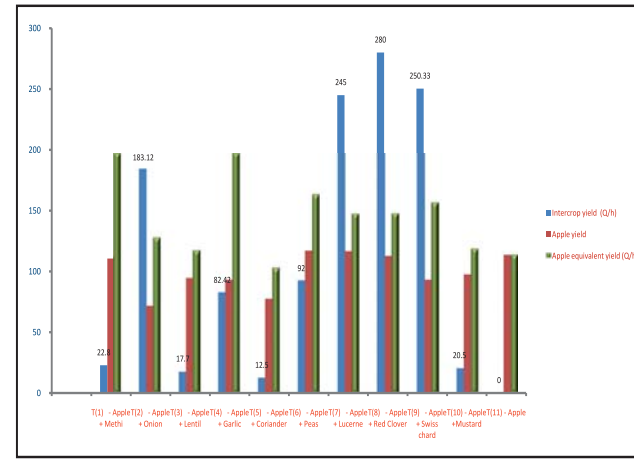


Fig 40- Effect of different inter cropping systems on yield of main crop, inter crop and apple equivalent yield

Table 21. Effect of intercropping on fertility status of the soil in apple orchard

Treatments	pH	EC (m.maho's)	O. C.%	Available N (kg/ha.)	Available K (kg/ha.)
T(1) Apple + Methi	6.77 (-.33)	0.15	0.54	429.86(+9.71)	403.64(+5.44)
T(2) Apple + Onion	6.90 (0.0)	0.16	0.52	417.95 (-2.2)	396.18(-2.06)
T(3) Apple + Lentil	6.80 (-0.1)	0.13	0.55	429.95(+9.80)	399.68(+1.48)
T(4) Apple + Garlic	6.70 (-0.2)	0.13	0.46	418.04(-2.11)	396.96(-1.24)
T(5) Apple + Coriander	6.75(0.15)	0.14	0.46	418.68(-1.47)	385.76(-12.44)
T(6) Apple + Peas	6.91(+0.01)	0.15	0.49	428.68(+8.53)	398.24(-.04)
T(7) Apple + Lucerne	6.90(0.0)	0.16	0.51	429.44(+9.29)	398.16(-.04)
T(8) Apple + Red Clover	6.70(0.2)	0.14	0.52	426.36(+6.21)	399.48(+1.24)
T(9) Apple + Swiss chord	6.90(0.0)	0.15	0.51	420.63(+0.48)	396.56(-1.64)
T(10) Apple +Mustard	6.90(0.0)	0.13	0.48	417.49(-2.66)	394.48(-3.73)
T(11)- Apple	6.90(00)	0.14	0.49	420.15(00)	397.21(-0.99)
Initial soil nutrient status	6.90	0.16	0.46	420.15	398.20

Table 22. Economics (Rs /ha.) of different inter crops grown with association of apple

Treatments	Cost of production (Rs/ha)			Total Return (Rs/ha.)	Net Return	Benefit: cost ratio
	Main crop	Intercrop	Total			
T(1) Apple + Methi	71500	34500	106000	784000	678000	6.40
T(2) Apple + Onion	71500	49000	120500	506640	386140	3.20
T(3) Apple + Lentil	71500	26500	98000	464360	366360	3.74
T(4) Apple + Garlic	75000	87500	159000	783520	624520	3.93

Treatments	Cost of production (Rs/ha)			Total Return (Rs/ha.)	Net Return	Benefit: cost ratio
	Main crop	Intercrop	Total			
T(5) Apple + Coriander	71500	25000	96500	408680	312180	3.24
T(6) Apple + Peas	71500	42000	113500	648320	534820	4.71
T(7) Apple + Lucerne	71500	23000	94500	584520	490020	5.19
T(8) Apple + Red Clover	71500	22500	95000	585640	490640	5.16
T(9) Apple + Swiss chord	71500	27000	98000	621760	523760	5.34
T(10) Apple +Mustard	71500	19000	90500	470680	380180	4.20
T(11)- Apple	74000	-	74000	450600	376600	5.09

Apple+ Peas | Apple+ Methi | Apple +Coriander

Intercropping with different crops in apple orchard

Antioxidant and phyto-nutrient characterization of minor temperate horticultural crops

To study the availability and variability of bioactive compounds and antioxidant in minor temperate horticultural crops, characterization and quantification was done in different genotypes/ accessions of mulberry, peaches/nectarine, pran and *Ziziphus* species.

In mulberry, fruit samples from 50 accessions were collected from the different regions of the Kashmir valley having different fruit characteristics and their physico-chemical properties examined including antioxidant potential of individual accessions. Among accessions maximum fruit length, fruit width was recorded in MB-26, fruit weight and TSS in MH-14 and titrable acidity in MH-40. Among antioxidant constituents maximum ascorbic acid was recorded in MB-32, total anthocyanin in MB-20, total carotenoides in MH-7, total phenolics in MB-34, total flavonoides, DPPH and FRAP content in MB-20 (Fig. 41).

Diversity in mulberry fruits

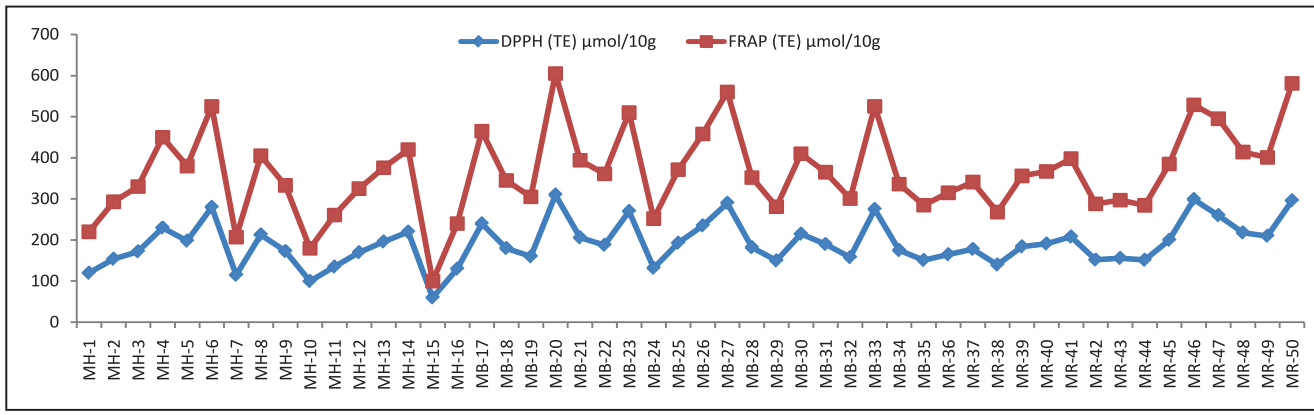


Fig 41: Anti-oxidental diversity among fifty mulberry accessions

In peaches/nectarine, antioxidant properties were analyzed from 20 genotypes. Among genotypes maximum ascorbic acid recorded in Gloheaven, total anthocyanin in Snowqueen, beta carotene in Red Globe, total carotenoides in Crest Heaven, total phenols in Elberta, total flavonoides in CITP-P-1, DPPH and FRAP in Fantasia, respectively (Fig. 42).

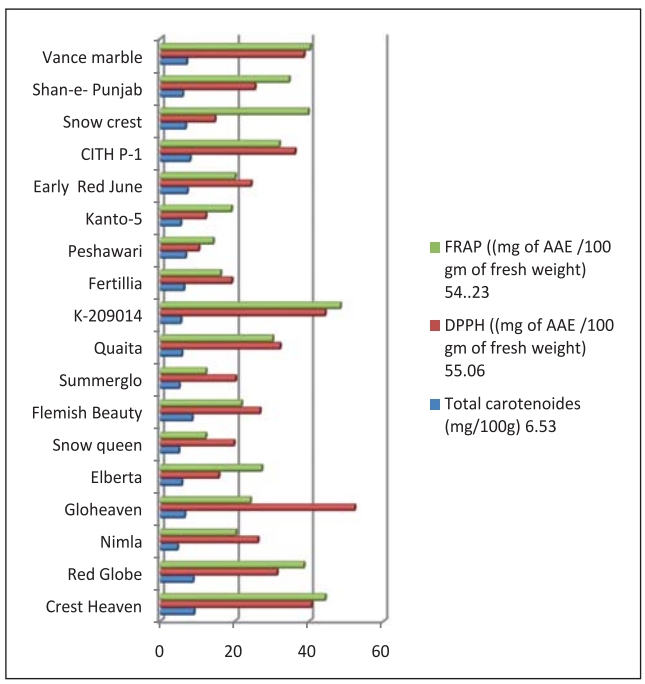


Fig 42. Variability in peach cultivars with respect to carotenoides and antioxidants activity

In *Ziziphus* total phenolics and flavonoides content in terms of gallic acid , quercetin and catechin was estimated using HPLC and among six accessions, maximum concentration of flavonoides in terms of quercetin and catechin was recorded in CITH-Z-1. Total phenolics were recorded higher in CITH-Z-3 followed by CITH-Z- 4 (Fig. 43).

Fruiting branches of different *Ziziphus* accessions

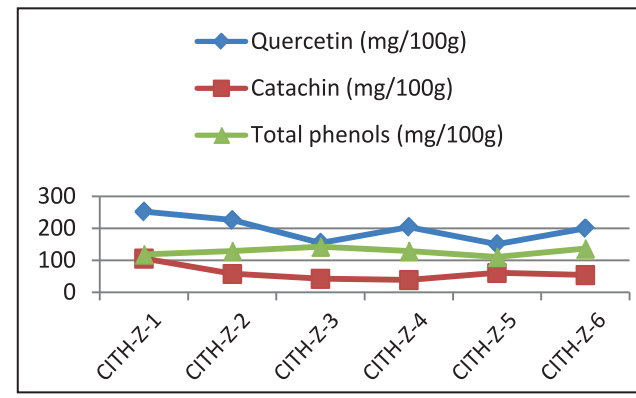


Fig. 43.Total phenolics and flavonoides content in ber

In pran, flavonoides content in terms of quercetin and catechin were estimated in leaves and bulbs

using HPLC and among six accessions, maximum concentration of quercetin in leaves was recorded in Pran -7 while catechin was in Pran-8. Similarly in bulbs maximum concentration of quercetin was recorded in Pran -1 however catechin was in Pran-3 (Table. 23).

Pran genotypes rich in flavonol contents

Table 23. Flavonoides variability in pran varieties quantified by HPLC

Variety	Source	Quercetin (mg/gm)	Catechin (mg/gm)
PRAN-1	Leaves	0.007	0.685
	Bulb	20.70	6.025
PRAN-3	Leaves	0.035	0.638
	Bulb	1.471	83.26
PRAN-6	Leaves	0.033	0.059
	Bulb	0.00	1.207
PRAN-7	Leaves	0.230	0.111
	Bulb	1.327	0.003
PRAN-8	Leaves	0.002	3.42
	Bulb	18.92	0.171
PRAN-9	Leaves	0.1900	0.190
	Bulb	7.425	21.99

Space and energy harvest under polyhouse through genotype selection, training and pruning.

To identify suitable varieties / hybrids and ideal training and pruning techniques for harvesting vertical space and energy for higher yield, three high value crops i.e. tomato, capsicum and cucumber were evaluated under protected conditions.

Tomato

In tomato, six hybrids were evaluated under poly house conditions with two spacing's and three pruning levels. Among hybrids, Heemsona-Sel-1 (822.67q/ha) followed by CITH-TH-1(750.66q/ha) and SH-TH-1 (644.997q/ha) were found best. While among three levels of pruning, double stem recorded highest yield (778.81q/ha) than single stem or natural. However, average fruit weight was highest in single stem (42.92g) and fruit number in double stem (77.73). Among two spacing's, the spacing 75x50cm recorded highest yield of (742.79q/ha) than wider spacing 90x45cm. Considering all the three factors genotypes, pruning systems and planting densities, the highest yield was recorded in CITH-TH-1 (934.23 q/ha.) followed by SH-TH-1 (874.46 q/ha.) and Heemsona-Sel-1 (790.89 q/ha.) among varieties, pruned to double stem at the spacing of 75x50 cm (Table. 24).

Table 24. Effect of varieties, spacing and training system on yield of tomato.

Factors	C(1)	C(2)	C(3)	C(4)	C(5)	C(6)
A1B1	623.39	398.49	639.99	437.33	519.10	817.77
A1B2	790.89	529.77	664.02	874.46	745.74	934.23
A1B3	497.77	373.33	444.44	469.33	444.43	586.66
A2B1	451.54	398.21	408.88	423.10	412.43	647.10
A2B2	613.91	508.44	543.99	543.99	465.77	497.77
A2B3	462.21	231.11	408.88	444.43	373.33	533.32

Spacing -A1-(75x50 cm), A2-(90x45cm) **Training systems** B1-Single stem B2-Double stem B3-Natural **Hybrids**-C1-Heemsona, C2- NS-6907, C3- NS-6677,C4- SH-TH-1,C5- SH-TH-2,C6- CITH-TH-1

Cucumber

Four varieties and two hybrids of cucumber were evaluated under poly house conditions with two spacing's and three pruning levels. Among varieties, Japanese Green Long was highest yielder (646.79q/ha) followed by Green Express (565.18q/ha). While in hybrids, SH-CH-1(764.90q/ha) recoded highest yield. Among pruning levels double stem recorded highest yield (686.17q/ha) than single stem or natural. However, average fruit weight was highest in single stem (341.95g) and fruit number in double stem (15.21). Among spacing's the spacing 120x60cm recorded highest yield (709.24q/ha) than wider spacing 100x75. Considering all the three factors genotypes, pruning systems and planting densities, the highest yield was recorded in SH-CH-1 (960.58q/ha.) among hybrids and in JGL (904.35q/ha.) among varieties pruned to double stem at the spacing of 120x60 cm (Table. 25).

Capsicum

Two varieties and six hybrids of capsicum were evaluated under shade net with two spacing's and three training levels. Among varieties SH-SP-706 was highest yielder (582.86q/ha). However, among hybrids NS-281(856.94q/ha), Bombay (819.09q/ha), Shalimar capsicum hybrid-1(Y) (659.88q/ha) and Shalimar capsicum hybrid -2 (R) (635.04 q/ha) were found best. While among pruning levels double stem recorded highest yield (658.09q/ha) than single or natural un-pruned plants. The number of fruits was also highest in double stem (8.22) however; average fruit weight was highest in single stem (101.72g). Among spacing's the spacing of 20x50cm recorded highest yield of (632.79q/ha) than wider spacing of 30x50cm. Considering all the three factors genotypes, pruning systems and planting densities, the highest yield among hybrids was recorded in SH-SPH-2 (1095.56q/ha.) and in SH-SP-706 (911.31 q/ha) among varieties pruned to double stem at the spacing of 20 x 50 cm (Table. 26).

Tomato, cucumber and capsicum crops under polyhouse conditions

Table 25: Effect of varieties, spacing and training system on yield of cucumber

Factors	C(1)	C(2)	C(3)	C(4)	C(5)	C(6)
A1B1	882.53	754.58	564.77	564.78	879.57	819.39
A1B2	904.35	851.79	597.18	694.40	960.58	851.79
A1B3	689.77	583.29	328.68	462.93	726.80	587.92
A2B1	857.75	666.65	497.76	524.43	786.65	679.98
A2B2	879.98	733.31	506.65	533.32	826.64	702.20
A2B3	712.91	615.70	356.46	486.08	736.06	597.18

Spacing - A1-(120x60 cm),A2-(100x 75cm) **Training** -B1-Single stem,B2-Double stem,B3-Natural **Varieties**-C1- JGL, C2- Pioneer Pickling,C3- NSX-2,C4- Green Express,C5- SH-CH-1,C6- SH-CH-2

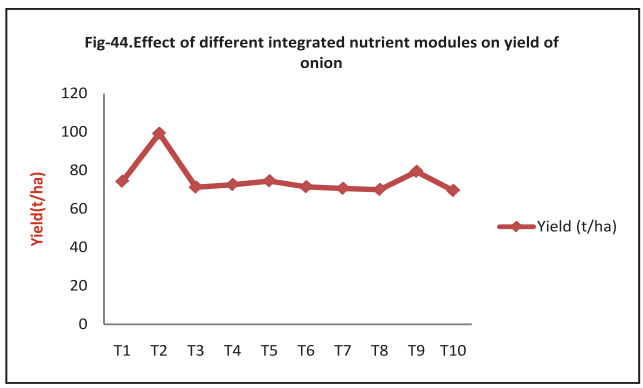
Table 26: Effect of varieties, spacing and training system on yield of capsicum.

Factors	C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)
A1B1	596.91	535.73	762.47	437.62	568.65	534.10	441.40	278.02
A1B2	797.45	517.64	828.03	536.84	716.81	638.17	590.88	574.23
A1B3	820.15	510.36	743.03	400.25	558.99	476.58	460.45	427.84
A2B1	793.24	642.53	942.20	650.71	830.84	799.92	717.53	460.85
A2B2	965.66	830.59	1059.49	802.24	1037.66	1095.56	911.31	833.24
A2B3	1080	833.13	1044.05	618.22	750.72	736.80	790.32	680.06

Spacing -A1-(30x50 cm),A2-(20x50 cm), **trainings** -B1-Single stem,B2-Double stem,B3-Natural,**Varieties**-C1-Bombay, C2-NS-284,C3-NS-281,C4- Orobell,C5-SH-SPH-1,C6-SH-SPH-2,C7-SH-SP-706,C8-SH-SP-5

Integrated nutrient management module for onion

Ten treatment combinations of integrated nutrient module i.e.T_1-local recommendation (180:70:60 kg/ha NPK), T_2-local recommendation with bio-fertilizer, T_3-150:50:80:50 kg NPKS + 20t FYM /ha (DOGR recommendation),T_4-110 :40:60:40 kg NPKS +15t FYM/ha,T_5-110:40: 60:40 kg NPKS +7.5t poultry manure/ha, T_6-110:40:60:40: kg NPKS +7.5t vermicompost /ha, T_7-110:40:60:40:kg NPKS +7.5t FYM+ 2.5t poultry manure /ha, T_8-110:40:60:40: kg NPKS +7.5t FYM+ 2.5t vermicompost /ha,T_9-110:40:60:40: kg NPKS +3.5.5t poultry manure + 3.5t vermicompost /ha and T_{10}-110:40:60:40:kg NPKS +7.5.5tFYM+2.5t poultry manure + 2.5t vermicompost /ha to find out suitable integrated nutrint module for yield of onion under long day conditions (Fig. 44)on variety Yellow Globe. Treatment combinaton T_2 recorded highest bulb yeild (99.24 t/ha) followed by treatment T_9 (79.42t/ha).

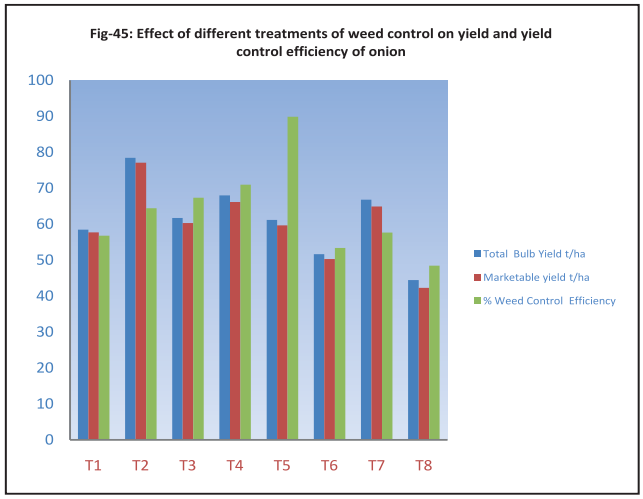


Weed Management studies in onion

Weed management in onion is cumbersome and labour intensive which enhance the cost of production of the crop .To find out suitable weed management practice eight treatment combinations viz.T1-Oxyflurofen 23.5% EC (Goal) application before planting and second application at 30 days after transplanting, T2-Oxyflurofen 23.5% EC(Goal) application before planting + Quizalofop Ethyl 5EC(Targa Super) application at 30 days after transplanting T3-Combined spray of Oxyflurofen 23.50% EC and Quizalofop Ethyl 5 % EC (Targa Super), T4-Pendimethalin 30 EC (Stomp) application before planting and second application after 30 days of transplanting, T5-Pendimethalin 30 EC (Stomp) application before planting + Quizalofop Ethyl 5 EC (Targa Super) application at 30 days after planting , T6-Combine spray of Pendimethalin 30 EC (stomp) + Quizalofop Ethyl 5EC(Targa Super) at time of planting and second application after 30 days of planting, T7-DOGR recommended practices

Field view of weed management trial in onion

(Oxyflurofen 23.5% EC application before planting + one hand weeding after 40- 60 days and T8- weedy check were tested on variety Yellow Globe. Treatment T_2 recorded highest average bulb weight of 117.64g with total and marketable yield of 78.43 and 77.10 t/ha, respectively, however treatment T5 recorded highest weed control efficiency of 89.89% (Fig. 45). Treatment T2 also recorded maximum net returns and B:C ratio. In storage studies minimum storage loss after 4 months was recorded in T2 (34.27%) followed by T4 (34.78%).



Diversification with off-season high value vegetables.

To identify crop / varieties of high value exotic vegetables for off season production their multiplication and distribution of elite varieties to farmers for increasing farm income 11 elite high value vegetables viz, lettuce, kale, parsley, celery, Chinese cabbage, pran, artichoke, asparagus, swisschard, sonchal and red cabbage were evaluated and the best varieties on the basis of yield performance in each crop were identified (Table 27), multiplied and are being popularized among farmers.

Table. 27. Performance of high value vegetable crops and their best varieties identified for the temperate region

S. No.	Crops	No. of varieties/ hybrids tested	Yield range (q/ha)	Best varieties/hybrids	Yield (q/ha)
1	Lettuce	8	252 to 505(q/ha)	LS-2 Grand Rapids Red Revolution	505 416.5 309.5
2	Kale	80	211-1094 (q/ha)	CITH-KC -28 CITH-KC-27 CITH-KC-8	944 805 664
3	Parsley	2	140-233 (q/ha)	CITH-P-1	233
4	Celery	2	128.5-215 (q/ha)	Ford Hook	226.4
5	Chinese cabbage	3	543-1172 (q/ha)	CITH-CC-1	1172
6	Pran	10	341-636 (q/ha)	CITH-Pran-2 CITH-Pran-5	636 541
7	Artichoke	1	76.5 (q/ha)	CITH-Artichoke-1	—
8	Asparagus	2	43.85-49 (q/ha)	CITH-Asparagus-1	49
9	Swisschard	3	278-374(q/ha)	CITH Green CITH Red	374 278
10	Sonchal	3	190.5-219(q/ha)	CITH-Sel-1	219
11	Red cabbage	1	(290q/ha)	CITH-RC-1	—

High value vegetable lettuce and Chinese cabbage

Standardization of integrated nutrient management and vegetables as inter-crop in apple orchard

Data on effect of integrated nutrient management (INM) on different growth parameters such as plant height, number of leaves, curd diameter, curd weight and yield in cauliflower, and plant height, number of branches, pod length and yield in pea were recorded. The treatment comprising of FYM + vermi-compost + bio-fertilizer + in-organics was found to be the best with both pea and cauliflower as intercrops in apple orchard exhibiting maximum growth and yield followed by FYM + vermi-compost + in-organics treatment (Table 28 & 29).

Development of saffron based intensive cropping system involving almond

In saffron and almond cropping system, data was recorded on vegetative growth characteristics in almond as well as flower and corm characteristic in saffron were recorded. There was no significant impact of almond on saffron yield and quality as almond plantation is in initial stage.

Intercropping of cauliflower var. Snow Crown under apple orchard

Intercropping with pea var. VL-7 under apple orchard

Table 28. Effect of INM on growth and yield of cauliflower as intercrop under apple orchard

Treatments	Plant height (cm)	No. of leaves/ plant	Curd diameter (cm)	Curd weight (g)	Yield q/ ha
FYM + inorganic (Recommended)	45.1	21.4	16.5	198	158.4
FYM + Vermi + inorganic	45.6	21.9	16.6	205	164.0
FYM + Vermi + bio-fertilizer + inorganic	48.8	22.0	16.5	210	168.0
FYM + in-organic (half of the recommended doses)	40.4	20.9	15.5	184	147.2

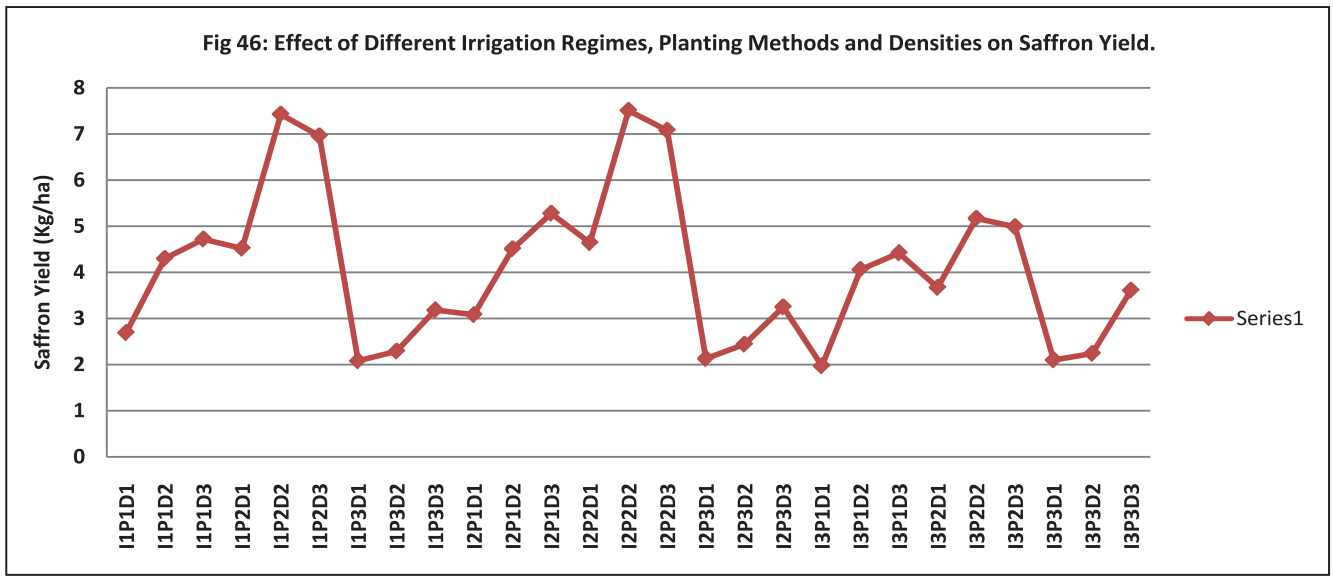
Table 29. Effect of INM on growth and yield of pea as intercrop under apple orchard

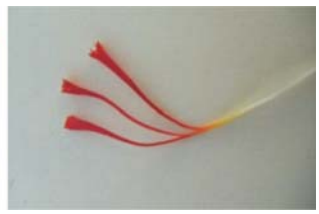
Treatments	Plant height (cm)	No. branches/ plant	Pod length (cm)	Yield q/ha
FYM + inorganic (Recommended)	57.2	9.4	7.1	45.0
FYM + Vermi + inorganic	59.2	10.0	7.5	47.5
FYM + Vermi + biofertilizer + inorganic	62.1	10.5	7.9	50.0
FYM + inorganic (half of the recommended doses)	55.2	8.8	6.9	42.5

Saffron –almond intercropping system

Standardization of improved agro-techniques for maximization of saffron productivity.

In intensive saffron production, sprinkler and drip irrigation methods caused early sprouting; early flowering with increased foliage height and more no. of leaves and flower/m^2 as compared to control (rain fed). Pistil fresh weight, pistil dry weight, pistil length and saffron yield per hectare were improved in sprinkler and drip irrigation methods as compared to control. Planting method- raised beds resulted in early flowering with increased foliage height and more no. of leaves and flower/m^2 as compared to ridge & furrow and flat bed systems. Planting density of 10 lakh corms/ha resulted in significant improvement in saffron yield (7.51 kg/ha) as compared to planting density of 15 lakh corms/ha (7.08 kg/ha.) and planting density of 5 lakh corms/ha (4.64 kg/ha.) in raised bed system with drip irrigation. While saffron yield was recorded 7.43 kg/ha in planting density 10 lakh corms/ha as compared to planting density 15 lakh corms/ha (6.96 kg/ha.). The planting density 5 lakh corms/ha gave 4.52 kg/ha. yield in raised bed system with sprinkler irrigation system. Whereas, under rainfed condition saffron yield was recorded 5.17 kg/ha. in planting density 10 lakh corms/ha as compared to planting density 15 lakh corms/ha (4.99 kg/ha.) and planting density 5 lakh corms/ha (3.67 kg/ha.) in raised bed system. Foliage height was recorded maximum (49 cm) in planting density 10 lakh corm/ha followed by 48 cm in planting density 15 lakh corms/ha in raised bed with drip irrigation system while foliage height was recorded minimum (20 cm) in flat bed with 15 lakh corms/ha under rainfed conditions(Fig. 46).

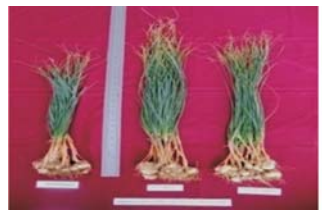


Improved stigma length and fresh weight under Sprinkler Irrigation System


Improved stigma length and fresh weight under Drip Irrigation System


Saffron under Drip Irrigation System




Saffron vegetative growth under Drip Irrigation System



Saffron in full vegetative growth in ridge and furrow method under different irrigation regime



Saffron in full vegetative growth in raised bed method under different irrigation regime

Development of organic package for saffron production

Saffron corms were planted during 2011-12 using organic inputs to improve yield and quality of saffron. The corms were treated with *Trichoderma viride* @ 5g/kg and different organic fertilizers FYM, vermicompost and poultry manure were applied in alone and different combinations. Among all the treatments, foliage height and number of leaves per plant were recorded maximum (27.64 cm and 15.60) in T13 (1/3 FYM+ 1/3 vermicompost+1/3 poultry manure) followed by (26.45 cm and 14.70) T11 (¼ FYM+ ¼ vermicompost + ½ poultry manure) as compared to minimum (19.61 cm and 8.10) in T14 (control), respectively. Pistil fresh and dry weight were also recorded highest (40.21 mg and 8.01 mg) in T13 (1/3 FYM+ 1/3 vermicompost+1/3 poultry manure) followed by (40.06 mg and 8.00 mg) T11 (¼ FYM+ ¼ vermicompost + ½ poultry manure) as compared to minimum (36.28 mg and 7.52) in T14 (control), respectively. Saffron yield was recorded highest 3.84 kg/ha in T13 (1/3 FYM+ 1/3 vermicompost+1/3 poultry manure) followed by (3.60 kg/ha) in T11 (¼ FYM+ ¼ vermicompost + ½ poultry manure) as compared to minimum (1.35 kg/ha) in T14 (control).

Evaluation and standardization of agro-techniques for quality cut flower production under polyhouse and field conditions.

Evaluation of gerbera genotypes under polyhouse and field conditions.

A total of twenty six different genotypes were evaluated under both poly house and field condition for growth , flowering and yield characteristics. In polyhouse condition, among all the germplasm lines Dune, Dana Ellen, Sunway and Fiorella yielded maximum flowers per plant i.e. 53.82, 46.35,40.67 and 38.70 respectively (Fig. 47). Whereas, the plant height was found maximum in germplasm lines Dune (43.75 cm) followed by Winter Queen (40.73 cm) and Salvadore (37.70 cm). Stalk length was found to be maximum (61.67 cm) in cv. Dune and it was also good in respect of vase life in preservative solution.

In field condition, among all the lines Dune, Dana Ellen, Fiorella and Sunway yielded maximum flowers per plant i.e. 43.26, 42.42, 36.58 and 36.21, respectively. The germplasm lines, Dune and Winter Queen were recorded maximum plant height i.e. 39.70 and 37.77 cm respectively. Stalk length was found to be maximum (59.01 cm) in cv. Dune followed by cv. Carambola (50.49 cm) and Zanzibar (50.34 cm).The quality of flower with respect to flower size, stalk length and vase life was found superior under polyhouse condition as compare to open condition.

Gerbera germplasm under poly house

Gerbera germplasm under open field condition

Effect of different stem lengths on vase life of gerbera cut flower

Among all the cultivars Dune and Dana Ellen expressed longest vase life (15.08 and 14.48 days respectively) followed by Carambola and Kayak. The vase life of flower also increases with increase in stem length. There is variation in vase life (varied from 9.05 to 15.08 days in 60 cm stem length) among the cultivars due to varietal characteristic (Table 30).

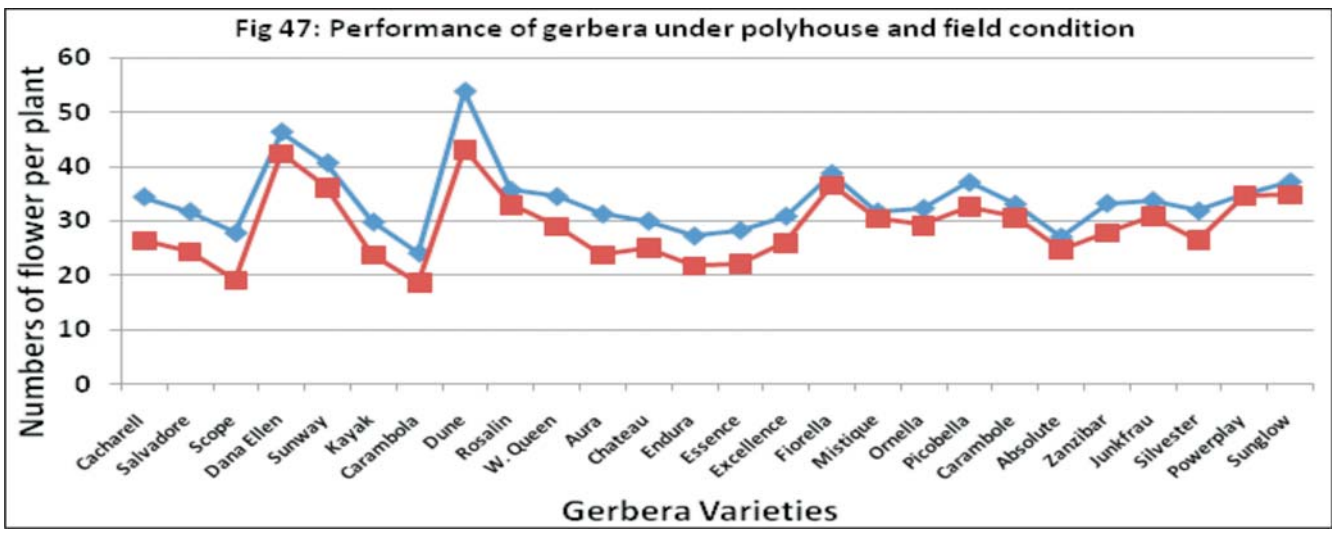


Table 30: Effect of different stem lengths on vase life of gerbera cut flower

Variety	Vase life (days)			
	Stem length 30 cm	Stem length 40 cm	Stem length 50 cm	Stem length 60 cm
Sunway	8.30	9.14	10.33	11.21
Rosalin	8.93	9.98	10.36	12.37
Dana Ellen	11.50	13.33	13.83	14.48
Carambola	11.15	13.15	13.68	14.27
Cacharell	10.9	11.96	12.88	12.99
Kayak	12.65	12.91	13.72	13.98
Winter Queen	12.00	13.27	14.13	13.73
Dune	11.26	13.93	14.82	15.08
Salvadore	11.06	12.47	12.78	12.97
Scope	7.89	8.19	9.06	9.05
C D at 5 %	*0.397*	*0.521*	*0.781*	*0.723*

Vase life study in gerbera cut-flower

Rejuvenation of old and unproductive almond orchards

For rejuvenation of old almond plantations of Kashmir valley, an experiment was conducted by giving following stepwise treatments. Three levels of pruning i.e. P1= Pruning of branches existing on main trunk, P2 =2nd order branches and P3=3rd order branches done in January-February with the objectives of facilitating production of new shoots from below the cut portion and allow the development of new canopy. To avoid infection or sun injury at cut portions, Chaubattia paste or Bordeaux paste was applied on cut portions of the branches. Fertilizers and manures: F1=0KgFYM+NPK=500+250+750g,F2=50KgFYM+NPK=500+250+750g,water harvesting structures:W1=Cup-plate type,W2=Full Moon and Varieties: V1=Waris, V2= Pranyaj. Half dose of nitrogen, full dose of DAP and MOP were applied in January-February and remaining ½ dose of nitrogen was applied in the end of June. Top grafting was performed in February-March on the one year old water shoots available on scaffold branch. Three to four shoots per branch were left for growing outwards and rest shoots were removed. Profusely emerging shoots in the inner canopy were also pruned out to develop open and strong canopy. The newly emerging shoots were allowed to grow up to a length of 50-70 cm, for budding in July-August (5-6 months old shoots after rejuvenation). Other criss-crossed, inter-mingling, over-crowding, dried and diseased branches in the orchards were also marked with red paint for complete removal. Copper-oxy-chloride (300g/100 l) water was sprayed during November and another spray was done one month later to avoid leaf curl and other fungal diseases. Observations were recorded for four consecutive years, 2009-2012 to monitor the annual growth trend and yield of the rejuvenated trees. The rejuvenated tree started bearing 2nd year after top grafting. Highest yield /tree 3.53kg was recorded in 1st order pruning , 50kg FYM + 500g N+ 250g P + 750g K in full moon water harvesting and Waris variety.

Rejuvenated almond trees

Demonstration on rejuvenation

III. Plant Health Management

Integrated disease management of chilli wilt

The wilt is the major problem in chilli. The field trial on the effect of different management modules involving combination of biocontrol agents (B_O = No biocontrol, B_1 = *T. harzianum,* B_2 = *T. viride*), chemicals (C_O = No chemical, C_1 = Carbendazim, C_2 = Ridomil MZ) and solarization (S_O = No solarization, S1 = solarization with black polythene, S_2 = solarization with transparent polythene) consisting of a total of 27 modules including the check having no biocontrol, no chemical, no solarization ($B_OC_OS_O$). The seed priming with respective biocontrol agents was done before their sowing. The beds were solarized with requisite polythene for about 40 days. The root of seedlings were dipped in bioagents/chemical preparations before transplanting. Later on after 40 days of transplanting the seedlings were drenched with 0.1 percent chemical preparation.

The maximum disease mitigation i.e. 65.9 percent was recorded in T_{23} i.e. $B_2C_1S_2$ i.e. with *T. viride* seed priming, Carbendazim root dip & soil drenching and solarization with transparent polythene followed by T_{22} with 57.1 percent disease mitigation i.e. $B_2C_1S_1$ i.e. with *T. viride* seed priming, Carbendazim root dip and soil drenching and solarization with black polythene and T_{26} with 51.6 percent disease mitigation i.e. $B_2C_2S_2$ by using *T. viride* seed priming, Ridomil MZ root dip and soil drenching and solarization with transparent polythene.

Management of corm rot of saffron with chemical seed treatment:

In saffron, corm rot is a persistent problem in production of corms by reducing vigour of plants with diminished plant stand, flowering and yield of saffron. Infected corms are major source of primary inoculum for spread of the disease from one area to another. In order to overcome the problem, the field trial on management of corm rot of saffron (*Fusarium oxysporum* f. sp. *gladioli*) with chemical seed treatment was planted. The treatments were as T_1 = Carbendazim 0.1%, T_2 = Carbendazim 0.2%, T_3 =Mancozeb 0.2%, T_4 = Mancozeb 0.3%, T_5 = Copper sulphate 0.2%, T_6 = Copper sulphate 0.3%, T_7 = Captan 0.2%, T_8 = Captan 0.3% and T_9 = Control.

The results revealed that among the nine treatments maximum plant stand i.e. 80.83 percent was recorded in T_2 (Carbendazim 0.2%) followed by 72.50 percent plant stand in T_8 (Captan 0.3%) with 86.54 percent and 67.32 percent, respective enhancement in healthy plants over check giving 43.33 percent healthy plant stand. The flowering was also recorded to be maximum in T2 (Carbendazim 0.2%) i.e. 36.04 percent followed by 34.55 percent flowering in T1 (Carbendazim 0.1%) and 34.42 percent in T_8 (Captan 0.3%) as compared to 21.23 percent flowering in check.

Studies on gummosis of stone fruits and its management

During 2012, the almond varieties were examined for symptoms of fruit gummosis due to shot hole fungus (*Wilsonomyces carpophilus*) having fungal spots along with exudation of gum, if any. The data revealed that all of the almond varieties planted at the experimental farm exhibited less than six gum droplets per fruit. The maximum gum exudation i.e. 8.94 percent fruits with 4-5 droplets and 31.42 percent fruits with one droplets were recorded in almond variety Merced. The almond strain CITH-Almond 14 exhibited minimum gum exudation i.e. 0.58 percent fruits with 4-5 droplets and 11.87 percent fruits with 1 droplet. Among the varieties maximum unblemished fruits with nil exudation were recorded in almond variety Shalimar.

Survey for incidence of different apple viruses

A Survey of apple growing areas of valley which included Lolab, Handwara, Khan Sahib, Chraar-e-Sharief, Uri, Tangmarg and Sopore indicated presence of Apple Mosaic Virus and Apple Chlorotic

Leaf Spot Viruses and the ELISA detection showed infection of APMV in these five apple growing areas ranging from 2.08-16.20 percent and mean infection of ACLSV in the same locations ranged from 2.83 to 19.64 percent.

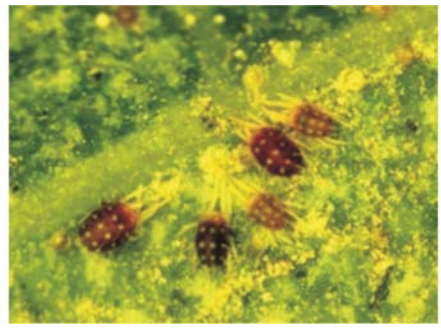
Symptoms of apple mosaic virus, apple chlorotic leaf virus and infection on apple leaves

Insect population dynamics on different cultivars/genotypes of apple, almond and apricot

Insect pests (aphids, European red mite, *Panonychus ulmi*, ash weevil, *Myllocerus* sp. and flea beetles) infestation have been recorded in apple, almond and apricot during 2012. The European red mite, *P. ulmi* infestation were recorded higher in Shireen (5.8 mite/leaf) and American Apirouge (8.8 mite/leaf) and lower in Golden Delicious (1.5 mite/leaf) and Silver Spur (3.6 mite/leaf) in apple planted at 4x4 m and 2.5x2.5 m, respectively. In case of almond, higher infestation recorded in California Paper Shell (23.6 mite/leaf) and IXL (15.8 mite/leaf) and lower in Makhdoom (11.8 mite/leaf) and Non-pariel (7.1 mite/leaf) in almond planted at 4x4 m and 2.5x2.5 m spacing, respectively. The aphids infestation was recorded higher in Akbar (65.12 aphids/leaf) and Cooper IV (41.14 aphids/leaf) and lower in Benoni (11.86 aphids/leaf) and Firdous (9.36 aphids/leaf) in apple at 4x4m and 2.5x2.5m, respectively. In case ash weevil *Myllocerus* sp. in concerned, substantial infestation was recorded in all the three fruit crops.

An emerging insect pest, flea beetle was identified as *Altica himensis* Shukla. The hibernating adult flea beetle starts its activity on 1st week of March and laying eggs singly or groups in soil. The grubs were found feeding on particular weeds only. The weed hosts plants were identified as *Rumax napalensis* and *Polygonium aviculare*. The Polygonium aviculare is the new weed host record for the *Altica himensis* larvae. It pupates in soil and emerging gregariously. The *A. himensis* has two generations per year and takes 101-122 days to complete single generation. The adult host plants were recorded as apricot, almond, apple, wild rose, *Rumax napalensis* and

Overwintering eggs of *Panonychus ulmi*



Panonychus ulmi feeding on almond

Aphids infestation on apple


Overwintering adults


Altica himensis-Eggs


Altica himensis-Grubs


Altica himensis-Pupae


Adult flea beetles feeding on Almond


Adult flea beetles feeding on *Polygonium aviculare*

Polygonium aviculare.

When calculating correlation co-efficient of mite population with weather data showed positive correlation with maximum temperature and negative correlation with minimum temperature, relative humidity and rain fall. Insect pollinators were also collected at different locations and identified.

Insect pollinators were documented under 13 families belonging to the four orders. Among these, family Halictidae was the dominating one, followed by Apidae (Table 31). The halictids bee collects the pollen for feeding their younger ones. The nesting of halictid bee was observed about 90 cm deep in the ground. The experiment was also conducted to assess the impact of insect pollinators on fruits set. In case of natural enemies concerned, studies were undertaken to document the coccinellid beetles fauna. A total of 17 species belonging to 14 genera of predatory coccinellids were recorded.


Halictids bee nest in the ground


Pollen ball prepared by Halictids bee


Halictids bee

Table 31. Relative abundance of different pollinators visiting apple and almond bloom (no. of insects/branch/minute)

Family/species	Apple						Almond	
	CITH		Shopian		Kralwadi		CITH	
	Mean ± S.E	%	Mean ± S.E	%	Mean ± S.E	%	Mean ± S.E	%
Apis mellifera	0.94 ± 0.18	10.44	0.45 ± 0.11	5.92	0.12 ± 0.12	0.85	0.90± 0.06	13.64
Apis cerana	0.40 ± 0.08	4.44	2.01 ± 0.39	26.42	0.78 ± 0.12	5.52	0.62 ± 0.19	9.40
Halictidae	6.40 ± 0.30	71.04	3.68 ± 0.51	48.36	11.67 ± 2.64	82.48	4.70± 0.53	71.22
Syrphidae	0.55 ± 0.09	6.11	0.35 ± 0.01	4.60	0.67 ± 0.20	4.74	0.18 ± 0.07	2.73
Tachinidae	0.30 ± 0.09	3.33	0.56 ± 0.22	7.36	0.23 ± 0.23	1.63	0.11 ± 0.02	1.67
Others	0.42 ± 0.10	4.67	0.56 ± 0.22	7.36	0.68 ± 0.34	4.81	0.09 ± 0.03	1.37

Development of IDPM module in tomato, cucumber and capsicum for protected cultivation

Tomato, capsicum and cucumber crops grown under polyhouse conditions were found infested by four insect pests *viz.*, aphids, black hairy caterpillar, whitefly and mite. However, only aphids were found dominant and cause economic damage to the crop. The population of rest of the pests was negligible. Among diseases only powdery mildew was observed. Three different IPM modules were evaluated for the management of these insect pests and were compared with farmers practices and untreated check. The module-III was found very effective for the suppression of population of sucking insect pests. This module comprises seedling root dipping with imidacloprid 17.8 SL @ 0.005% for controlling of sucking pests at early stage + recommended dose of fertilizers (NPK) + soil treatment with neem cake @ 200 kg/ha to manage soil born diseases and nematodes + foliar application of imdacloprid @ 0.007% to manage aphid population and other minor pests like whitefly. For the management of powdery mildew in cucumber, Carbendazim 50WP @ 0.05% was applied as a foliar spray. The results showed that the module-III proved to be very effective and may be used for the management of insect pests of tomato, capsicum and cucumber under polyhouse condition.

Management of the Asian hornet *Vespa* sp. in apiary

Honey bee colonies being attacked by *Vespa* species was observed throughout Kashmir valley and also at CITH, It starts attacking bee colonies during first week of August and the predation rate reach higher during mid September (an average, 92 bee/colony/day). Wasp activity was higher between 11.00 AM to 3.00 PM, and its activity positively correlated with bee activity. The experiments were conducted to identify different types of traps (sticky trap, bucket trap and modified bait tarp) and food baits, namely meat (head and body), fish, fresh and rotten apple, pear and *paneer* to attracting and killing the *Vespa* species (Table.32). Among these, modified bait trap attracted more number of wasps compared to other traps. In case of food baits concerned, head meat attracting more number of wasps. The trap was also designed for mass trapping of wasps, which needs further improvements for effective trapping.

Table 32. Efficiency of different food lure attracting hornet Wasp

S.No.	Bait types	No. of hornets attracted (mean)
1	Chicken	50.34 (7.13) [c]
2	Fish	68.34 (8.32) [b]
3	Meat (Head)	86.34 (9.34) [a]
4	Meat (body)	54.34 (7.44) [c]
5	Paneer	1.34 (1.49) [d]
6	Apple (Fresh)	0.68 (1.28) [d]
7	Apple (rotten)	1.34 (1.52) [d]
8	Pear	0.34 (1.14) [d]
CD at 5%= 0.89		

Trap design

Baited trap with catch of wasp

Modified bait trap

Development of spray schedule against major canker and foliar diseases of apple in Uttarakhand

Smoky blight, papery bark, pink canker, stem black and European canker were recorded as most serious cankers in Kumaon hills of Uttarakhand with average disease incidence of 52.21, 41.09, 3.26, 52.12 and 46.98 per cent, respectively, (Table 33). Besides this, Marssonina blotch, Alternaria leaf spot, Mycosphaerella leaf spot and powdery mildew with average disease incidence of 55.62, 34.10, 31.97 and 50.92 per cent, respectively, were recorded as major foliar disease in different localities of Kumaon hills. Infection of Apple Mosaic *Virus* (ApMV) and Chlorotic Leaf Spot Virus (ACLSV) was also observed with average incidence of 1.92 and 3.92 per cent respectively. Among fruit diseases sooty blotch and fly speck were recorded as major fruit diseases during the survey with average disease incidence of 39.94 and 43.83 per cent, respectively (Table 34). Apple rough skin and green crinkle diseases of apple (unknown etiology) were also recorded with average incidence of 4.75 and 2.35 per cent respectively. Among the different aforementioned apple diseases, cankers were recorded as most serious problem in apple orchards of Kumaon hills. During extensive surveys in Kumaon hills of Uttarakhand, unawareness about the use of fungicidal paste during the process of training and pruning of pome and stone fruits and lack of knowledge about suitable fungicides were diagnosed as the major reasons for increased prevalence of apple diseases.

Table -33. Incidence (%) of major canker diseases of apple in Kumaon hills of Uttarakhand.

Locations	Papery bark	Stem black	Pink canker	Smoky blight	European canker	Mean
Mukteshwar	46.33	25.57	0.00	45.67	40.33	31.58
Darim	54.25	42.82	14.25	50.33	43.22	40.97
Ramgarh	58.25	40.42	0.00	48.67	39.47	37.36
Khabrar	30.67	36.25	0.00	42.35	35.75	29.00
Hartola	26.15	15.33	0.00	34.42	31.82	21.54
Dhanachuli	68.57	53.82	0.00	60.75	56.55	47.94
Letibunga	60.33	51.67	0.00	62.57	56.25	46.16
Satbunga	58.42	48.67	0.00	58.33	53.66	43.82
Nathuakhan	56.75	44.82	18.33	53.67	50.44	44.80
Pahadpani	62.33	51.57	0.00	64.42	62.33	48.13
Mean	52.21	41.09	3.26	52.12	46.98	-

Table 34. Incidence (%) of major foliar and fruit diseases of apple in Kumaon hills of Uttarakhand.

Locations	Marssonina blight	Foliar diseases					Mean	Fruit diseases				Mean
		Alternaria leaf spot	Mycosphaerella leaf spot	Powdery mil-dew	Apple mosaic virus	Apple chlorotic leaf spot virus		Sooty blotch	Fly speck	Apple rough skin	Green crinkle	
Darim	69.25	35.57	33.25	46.82	0.00	0.00		43.42	45.57	0.00	0.00	
Ramgarh	54.48	29.50	28.22	35.33	0.00	0.00	30.82	29.82	42.33	0.00	0.00	22.25
Khabrar	52.46	39.25	36.33	35.33	0.00	0.00	24.59	29.67	42.33	0.00	0.00	18.04
Mukteshwar	40.57	25.57	23.27	45.57	5.77	10.33	27.23	33.27	39.25	11.27	3.28	18.00
Hartola	35.25	30.67	28.33	42.83	0.00	0.00	25.18	29.33	36.47	0.00	0.00	21.77
Dhanachuli	52.25	25.57	27.67	53.25	7.66	13.68	22.85	60.75	65.33	15.67	7.68	16.45
Letibunga	58.75	35.33	32.57	69.25	5.77	15.22	30.01	37.67	32.82	20.57	12.58	37.36
Satbunga	68.82	40.42	42.82	58.25	0.00	0.00	36.15	40.57	36.33	0.00	0.00	25.91
Nathuakhan	54.57	45.58	40.57	52.33	0.00	0.00	35.05	42.57	39.67	0.00	0.00	19.23
Pahadpani	69.82	33.57	26.75	70.33	0.00	0.00	32.18	52.42	58.25	0.00	0.00	20.56
Mean	55.62	34.10	31.98	50.93	1.92	3.92	33.41	39.95	43.84	4.75	2.35	27.67


Marssonina blotch


Powdery mildew


Papery bark


Chlorotic leaf spot


Smoky blight


European canker


Apple Mosaic


Green crinkel


Sooty blotch and fly specks


Apple rough skin

Characteristic symptoms produced by major canker, foliar and fruit diseases of apple in Kumaon hills of Uttarakhand

Management of major soil born diseases of apple

White root rot and Phytophthora rot were identified as the major soil born diseases in apple orchards. White root rot disease was recorded more severe as compared to Phytophthora root rot in both nursery and orchard areas surveyed. Maximum incidence of white root rot was found in Dhanachuli while minimum was recorded in Hartola both in nurseries as well as in orchards. Further, the maximum incidence of Phytophthora root rot was found in Letibunga and minimum in Hartola. However, in orchards maximum incidence of Phytophthora root rot was recorded in Satbunga and minimum again was recorded in Hartola (Fig. 48). White root rot of apple was found more destructive in the orchard therefore, more attention was paid towards this disease. Pathogen of this disease was isolated and identified on the basis of pear shaped swelling at the septum as *Dematophora necatrix*. Incidence of soil born diseases of apple was recorded more in nurseries as compared to main orchards. Both of these diseases result in rotting of root system. Prevalence of this disease was recorded more under water logged conditions. None of the available commercial rootstocks found resistant against these diseases, however, locally available thorny rootstock called 'Paron' showed resistance against these diseases. This rootstock is quite hardy, graft compatible with commercial cultivars of apple and well adapted to water logged and scarcity conditions.

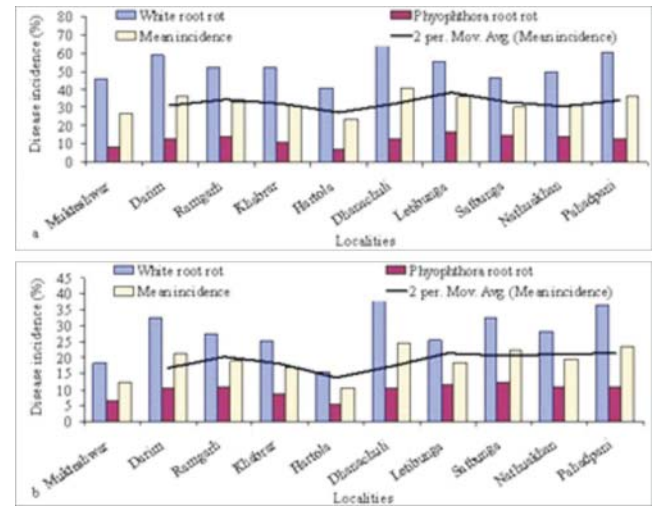


Fig.-48. Incidence (%) of major soil born diseases of apple in nurseries (a) and orchards (b) in Kumaon hills of Uttarakhand

White root rot (Nursery)

White root rot (Orchad)

Phytophathora rot (Nursery)

Phytophathora rot (Orchad)

Characteristic symptoms produced by major soil born diseases of apple in Kumaon hills of Uttarakhand

IV. Post Harvest Management

Value addition, storage and sensory quality evaluation of different products from major and minor temperate fruits

The fruits having lesser market value as fresh can be best utilized by preparing valuable products of commercial importance. The locally available fruits were used for preparation of squashes. Among the different treatments comprising Malta juice and ginger, the squash prepared from Malta (20%) and ginger (5%) was found to be the best at the time of preparation and after three months storage for three years. The technology for the preparation of these products was also demonstrated to the farmers. The acidity, ascorbic acid and reducing sugars were found to be reduced whereas the total soluble solids and total sugars increased significantly during storage of the products. Further, products (10 treatments) prepared by blending major and minor temperate fruit juices *viz.*, rhododendron, *kaphal, kilmora, galgal* and ginger in different ratios revealed that best squash prepared from rhododendron (15%) + *galgal* (5%) + ginger (5%) among various combinations during third year. The ascorbic acid content of the prepared products was found to reduce significantly during storage at ambient conditions as compared to those at low temperature. The colour of the prepared products showed a significant difference due to blending ratios. The prepared products have commercial value and if these products are prepared on large scale the state can earn a huge economy.

Enhancement of shelf life of different temperate fruits through post harvest chemical interventions

In a storage study of three cultivars of apple *viz.*, Fanny, Golden Delicious, Vance Delicious after treating with salicylic acid (200ppm) and calcium (0.4%) along with control was carried out for third year. Among the various treatments Ca treated fruits had better firmness and storage life with minimum PLW of 12.10 % as compared to others for 60 days (Table.35). Similarly, storage study of pear at ambient conditions comprising five cultivars after treating with salicylic acid and calcium was also carried out for the third year. The fruits treated with salicylic acid and Ca had better shelf life as compared to control for 30 days. Similarly, among different cultivars under the study it was observed a minimum PLW (%) in *Kakria* followed by Olympia and Sand pear (Table -36). The plum cultivar Santa Rosa was also treated with the bio-regulators (salicylic acid, CA-EDTA, Thyme oil) along with control (water dip) and the storage study at ambient and low temperature revealed significant reduction in physico-chemical characters in all the treatments. The ascorbic acid contents as well as total anti-oxidants were retained better in the fruits treated with salicylic acid and stored both at ambient and low temperature (Table 37 & 38). The Santa Rosa plum fruits could be stored for 20 days at ambient conditions by treating either with salicylic acid or calcium whereas the shelf life was more than 40 days at low temperature. The physico-chemical characters of two cultivars of kiwi namely Allison and Hayward were studied and were found at par with respect to quality traits such as vitamin c, TSS, acidity, juice and pomace percentage.

Table 35. Physiological loss in weight (%PLW) of different varieties of apple during storage

Treatment	Storage period (days)						
	0	10	20	30	40	50	60
T_1	0.0	1.92	5.35	8.74	11.10	13.79	15.46
T_2	0.0	1.27	4.74	7.19	9.10	11.78	13.69
T_3	0.0	3.84	7.47	11.30	14.66	17.51	20.26
T_4	0.0	1.45	4.70	7.87	10.35	11.85	13.32
T_5	0.0	1.02	3.92	6.40	8.30	10.58	12.10
T_6	0.0	2.75	6.72	9.65	12.68	15.67	18.75
T_7	0.0	1.56	5.10	8.26	10.86	12.46	14.38
T_8	0.0	1.15	4.24	6.90	8.90	11.10	12.80
T_9	0.0	3.08	7.18	10.95	13.20	16.75	19.35
CD at 5%	-	*0.030*	*0.028*	*0.046*	*0.035*	*0.039*	*0.045*

T_1= Fanny 200 ppm salicylic acid, T_2= Fanny 0.4% Ca-EDTA, T_3= Fanny control, T_4= Golden Delicious 200 ppm salicylic acid, T_5= Golden Delicious 0.4% Ca-EDTA, T_6= Golden Delicious control, T^7= Vance Delicious 200 ppm salicylic acid, T_8= Vance Delicious 0.4% Ca-EDTA, T_9= Vance Delicious control

Table 36. Physiological loss in weight (%PLW) of different cultivars of pear during storage

Treatments	Storage period (days)			
	0	10	20	30
T_1	0.00	3.79	6.34	8.37
T_2	0.00	4.18	6.85	9.43
T_3	0.00	4.72	8.13	11.10
T_4	0.00	4.15	7.20	10.24
T_5	0.00	4.95	9.82	13.25
T_6	0.00	6.25	9.99	14.08
T_7	0.00	5.14	8.96	12.34
T_8	0.00	6.08	10.24	13.30
T_9	0.00	7.08	11.71	15.95
T_{10}	0.00	0.76	1.49	2.29
T_{11}	0.00	1.00	2.10	3.12
T_{12}	0.00	2.11	4.04	5.46
T_{13}	0.00	2.27	4.35	5.73
T_{14}	0.00	2.61	4.87	6.85
T_{15}	0.00	4.47	7.93	11.32
CD at 5%	*0.00*	*0.050*	*0.027*	*0.030*

T_1= Sand pear 200 ppm salicylic acid, T_2= Sand pear 0.4% Ca-EDTA, T_3= Sand pear control, T_4= *Jagner* 200 ppm salicylic acid, T_5= *Jagner* 0.4% Ca-EDTA, T_6= *Jagner* control, T_7= *Kashmiri* 200 ppm salicylic acid, T_8= *Kashmiri* 0.4% Ca-EDTA, T_9= *Kashmiri* control, T_{10}= *Kakria* 200 ppm salicylic acid, T_{11}= *Kakria* 0.4% Ca-EDTA, T_{12}= *Kakria* control, T_{13}= *Olympia* 200 ppm salicylic acid, T_{14}= *Olympia* 0.4% Ca-EDTA, T_{15}= *Olympia* control

Table.37. Ascorbic acid (mg/100g) of plum affected by salicylic acid and calcium treatments during storage

Treatment (F_1)	Ambient temperature							Low temperature										
	Storage period (F_2)							Storage period (F_2)										
	0	3	6	9	14	20	Mean (F_1)	0	3	6	9	14	20	29	34	46	55	Mean (F_1)
1	13.64	12.73	11.82	9.09	9.09	7.27	10.61	13.64	13.64	13.6	13.58	13.5	13.24	13.1	12.8	12.1	11.4	13.06
2	13.64	11.82	9.99	9.09	8.18	5.45	9.70	13.6	13.58	13.55	13.48	13.4	13.12	12.9	12.5	11.7	11.1	12.89
3	13.64	12.27	10.91	9.09	8.18	6.36	10.08	13.68	13.6	13.5	13.36	13.18	12.95	12.72	12.25	11.2	10.6	12.70
4	13.64	10.91	9.09	7.27	6.36	4.55	8.64	13.65	13.5	13.42	13.2	13.04	12.6	12.2	11.8	10.9	9.5	12.38
Mean (F_2)	13.64	11.94	10.46	8.64	7.96	5.91		13.65	13.58	13.52	13.41	13.28	12.98	12.73	12.34	11.47	10.65	
CD at 5%	*F_1= 0.021, F_2= 0.026, F_1xF_2=0.052*							*F_1= 0.013, F_2= 0.020, F_1xF_2= 0.040*										

1=Salicylic acid (200 ppm), 2=Ca-EDTA (0.4%), 3= Thyme oil (100 ppm), 4= Control

Table.38. Total antioxidants (mMTE/L) of plum affected by salicylic acid and calcium treatments during storage

Treatment (F_1)	Ambient temperature							Low temperature										
	Storage period (F_2)							Storage period (F_2)										
	0	3	6	9	14	20	Mean (F_1)	0	3	6	9	14	20	29	34	46	55	Mean (F_1)
1	14.29	14.24	10.85	9.55	8.62	5.97	10.59	14.29	14.20	14.10	14.00	13.75	13.46	13.15	12.98	12.25	11.80	13.40
2	14.34	14.16	9.84	9.12	7.83	5.65	10.16	14.34	14.26	14.05	13.90	13.50	13.32	13.00	12.82	12.08	11.20	13.25
3	14.30	14.19	10.38	9.40	8.00	5.87	10.36	14.29	14.08	14.00	13.65	13.30	12.95	12.40	11.88	11.30	10.70	12.85
4	14.34	13.50	9.08	6.01	4.98	4.32	8.71	14.34	13.92	13.80	13.30	12.85	12.45	12.04	11.70	11.05	10.20	12.56
Mean (F_2)	14.32	14.03	10.04	8.52	7.36	5.46		14.32	14.12	13.99	13.71	13.35	13.05	12.65	12.35	11.67	10.97	
CD at 5%	*F_1= 0.021, F_2= 0.026, F_1xF_2=0.052*							*F_1= 0.025, F_2= 0.039, F_1xF_2= 0.078*										

1=Salicylic acid (200 ppm), 2=Ca-EDTA (0.4%), 3= Thyme oil (100 ppm), 4= Control

Minimal processing and packaging of high value vegetables and fruits for quality maintenance and storage.

Effect of chitosan coatings on post harvest life and quality of strawberry (*Fragaria x ananassa*)

Strawberry (*Fragaria x ananassa*) is a highly perishable non-climacteric fruit which must be harvested at full maturity to achieve the produce of better quality. For extending post harvest life and maintaining quality during storage at low temperature, strawberries were treated with 0.5%, 1% and 1.5% chitosan acetate solution. Fruit dipped in the acid solution without chitosan pH 5.0 were used as control. The data showed weight loss during storage (4°C, RH 90%) of uncoated fruit compared to fruit coated with 0.5%, 1% and 1.5% chitosan (Fig.-49). Throughout the storage, the loss of uncoated fruit was significantly greater than that of coated fruit. At the end of the storage untreated strawberries showed 11.8% loss in weight. Whereas loss of weight in samples coated with 0.5, 1.0 and 1.5% was 4.9, 5.0 and 4.0 percent, resceptively. Uncoated strawberries showed legions of fungal decay after 14 days of storage at 4° C. However, significant infection of 7% was recorded in control fruits after 21 days of storage and it reaches to maximum of 32% on 42 days after storage. In fruits coated with chitosan (0.5%, 1.0%, 1.5%) was observed on 35 days of storage and chitosan 1.5% was significantly found effective to reduce the fungal infection and after 42 days of storage 7% of fruits showed moulds and other infections symptoms. Change in flesh firmness of coating and chitosan treated fruits during the storage period of 42 days at 4°C and 90% RH are given in Fig. 50. Higher values for flesh firmness were recorded in 1.5% chitosan. The changes in surface colour of strawberries stored at 4°C and RH 90°C for 42 days have been given in Fig.51. By the end of the storage period, L* value in control fruit was 8 where as maximum (20) was recorded in fruits coated with 1.5% chitosan (Fig. 52a). Change in chroma value of the strawberry surface during storage is presented in Fig. 52b. The reduction in chroma values was greater for uncoated fruits and significant difference was recorded after 14 days of storage. As for coated fruits no significant difference was observed between 0.5 and 1.0% chitosan coating, however 1.5% chitosan coated fruits showed maximum value of chroma (31.41), the hue angle of uncoated strawberry began to decrease after 2nd day of storage and at the end of storage the decline was 23% (Fig. 52c). The hue angle of uncoated strawberry began to decrease after the second day of storage and at the end of the storage period the decline was 32%. The hue angle of coated fruit did not show any significant change during storage. Change in TSS, acidity and ascorbic acid of strawberries over storage time are shown in Table 39. TSS of all the fruits irrespective of treatments increased with storage. At the end of storage in control fruit TSS was minimum (5.8° Brix), whereas treated fruits maintained the TSS and maximum (7.9° B) was found in 1.5% chitosan coatings. No significant changes in titrable acidity was recorded in treated fruits throughout storage period. Fruits treated with 1.5% chitosan had maximum ascorbic acid (48.2 mg/100g) and in control it was 21.5 mg/100g, which can attribute to low transpiration. It can be expected that soluble solids content increases during strawberry ripening and decreases in mature fruit due to respiration. Application of chitosan coatings (1.5% concentration) could be beneficial in extending post harvest life and maintaining quality and to some extent decay of strawberry fruits up to 35-40 days when stored at 4°C and relative humidity of 90% (Fig. 53 & 54).

Table 39. Analysis of chitosan coated and control strawberry fruits after 42 days of storage at 4°C

Chitosan %	TSS°B	Tit. acidity (%)	Ascorbic acid (mg/100g)
Before Storage	8.2	0.64	54.0
After storage			
T_1 **0.5%**	7.4	0.55	44.2
T_2 **1.0%**	7.3	0.53	43.7
T_3 **1.5%**	7.9	0.58	48.2
T_4 **Control**	5.8	0.32	21.5

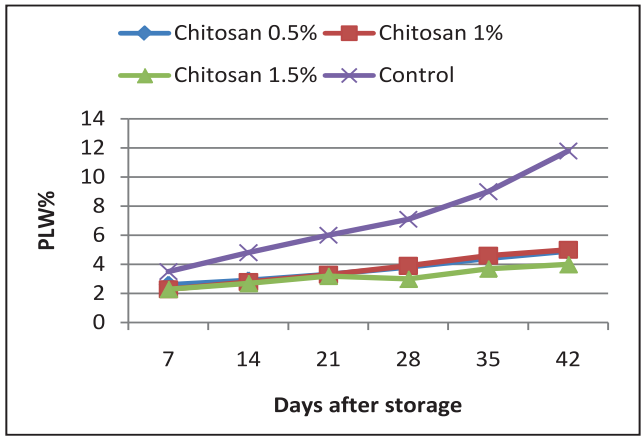


Fig 49. Effect of chitosan coatings on PLW% of strawberry stored at 4°C

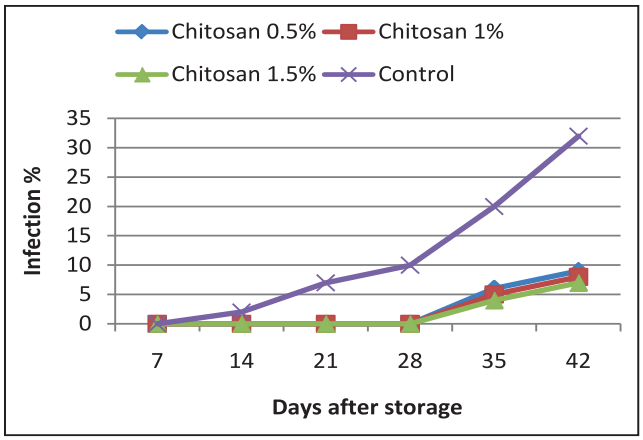


Fig 50. Percentage of infected strawberries as a function of chitosan coatings and stored at 4°C

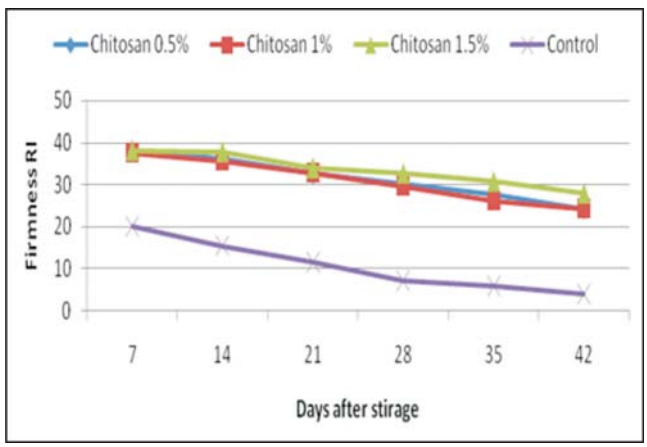
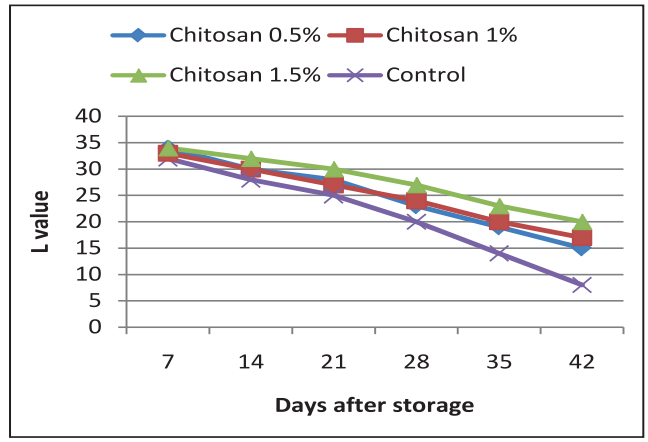
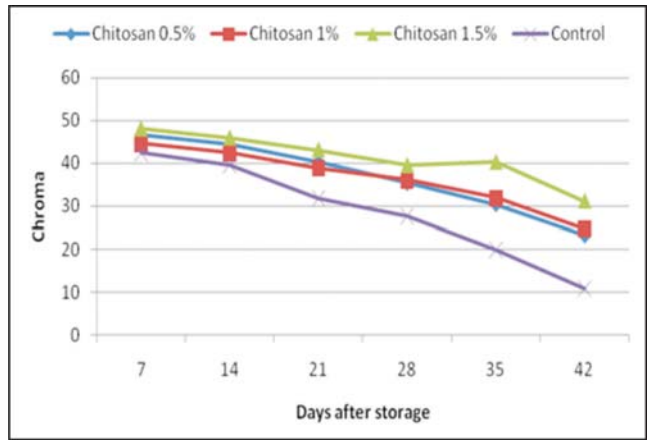


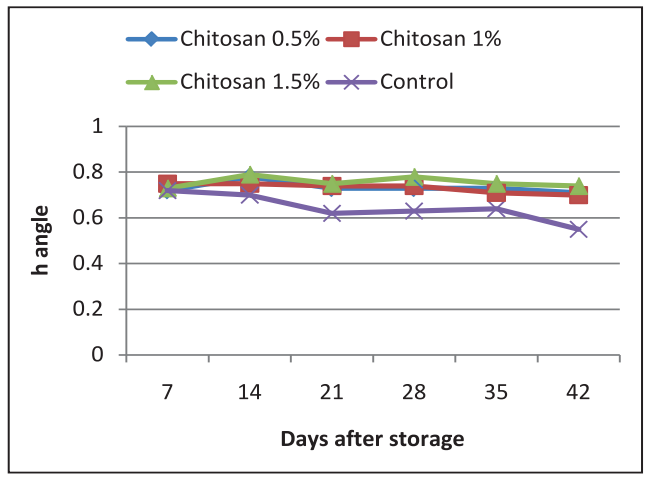
Fig 51. Effect of chitosan coatings on firmness (RI) of strawberry stored at 4°C



52 a



52 b



52 c

Fig 52 . External colour evaluation (a :lightness, b:chroma and c:h angle) of control and chitosan coated strawberries stored at 4°C

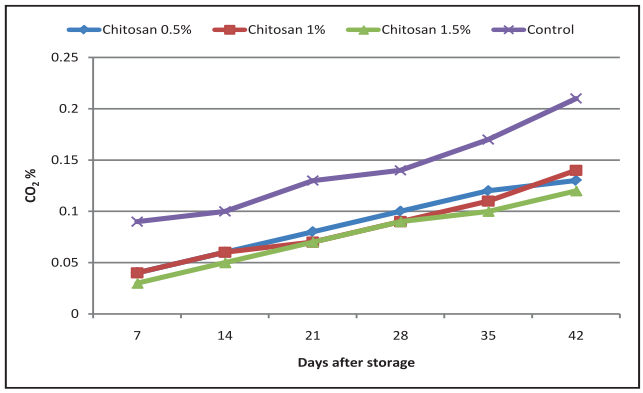


Fig. 53. Effect of chitosan coatings on CO2 % production of Strawberries stored at 4°C

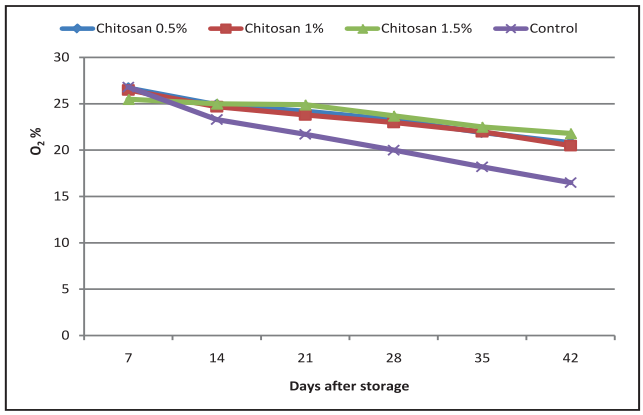


Fig -54. Effect of chitosan coatings on O2% production of Strawberries stored at 4°C

Effect of anti browning agents and slice thickness on drying and quality of apple slices in cultivar Red Chief

To study the effect of anti browning agents and slice thickness on drying and quality of apple slices cultivar Red Chief, fruits were stored at 4°C and R H 90%. After stabilization at the ambient temperature, the apples were manually peeled and cut into disc shaped slices of 20 mm diameter and 2 mm and 3 mm thickness. Ascorbic acid and citric acid were used as anti browning agents. The fruits were initially washed with chlorinated water (125 ppm of active chlorine or 100 ppm sodium hypo chlorite) for 30 seconds to prevent surface contamination. After peeling and coring, apples were cut in to 2 mm and 3 mm thickness cubes/slices and then dipped in to different solutions of ascorbic acid and citric acid i.e. 2mm slice + 1% citric acid, 2mm slice + 1% ascorbic acid, 2 mm slice +1% citric acid + 1% ascorbic acid, 2mm slice (control), 3mm slice + 1% citric acid, 3mm slice + 1% ascorbic acid, 3 mm slice +1% citric acid + 1% ascorbic acid, 3mm slice (control) for 2 minutes. Drying was performed in a cross flow cabinet dryer at 55° C in trays. Dehydration lasted until the moisture content of about 12-15% (wt base) was achieved. The dried samples were kept in air tight glass jar until the beginning of rehydration experiment.

Pretreatment of slices with anti browning agents and their size significantly influence the drying time. Size of slice irrespective of pre treatments significantly took minimum time for drying. In all the pre treatments the samples treated with citric acid and ascorbic acid alone or in combination (citric acid + ascorbic acid) reduced the drying time, however minimum time taken was recorded in case of 2 mm slice treated with 1% citric acid (300 minutes). The pretreatment of citric acid and ascorbic acid resulted in the highest rehydration value as compared to control, however, it was maximum in 2 mm and 3 mm size slices treated with 1 % citric acid and 1% ascorbic acid (4.0 and 4.9 respectively) Maximum dry matter content were recorded in 3 mm slices treated with combination of citric acid and ascorbic acid (92%). However maximum firmness(11.9 RI) was recorded in 2 mm size treated with citric acid and ascorbic acid. Maximum TSS (18.9° Brix) was recorded in 2 mm slice treated with citric acid and ascorbic acid. Anti browning agents were significantly effective to stabilize the ascorbic acid content, however, maximum (18.0 mg/100g) was recorded in 2mm + citric acid and ascorbic acid. Total colour change (difference) vs. size of slice and application of anti browning agents is shown in Fig.55. The pretreatments with anti browning agents and size significantly affected the colour change. Minimum colour change was observed in case of 2 mm slice treated with ascorbic acid and citric acid (10.10). Apple slices of 2 mm thickness size and pre-drying treated with 1% ascorbic acid + 1% citric acid take minimum time for dehydration with maximum colour and quality retention.

Effect of anti browning agents and slice thickness on dehydrated apple slices

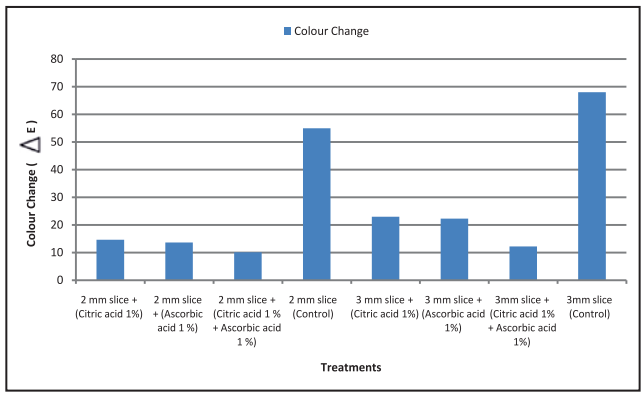


Fig -55. Effect of anti browning agents and thickness of slice and on colour change of dehydrated apple slices

Post Harvest management of temperate fruits for storage and value added products.

Post harvest study of apple cultivars for storage and quality

Experiment on post harvest study of ten apple cultivars of mid season were studied for their physico chemical characteristics and post harvest changes at room temperature (25° C) and R H 70%. Before going for storage study the fruits of different varieties were analyzed for initial physico chemical characteristics (Table.40). Maximum fruit size was recorded in Starkrimson (174 g) followed by Red Fuji (168 g).

There was significant loss in weight during storage, however after 27 days of storage PLW was maximum (17.99%) in fruits of cultivar Golden Delicious (Fig. 56) and Silver Spur (17.73%), whereas least was recorded in fruits of cultivar Granny Smith (6.55%), Well Spur (7.88%), Oregon Spur (7.99%). Firmness of the fruits of different apple cultivars during storage reduced significantly (Fig. 57) and minimum was recorded in Granny Smith (17%) and maximum in Golden Delicious (56%). TSS of the fruits gradually increased with storage period in all the varieties up to 24 days of storage and after that it started declining (Fig. 58). The acidity of the fruits increased with storage time up to 21 to 24th day of storage, after that it was found in decreasing trend (Fig. -59). During the storage study up to 27 days at room temperature there was significant reduction of ascorbic acid (Fig.60) in Well Spur and Oregon Spur (21.42 % in each), whereas maximum was recorded in Starkrimson (47%) and Red Fuji (41%). Colour values for L, a and b values of peel and flesh of different varieties significantly varied with storage period (Fig 60& 61). At the end of the storage study L value indicating freshness and brightness was more in Red Spur (74.19), Golden Delicious (71.26), Red Fuji (71.6) and Starkrimson (Fig.62). Flesh of apple cultivars showed little value for redness and it was found on little higher side in cultivar Red Chief (5.87) and Oregon Spur (4.17), whereas yellowness in flesh were recorded in Red Chief (35.32) and Oregon Spur (33.76). The first year results indicate that cultivar Well Spur, Granny Smith, Oregon Spur and Red Chief have more shelf life when stored at room temperature.

Table. 40: Physico-chemical characteristics of ten apple cultivars

Varieties	Weight (g)	Length (mm)	Breadth (mm)	Firmness (RI)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100g)	Colour of Peel			Colour of Pulp		
								L*	a*	b*	L*	a*	b*
Red Fuji	168	61	73	87.9	16.0	0.29	23	59.82	13.36	22.0	71.6	1.87	28.85
Starkrimson	174	57	75	81.5	15.2	0.54	25.5	46.73	19.22	12.02	69.27	3.74	30.76
Well Spur	150	63	70	81.7	11.7	0.32	21	48.85	14.02	11.89	68.77	-3.75	27.77
Granny Smith	167	64	74	94.06	10.0	0.25	21	62.76	-7.00	29.09	58.12	-3.03	17.01
Red Chief	155	61	72	77.46	19.0	0.32	28.5	52.60	17.75	17.61	70.17	5.87	35.32
Oregon Spur	152	59	71	79.83	12.80	0.29	21	47.85	11.54	11.55	60.44	4.17	33.76
American Apirogue	104	47	68	75.26	11.2	0.29	22.5	64.93	-5.70	29	66.13	-3.49	23.85
Golden Delicious	137	57	68	81.43	17.0	0.51	27	65.48	1.75	36.35	71.26	2.63	3.53
Silver Spur	130	58	63	82.1	13.1	0.35	24	42.96	11.35	8.02	60.2	-1.99	-29.99
Red Spur	135.5	57	67	90.9	16.0	0.54	25.5	47.16	13.60	12.44	74.19	0.61	29.97

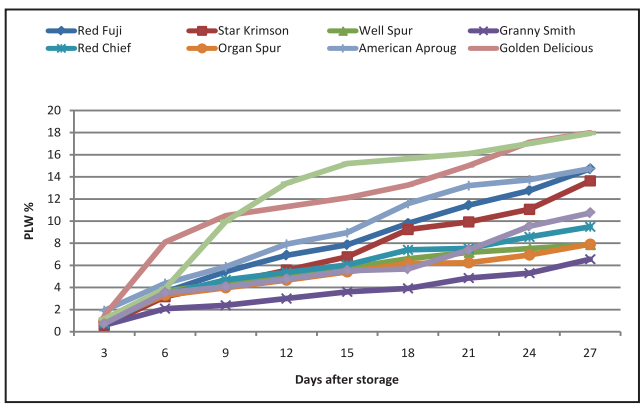


Fig. 56: Change in PLW (%) of apple cultivars during storage.

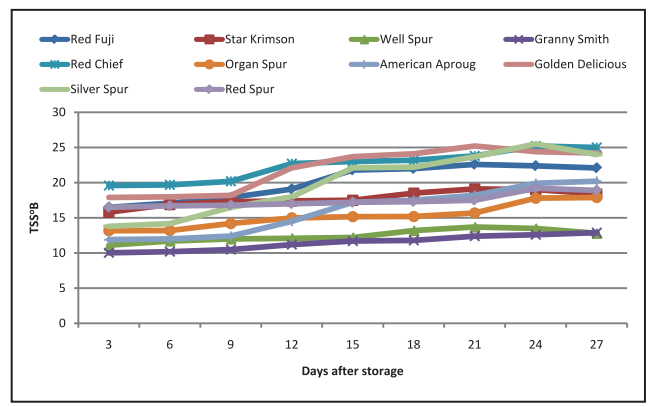


Fig. 58: Change in TSS° B of apple cultivars during storage.

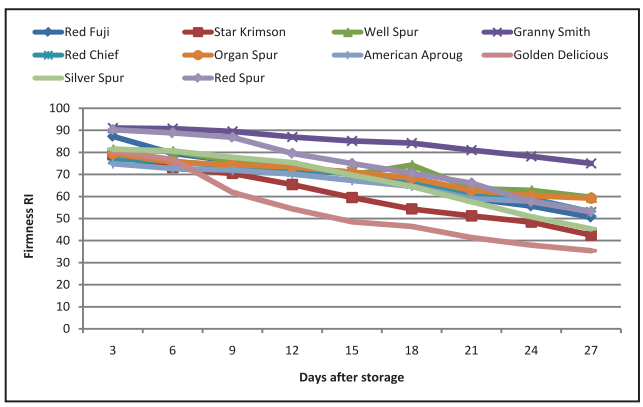


Fig. 57: Change in firmness (RI) of apple cultivars during storage.

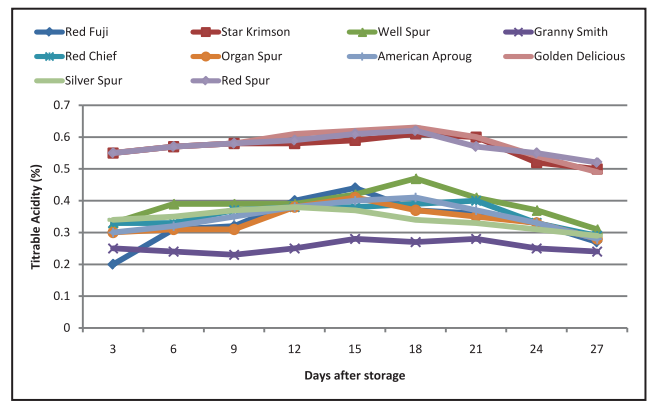


Fig.59: Change in titrable acidity (%) of apple cultivars during storage.

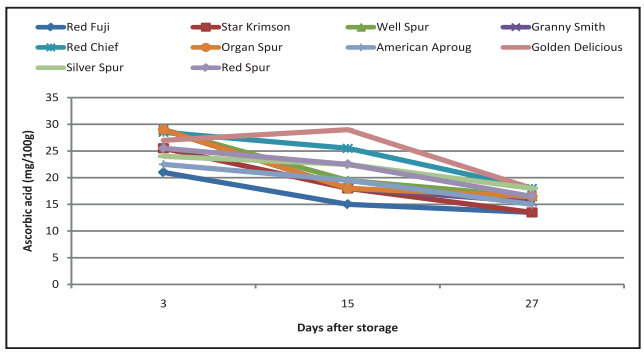


Fig.60: Change in ascorbic acid (mg/100g) of apple cultivars during storage.

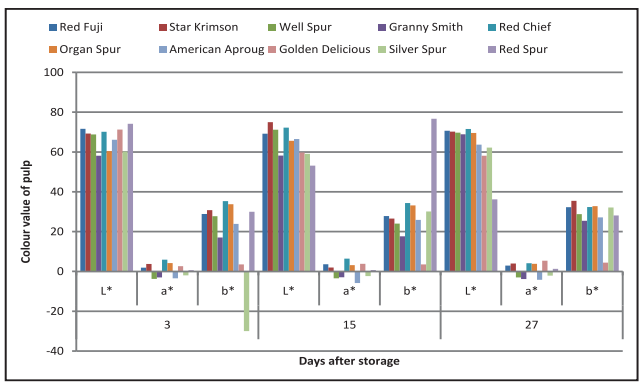


Fig.61: Change in colour value of apple flesh cultivars during storage.

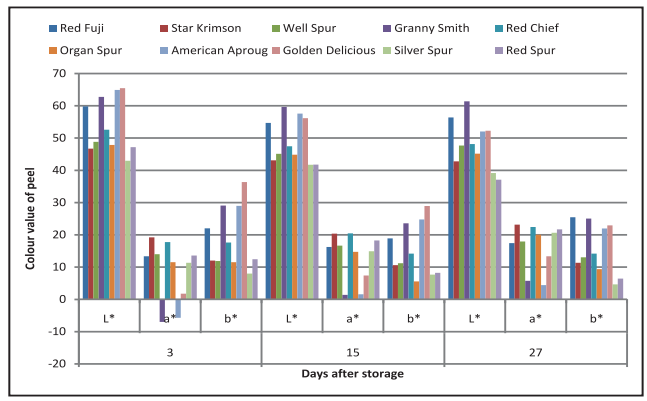
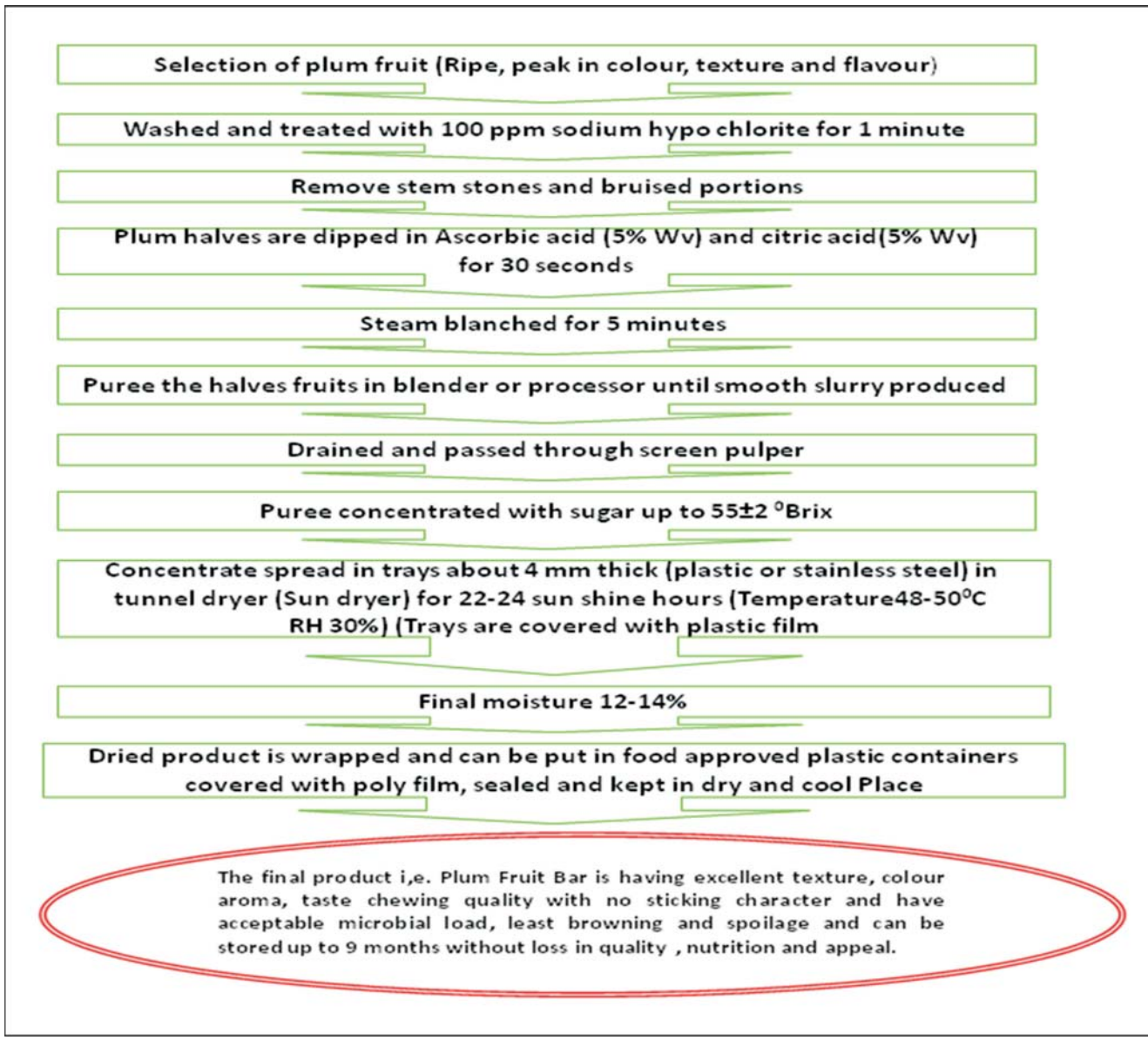


Fig.62: Change in colour value of peel of apple cultivars during storage.

Development of technology for preparation of plum fruit bar

Technology was developed and standardized for making plum fruit bar having excellent texture, colour, taste and chewing quality with least browning and spoilage and can be stored for nine months without loss in nutrition, quality and appeal.

Plum fruit bar product of CITH

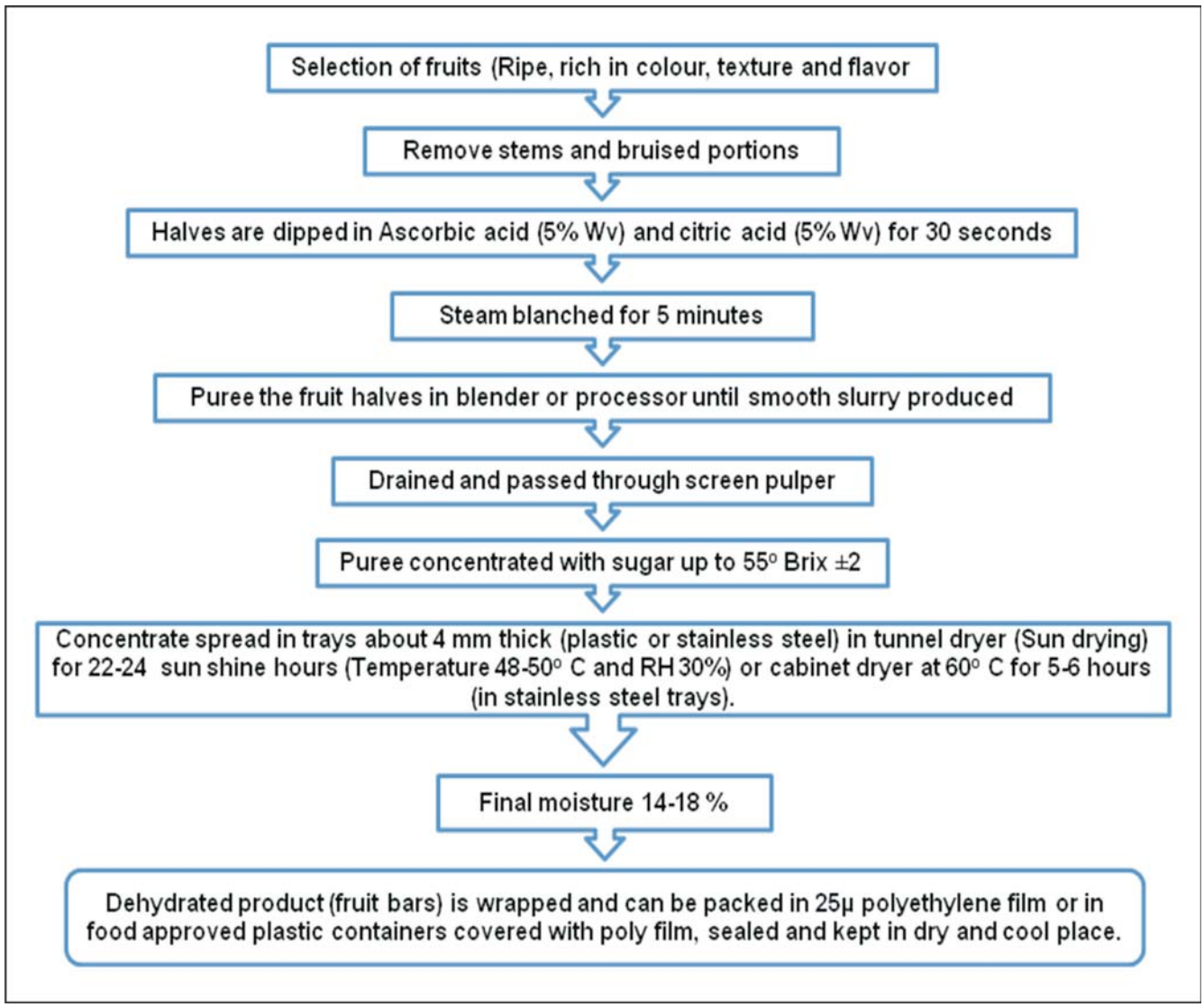


Flow diagram of plum fruit bar

Development of technology for preparation of Cape goose berry fruit bar

Technology was developed and standardized for making cape gooseberry fruit bar having excellent texture, colour, taste and chewing quality with least browning and spoilage and can be stored for nine months without loss in nutrition, quality and appeal.

Fruit bar of cape gooseberry



Flow diagram for preparation of cape gooseberry fruit bar

Refinement and popularization of tunnel dryer for preparation and safe packaging of value added products in temperate fruits

Studies on osmo-dehydration of cherry cultivar Mishri under solar tunnel dryer

Studies to develop technology for osmo-dehydration of cherry cultivar Mishri under CITH modified solar tunnel dryer (Model M1:covered with UV stabilized ethylene film, size 8 ft. X 3 ft., 25 cm from the base which is at the height of 60 cm from the ground level) was standardized during 2012-13. Two types of fruit material i.e., whole without stone (WWOS), half without stone (HWOS), and two concentrations of sugar solutions (50 and 55° Brix) were used for osmo-dehydration. The fruit material was also subjected to treatment of 1% KMS. The prevailing temperature and relative humidity range was recorded as 51-60° C and 38-53% respectively during June 2012 under solar drier.

Type of material and sugar solutions significantly affected the time taken for dehydration (15±2% moisture level). Half fruits without stone (HWOS) took minimum time for dehydration as compared

with whole fruit without stone (WWOS). Among sugar solutions as more effective for taking minimum time for dehydration, however, HWOS dipped in 55° Brix sugar solution and pre drying treatment with KMS 1% took least time (9 hrs 20 min)for drying up to desired level (15±2% moisture). Maximum dehydration (moisture loss) during osmosis (dipped in sugar solution) was recorded in case of half fruits without stone treated with 1% KMS and dipped in 55 °Brix sugar solution. Colour of the fruit product for L value indicate brightness and redness, a value indication redness and b value indicating yellowness was retained in half fruits without stone and maximum value s were recorded in case of half fruits without stone treated with 1% KMS and dipped in 55 °Brix sugar solution: L (29.9), a (219.91) and b(17.23). The TSS, acidity and ascorbic acid contents significantly varied with type of drying material, sugar solution and treatment of KMS 1%. Half fruits without stone (HWOS) dipped in 55° Brix sugar solution and pre drying treated with 1% KMS retained maximum TSS (30.2°B), ascorbic acid (17.9 mg/100g) and acidity (0.98%).

Osmodehydration of cherry cv. Mishri

Studies on osmo dehydration of apricot under solar tunnel dryer

The type of material and sugar solutions significantly affected the time taken for dehydration (15±2% moisture level). Half fruits without stone (HWOS) took minimum time for dehydration as compared with whole fruit without stone (WWOS). Among sugar solutions as more effective for taking minimum time for dehydration, however, HWOS dipped in 55° Brix sugar solution and pre drying treatment with KMS 1% took least time for drying up to desired level (15±2% moisture) (37 hours). Maximum dehydration (moisture loss) during osmosis (dipped in sugar solution) was recorded in case of half fruits without stone treated with 1% KMS and dipped in 55 °Brix sugar solution. Colour of the fruit product for L value indication brightness, a value indication redness and b value indicating yellowness was retained in half fruits without stone and maximum values were recorded in case of half fruits without stone treated with 1% KMS and dipped in 55 °Brix sugar solution: L (33.9), a (23.5) and b(20.13). The TSS, acidity and ascorbic acid contents significantly varied with type of material, sugar solution and treatment of KMS 1%. Half fruits without stone (HWOS) dipped in 55° Brix sugar solution and pre drying treated with 1% KMS retained maximum TSS (24.2°B), acidity (0.37%) and ascorbic acid (17.5 mg/100g).

Osmodehydration of apricot without stone

Dehydration of saffron under solar tunnel

Preliminary studies were carried out on dehydration of saffron (Mogra grade) under modified solar tunnel dryer. During the experiment drying temperature inside the solar tunnel dryer remains (25-35°C) and RH was 30-55%. It took 7 hours for dehydration of saffron reaching desirable moisture level of 18-20%. (Fig. 63). The data indicates that maximum dehydration took place between 11:00AM to 12:00 Noon and there after 3:00 PM to 5:00 PM.

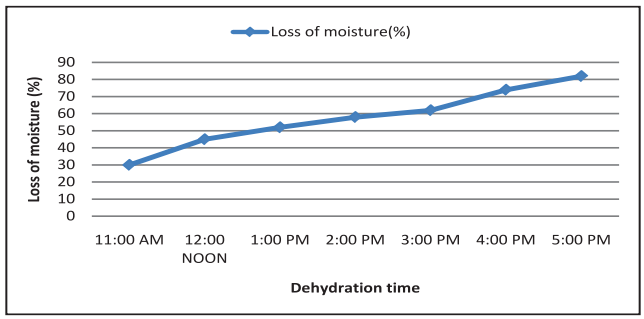


Fig.63: Loss of moisture during dehydration of saffron in solar tunnel dryer.

with improved flowering duration (26.32 days) and flower size (6.56 cm). While GA3 application 200 ppm resulted in longest flowering duration (27.14 days). CCC and MH delayed sprouting and reduced plant height, but improved no. of leaves and bulb per plant with their increasing concentrations. CCC and MH also induced late flowering and increased flowering duration, but reduced flower size with their increasing concentration in comparison to control.

Effect of different storage periods on tulip blooming and cut flower production

Among different treatments of cold storage, treatment (12 week storage at 5° C) causes early sprouting (77.26 days) with improved no. of leaves (5.01) and bulbs (4.22) per plant as compared to control. It also induced early flowering (142.65 days) with improved flowering duration (26.06 days) and flower size (7.84 cm). Successive increase in cold storage duration up to 12 weeks caused early sprouting and increased no. of leaves per plant and no. of bulb per plant. It also induced early flowering with increased flowering duration, flower size and flower stalk diameter.

View of tulip experimental field

Enhancing blooming period of tulip involving PGRs and different storage period of bulb.

The short blooming period is one of the bottlenecks in commercialization of tulip cultivation. To enhance the blooming period in tulip, different PGR's were tried. Among all the PGRs, GA3 at 400 ppm caused early sprouting (77.49 days) and increased plant height (36.63 cm), no. of leaves (4.47) and bulbs (4.22) per plant as compared to control. It also induced early flowering (129.02 days)

Study on vase life of tulip cut flower

Among treatments, longest vase life of tulip (9.5 days) was recorded in treatment of 8-HQS @ 300 ppm followed by treatment aluminium sulphate @ 300 ppm (9.2 days) and treatment 8-HQS @ 200 ppm (9 days) as compared to control (6.2 days).

Study on vase life of tulip cut flower

10th Research Advisory Committee Meeting

The 10th RAC meeting was held on 16th Oct. 2012 at CITH main campus, Srinagar under the chairmanship of Dr Jagmohan Singh Chauhan, Former Vice Chancellor, Dr. Y.S. Parmar University of Horticulture & Forestry, Solan (HP) The other members of RAC who attended the meeting were Dr. S. N. Pandey, Ex-ADG(Hort.), ICAR, New Delhi, Dr. D.P. Singh, Ex. ADG(Veg. Crops), ICAR, New Delhi, Dr. N. Kumar, Dean (Hort.) TNAU, Coimbatore, Tamil Nadu, Dr. J. Kumar, Dean, College of Agriculture, GBPAU&T Pant Nagar, Uttarakhand, Dr. A.K. Dhawan, Ex. Prof. & Head, Div. of Entomology PAU, Ludhiana, Punjab, Dr. Dr. W. S Dhillon, Asstt. Director General (Hort.I), ICAR, KAB-II, Pusa, New Delhi, Prof. Nazeer Ahmed, Director CITH, Sh. Syed Altaf Bukhari, Progressive orchardist & Managing Director, FIL Industries Srinagar and Dr. D.B. Singh, Pr. Scientist & Member Secretary RAC, CITH. The Committee visited the experimental farm as well as laboratories, and had detailed discussion and interactions with the scientists and suggested recommendations after reviewing all the ongoing projects presented by different scientists.

Dr. Jagmohan Singh Chauhan chairing RAC meeting

10th Institute Research Council Meeting

Institute Research Council meeting was held on 6th Oct., 2012. Project wise presentations were made by all the scientists. The salient achievements along with the research activities to be undertaken next year were presented. Prof. N. Ahmed, Director, CITH (Chairman of IRC), stressed for research on priority areas and gave critical inputs on experimentation for obtaining realistic and reproducible results. Some new projects were also proposed and approved by the house.

Director, CITH giving his critical input during IRC

Media Meet

For highlighting various technologies developed at CITH for increasing quality production of temperate fruits, a Media Meet was organized on 1st November, 2012. Several media personnel's visited the Institute and interacted with Director and scientists of the Institute about new varieties and technologies developed by the Institute.

Director CITH addressing media persons

Hindi Week

To promote and implement the national language in the Institute, Hindi Week was celebrated at CITH main campus as well as at Regional Station w.e.f. 14-20 Sept. 2012. All the staff members participated in the Hindi Week. Several competitions were organized and winners were honoured with various prizes.

Hindi Week organized at CITH Srinagar

Director, CITH distributing prizes in Hindi Week

Parthenium awareness week

Parthenium awareness week was observed at main as well as Regional Station w.e.f. 16-22 August, 2012 for creating awareness regarding the harmful effects of this weed.

Communal harmony campaign and fund raising week

Communal harmony campaign and fund raising week was observed at CITH w.e.f. 19-25th Nov., 2012.

Vigilance week

Institute observed Vigilance week w.e.f 29th Oct. to 3rd Nov., 2012 in which staff members were sensitized on the role of vigilance and oath was taken by staff for working sincerely and honestly.

Innovators Day

To make the farmers of the region aware of their role in innovation in different areas and their benefits, an Innovators Day was celebrated at CITH on 15th November, 2012. On this day about 55 farmers shared various local innovations and ITK with each other as well as with scientists for further validation.

ICAR Inter- Institutional Sports Meet

The participants from CITH participated in ICAR Inter- Institutional Sports Meet w.e.f. 25 to 28th April, 2012 held at NDRI, Karnal. All the participants took part in various games. The 2nd position in high jump and 3rd position in 400m race was won by Dr Girija Shankar and Farman Ali respectively.

CITH team in ICAR Inter- Institutional Sports Meet

Graduate trainings

A training course for students of B. Tech. (Ag. Engineering) final year students of SKUAST (K) was organized at CITH w.e.f. 7th May to 15th June, 2012. The students were taught various engineering components involved in temperate fruit production through lectures and practicals. Ten students participated and passed out in this training.

Student of B.tech during training on post harvest technology and quality control

Students of B. Tech. (Ag Engineering) during training on post harvest technology, receiving certificate from Director, CITH

Participation in the exhibition/ Kissan Melas

The various technologies generated at CITH were displayed in a Kissan Mela during 2nd J&K Agriculture Science Congress held at SKUAST-J w.e.f 15-17th Dec, 2012.

Dr. D.B.Singh explaining the technologies to Hon'ble Agricultural Minister of State Jenab G.H. Mir.

Extension and Trainings

Extension Activities

The Central Institute of Temperate Horticulture, Srinagar has emerged as a technological hub as well as model for farmers, extension officers and students of whole country. Besides generation of new technologies for enhancing temperate fruit production, the Institute is also becoming core centre for dissemination of technologies through various modes like demonstrations, on campus & off campus trainings, farmer's participatory location specific research, farmers visits, diagnostic visits and various programmes through media. The number of farmers as well as officers from various line departments who are visiting to the Institute is increasing every year. Many departments as well as other agencies are arranging visits of farmers to CITH from all over the country. During current year, more than 4500 farmers visited/ trained/ advised on various aspects at the Institute and Regional Station along with officers from Development Departments. They were taken around the experimental farms, other units and demonstrated various technologies being developed in temperate horticultural crops. Advisory services/Technical advice was rendered to different farmers coming from various regions of the state on scientific cultivation of temperate horticultural crops for higher production and farm income.

Almond Day organized

To promote various technologies developed in almond an "Almond Day" was organized on 9th August 2012 at Central Institute of Temperate Horticulture, Srinagar. A large number of farmers and a team of Horticulture Officers from different almond growing area of Jammu and Kashmir participated. The Director, Prof. Nazeer Ahmed explained in detail about prospect of almond cultivation in Jammu and Kashmir. An interaction session of scientists and farmers were also held in which various queries raised by almond growers were addressed. Farmers visited almond field of different varieties planted at different densities. They were impressed with high density planting, water harvesting system, fertigation and its scientific way of cultivation. On this occasion the bud wood of elite almond varieties were also distributed for their popularization.

Director, CITH addressing gathering on Almond Day


Officers and farmers attending Almond Day

Saffron Day organized

For increasing the quality production of saffron through intensive cultivation, a Saffron Day was organized at CITH on 4th Nov, 2012. The various technologies developed at CITH were demonstrated to the farmers of saffron growing areas. The queries of farmers were also addressed at saffron field of CITH.

Farmers participating during Saffron Day

Scientists interacting on intensive production technology of saffron

Demonstrations

During the year about 181 demonstrations on 13 aspects were laid out at farmer's field for early and large scale adoption of various technologies. The demonstrations (Table-41) have yielded very encouraging results.

Table-41: List of demonstrations laid at farmer's field for popularization and adoption of various technologies

S.No	Demonstrations	No. of demonstrations	Location/ District
1	Standardization of technology for rejuvenation of old and unproductive almond orchards in Kashmir valley	08	Pulwama, Srinagar and Budgam
2.	Refinement and large scale demonstration in high density almond plantation	15	Pulwama and Budgam
3	Refinement and demonstration of rain water harvesting under *insitu* moisture conservation techniques in almond and apple.	13	Pulwama and Budgam
4	Outreach of technologies for temperate fruit crops	12	Pulwama, Baramulla, Srinagar and Budgam
5	Demonstration of espalier plant architectural training for higher apple productivity.	07	Pulwama, Shopian, Anantnag, Baramulla and Budgam
6	Refinement and demonstration of high density plantation on clonal rootstock for higher apple productivity.	14	Pulwama, Shopian, Anantnag, Kupwara Baramulla, Srinagar and Budgam
7	Diversification and popularization of high value vegetable crops.	62	Kishtiwar, Budgam and Srinagar
8	Protected cultivation of vegetables.	03	Kishtiwar, Budgam and Srinagar
9	Popularization of zero energy polyhouses for walnut propagation	03	Kishtiwar, Budgam and Srinagar
10	Pollination management in apple and almond	19	Budgam, Baramulla & Bandipora
11	Demonstration of intensive production technology for higher saffron yield	04	Pulwama & Srinagar
12	Low cost polyhouse production technology for strawberry and Cape gooseberry cultivation.	07	Baramulla & Budgam
13	Integrated Disease Management of chilli wilt and corm rot of saffron	14	Budgam, Pulwama & Srinagar
	Total	**181**	

Refinement and demonstration of intensive production technology for higher saffron yield at farmer's field

Demonstration on protected cultivation of vegetable and low cost propagation techniques of walnut

Demonstration on diversification of high value vegetable crops

Demonstration on placement of pollinizer bouquet, pollinators, top working and bearing in apple after pollination management

Model Training Course organized

Eight days training programme on "Productivity enhancement in temperate fruits through rejuvenation techniques and canopy re-orientation of old and senile orchard" was organized from 5-12th Dec, 2012 at CITH, Srinagar. Twenty participants from line Department of Jammu and Kashmir, Uttarakhand, Himachal Pradesh and Arunachal Pradesh attended the programme. The MTC was

Director, CITH interacting with MTC trainees during a lecture

Practical training on canopy management

sponsored by Krishi Vistar Bhawan, Directorate of Extension MOA, GOI, New Delhi. During the programme all the aspects of canopy management and rejuvenation were delivered in detail through lectures as well as demonstrations in the field.

Practical training on architectural engineering

Hands-on training on architectural engineering

Training programme for farmers of other states

A training programme for progressive farmers from district Mandi (H P) was organized w.e.f. 3rd to 7th Sep, 2012 on Advanced cultivation techniques of temperate horticultural crops. In this training farmers were enlightened about advanced technologies generated / available at CITH through various lectures as well as through practical demonstrations.

Director CITH interacting with farmers of HP

Scientists discussing CITH technologies with farmers from HP

Trainings

To train the farmers on various aspects of productivity enhancement in temperate horticultural crops, 31 training/ awareness camps were organized at CITH as well as in different villages. About 1377 farmers participated in various camps related to CITH technologies. The list of various training camps are presented in Table 42. Besides this number of farmers, NGO's, scientists, officers from line departments and students visited CITH as well as Regional Station Mukteshwar and were made aware of various activities of CITH. As per demands of farmers of different region, many visits related to diagnostic were made at farmers field. About 20 Radio/ TV talks were delivered by various staff members of CITH Srinagar and Regional Station regarding new emerging technologies for the farmers of temperate region.

Table-42: Training programmes conducted during 2012-13

S.No	Date	Title	Venue	No. of participants
1	09/09/2012	Popularization of low cost poly house propagation techniques of walnut	Kishtiwar	58
2	3-4/9/2013	Budding of temperate fruits and multiplication of clonal rootstock	Main campus	10
3	22/09/2012	Popularization of low cost poly house propagation techniques of walnut	Harwan	50
4	09/09/2012	Diversification with high value vegetable	Kishtwar	58
5	22/09/2012	Diversification with high value vegetable	Harwan	50
6	30/04/2012	Plant architecture and nursery management	Main campus	37
7	18/07/2012	Pruning and canopy development	Main campus	68
8	19/07/2012	Canopy development and pruning procedure in temperate fruits	Main campus	32
9	31/10/2012	Canopy development and pruning procedure in temperate fruits	Main campus	35
10	12/11/2012	Canopy development and pruning procedure in temperate fruits	Main campus	44
11	12-13/12/2013	Improvised techniques of canopy management in apple	Main campus	55
12	6/9/012	Budding of temperate fruits and multiplication of clonal rootstock	Main campus	26
13	11/07/2012	Rain water harvesting and *in-situ* moisture conservation techniques in almond and apple	Sharshali	65
14	12/07/2012	Rain water harvesting and *in-situ* moisture conservation techniques in almond and apple	Chandhara	75
15	14/07/2012	Rain water harvesting and *in-situ* moisture conservation techniques in almond and apple	Kachhwari	50
16	16/07/2012	Rain water harvesting and *in-situ* moisture conservation techniques in almond and apple	Chadoora	25
17	29/3/2013	Cape gooseberry production under low tunnels	Wahipora	37
18	30/3/2013	Strawberry production under low tunnels for extending availability period	Wataco	39
19	31/3/2013	Strawberry production under low tunnels for extending availability period	Wahipora	38
20	28/02/2013	Pollinizer and pollinator management in apple and almond	Chrawni	51
21	12/03/2013	Pollinizer and pollinator management in apple and almond	Surush	29
22	16/03/2013	Pollinizer and pollinator management in apple and almond	Watapora	20
23	27/03/2013	Pollinizer and pollinator management in apple and almond	Hayatpora	26
24	28/03/2013	Pollinizer and pollinator management in apple and almond	Nagam	24
25	29/03/2013	Pollinizer and pollinator management in apple and almond	Radbough	53
26	30/5/2012	Management of apple for quality production and profitable marketing" to Bayer Internal team and selected apple crop growers	Main Campus	42
27	30/3/2013	Product diversification of temperate fruits for novel value added products	Main Campus	20
28	9/05/2012	Preparation and use of fungicidal paste in plant disease management and field demonstration for identification of major canker disease	Reetha Pokhri (Uttarakhand)	20
29	12/06/ 2012	Scientific orchard management	Mukteshwer	10
30	23/01/2013	Scientific training and pruning of the temperate fruit crops	Darim (Mukteshwar)	30
31	27/02/2013	Training programme on kiwi fruit	Badagaon (Uttarakhand)	200

On and off campus trainings organized by scientists of CITH

Chandhara, Pulwama

Sharshali, Pulwama

Kachhwari, Budgam

Training programmes in different villages on rain water harvesting and *in situ* moisture conservation techniques in almond and apple

Training on high value and round the year vegetable production under protected condition

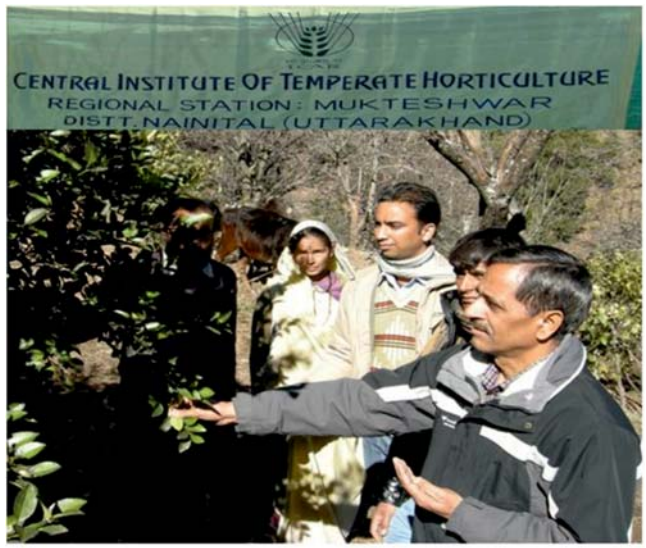
Training on rootstock production and low cost polyhouse propagation techniques in walnut

Training on Management of apple for quality production and profitable marketing to Bayer Internal team and selected apple growers

Training on pollination management and top working with pollinizers in different villages

Farmers of different villages taking scion wood of pollinizers for top working in their orchards after training programme

Training on "Preparation and use of fungicidal paste in plant disease management and field demonstration for identification of major canker diseases" at Reetha Pokhri in Nainital district of Uttarahkand



Training on "Diagnosis and management of citrus fruit fly and stalk end rot of malta" at Gahana area in Nainital district of Uttarahkand

Training on "Training and pruning of pome and stone fruits" at Darim in Nainital district of Uttarahkand

Training for tribal farmers

During 2012-13, three training camps were organized for tribal farmers of Ladakh region (Kargil and Leh district) and Dirang area of Auranachal Pradesh on various aspects of fruit production by CITH, scientists at CITH, Takmachik (Leh) and Dirang respectively (Table 43). Total of 185 tribal farmers were benefited with knowledge on various technologies.

Table-43.List of trainings for tribal farmers/ officers

S.No	Date	Tile of Training	Location	Total participants
1.	3-6/9/2013	"Product diversification of temperate fruits for novel value added products" to farmers and processors of Kargil, Ladakh	Main campus	9
2.	1.8.2012	Awareness on pollination management in temperate fruits	Takmachik, Leh (Ladakh)	118
3.	5-7/02/2013	Canopy reorientation, orchard floor management and production of quality planting material	Dirang, (Arunachal Pradesh)	58

Trainings on product diversification of temperate fruits for value added products and dehydration of temperate fruits

Awareness programme on pollination management in temperate fruits at Takmachik village of district Leh

Awards and Recognitions

Prof. Nazeer Ahmed, Director

Received prestigious "Dr. M.H. Marigowda National Endowment Award" for 2012 in recognition of contribution made in the field of horticulture instituted by Dr. M.H. Marigowda Horticulture Education and Research Foundation and UAS Banglore.

Prof. Nazeer Ahmed receiving the award from His Excellency The Governor of Karnataka Dr. H.R. Bhardwaj

Received best paper presentation award for key note lecture on "plant architectutal engineering and canopy management in temperate fruits for enhancement of productivity and quality", Global conference on horticulture for food, nutrition and livelihood organized by ASM Foundation and OUAT, Bhubaneshwar w.e.f. May 28-31, 2012.

Awarded Fellow CHAI by Confideration of Horticulture Associations of India at Global Conference on Horticulture, OUAT, Bhubaneshwar, during May 2012.

J.I.Mir & Associates

Received best paper presentation award on Apocarotenoid gene expression in *in-vitro* developed stigma like structures in saffron (*Crocus sativus*) in 4th International saffron symposium, advances in saffron biology technology and trade, organized by ISHS and SKUAST (K), Srinagar, 22-25th Oct., 2012.

List of Publications

Research publications (International/ National)

Ahmed N, Khan S H, Afroza B, Hussain K, Qadri S and Gazala Nazir (2013). Morphological characterization in onion (*Allium cepa* L.) for preparation and implementation of plant variety protection (PVP) legislation and distinctness, uniformity and stability (DUS) testing under temperate conditions of Kashmir. *African Journal of Agricultural Research.* 8(14):1270-1276.

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Popular Articles

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Kumar D, Ahmed N, Srivastava K K, Kumar S and Hassan A (2012). Rain water harvesting techniques for higher almond productivity under rainfed upland Karewa conditions. *Extension Bulletin*-01/2012, CITH publication, Srinagar. 9p.

Participation in Workshops/ Conferences/ Trainings/ Meetings

Prof. Nazeer Ahmed (Director)

- Attended 12th plan meeting from 5th-7th May, 2012 at NASC, New Delhi.
- Attended Global Conference on horticulture for food and nutrition from 28th to 31st May, 2012 at OUAT, Bhubanesdhwar, Orissa.
- Attended XXII Meeting of ICAR, Regional Committee no. 8 on 8th June 2012 at Palampur.
- Attended Horticulture Technology Mission Meeting with Director Research and PI's on 10th June, 2012 NASC, New Delhi.
- Attended Steering Committee Meeting of Horticulture Technology Mission from 22nd to 23rd June 2012 at NASC, New Delhi.
- Attended meeting for formulation the guidelines for the students of other institutions to conduct research for their degree programme as trainees on 5th June, 2012 at Education Division, ICAR, KAB-II, Pusa, New Delhi.
- Attended Divisional Meeting of the Directors/ Project Directors of Horticulture Division from 23rd to 24th July, 2012, at NASC, New Delhi.
- Attended Knowledge Meet and Divisional meeting on 21st to 22nd August 2012 at NASC, New Delhi.
- Visited Regional Station, Mukteshwar to monitor and review the ongoing activities of the station on 24th Aug., 2012.
- Attended Directors meeting with DDG(Hort.) on 5th & 6th September 2012 at KAB-II, New Delhi.
- Attended National Conference on temperate horticultural crops and presented lead paper on status of temperate fruit crops in India and their potential in sub temperate southern hills on 8th and 9th Sept., 2012 at Kodaikanal.
- Visited, HRS, TNAU, Kodaikanal on 10th Sept., 2012 to review & monitor the network project trials.
- Attended J&K Vice Chancellor's Meeting on 8th Oct., 2012 at SKUAST(K), Srinagar.
- Attended Biotechnology Meeting of Heads of Institutions of J&K on 8th Oct., 2012 at SKUAST(K), Srinagar.
- Attended DPC Meeting as nominee of DDH(Hort.) on 10th & 11th of October 2012 at IIHR, Bangalore.
- Attended 4th International Saffron Symposium from 22nd to 25th Oct., 2012 organized by ISHS & SKUAS(K) at SKICC, Srinagar and chaired technical session II.
- Attended Review Meeting with PI's of HTM, SKUAST(J), Jammu on 5th November 2012.
- Attended 5th Indian Horticulture Congress at PAU, Ludhiana from 6 to 8th November 2012 and presented lead paper on "Present status and future research priorities in temperate fruits".
- Attended Meeting of National Consultation on Horticulture at NBPGR New Delhi from 18th to 20th Dec., 2012.
- Attended Interaction Meeting of ICAR Institutes engaged in horticulture to highlight potential technologies and varieties with DAC on 26th Feb., 2013 at New Delhi.
- Attended Meeting of Director's/HOD's from 11th to 13th March 2013 at NASC, New Delhi.
- Attended Director's Conference on 19th & 20th March, 2013 at NASC, New Delhi.
- Attended National Seminar on protected cultivation on 21st March, 2013 at New Delhi.
- Attended HTM Meeting regarding review of physical and financial progress of 2012-13 and

action plan for 2013-14 on 22nd March 2013 at DAC, Krishi Bhawan, New Delhi.

- Attended one day Temperate Horticulture Workshop on 23rd March 2013 at Ooty and presented lead paper on status of temperate fruit crops and their potential in Southern Hills.

Dr R K Verma (Principal Scientist)

- Attended Second Meeting of Project Monitoring Committee (PMC) on Apple Network Programme on 30th May, 2012 in Department of Biotechnology, CGO Complex, New Delhi .
- Attended Fourth International Saffron Symposium on "Advances in saffron Biology, Technology and Trade" organized by ISHS & SKUAST(K) at Srinagar w.e.f. 22-25th October, 2012.

Dr D B Singh (Principal Scientist)

- Attended Fourth International Saffron Symposium on "Advances in saffron Biology, Technology and Trade" organized by ISHS & SKUAST(K) at Srinagar w.e.f. 22-25th October, 2012.
- Attended 5th Indian Horticulture Congress, An International Meet, held at PAU Ludhiana w.e.f. 6-9th Nov., 2012.
- Attended meeting of Head of Departments and Directors with DDG (H) and DG, ICAR held at NASC New Delhi w.e.f. 11-12th March 2013.
- Attended training programme attended on Management Development Programme on Leadership Development (a Pre-RMP Programme) from 8-19th October, 2012 at NAARM, Hyderabad.

Dr Dinesh Kumar (Principal Scientist)

- Attended National conference on Temperate Horticultural crops at Kodaikanal, Tamil Nadu w.e.f. 8-9th September, 2012.
- Attended 5th Indian Horticulture Congress-An International Meet at PAU Ludhiana w.e.f 6-9th November, 2012
- Attended RFD meeting of Horticulture Division at Krishi Anusandhan Bhavan on 23rd November, 2012.
- Attended First Meeting of Task Force for Validation of DUS test guideline for temperate fruits at NASC Complex, New Delhi w.e.f.15-16th January, 2013

Dr. K K Srivastava (Senior Scientist)

- Attended 5th Indian Horticulture Congress, An International Meet, held at PAU Ludhiana w.e.f. 6-9th Nov., 2012
- Attended three days training programme organized by PPV & FRA Authority, New Delhi w.e.f. 21-23rd May, 2012.
- Attended workshop organized by PPV & FR Authority and presented the final "Guideline for the conduct of test for DUS on apple and pear w.e.f. 15 -17th January.2013.

Dr S R Singh (Senior Scientist)

- Attended training on Computational genome analysis techniques in discovery of agronomically important crop gene at NBPGR New Delhi w.e.f.24-29th Sep, 2012.
- Attended training on breeding for higher productivity and industry suitable fruit colorant and bioactive health compound in vegetable crops : conventional and hi-tech cutting edge approaches at IARI New Delhi w.e.f. 4-24th Dec, 2012.

Dr O.C.Sharma (Senior Scientist)

- Attended review workshops of PME Cells of ICAR held at NDRI, Karnal (Haryana) on 8th Dec, 2012.
- Attended Annual Workshop on Urban and Peri-Urban Horticulture at Bangalore (Karnataka) on 2nd March, 2013.

Dr Anil Sharma (Senior Scientist)

- Attended 2nd Jammu and Kashmir Agricultural Science Congress held at SKUAST-Jammu w.e.f 15-17th December, 2013
- Attended one day training on remote sensing and GIS applications in soil science organised by

Intergraph International at Hyderabad on 22nd February, 2013.

Mr. Shiv Lal (Scientist)

- Attended Fourth International Saffron Symposium on "Advances in saffron biology, technology and trade" organized by ISHS & SKUAST(K) at Srinagar w.e.f. 22-25th October, 2012.
- Attended 5th Indian Horticulture Congress, An International Meet, held at PAU Ludhiana w.e.f. 6-9th Nov., 2012.
- Attended 6th DUS review meeting at PPV& FRA, New Delhi w.e.f. 21-22nd May, 2012.

Mr.Ramesh Kumar (Scientist)

- Attended Fourth International Saffron Symposium on Advances in saffron Biology, Technology and Trade" organized by ISHS & SKUAST(K) at Srinagar w.e.f. 22-25th October, 2012.
- Attended 21 days winter school on "Protected Cultivation" at High-Tech Horticulture Unit, University of Agricultural Sciences, Dharwad w.e.f. from 4-24th Dec., 2012
- Attended the review meeting of the project "Economic Revival of J&K Saffron Sector" held at Srinagar on 9th April, 2012
- Attended the review meeting of the project "National Saffron Mission" at Pampore on 21st April,2012
- Attended meeting of Centrally Sponsored Scheme "Rashtriya Krishi Vikash Yojana" at Jammu on 23rd April, 2012.
- Attended visit cum meeting of Saffron Park at Srinagar on 19th June, 2012.
- Attended State Level Sanctioning Committee (SLSC) of RKVY meeting at Srinagar on 26th July, 2012
- Attended five days training on "Dry Flower Arrangements and Value Addition in Ornamentals" at Division of Floriculture and Landscaping, IARI, New Delhi w.e.f. from 27th - 31st Dec., 2012

Dr G Mahendiran (Scientist)

- Attended Summer school on Niche area of Excellence training programme on "Taxonomy of insects and mites" organized by Department of Agricultural Entomology, University of Agricultural Sciences, GKVK, Bangalore w.e.f. 25th July -14th August, 2012".

Dr Sarvendra Kumar (Scientist)

- Attended training programme focused on statistical models for forecasting in agriculture organized by IASRI, New Delhi under the aegis of education division, ICAR, New Delhi w.e.f. 11th Sept to 1st Oct, 2012.
- Attended National workshop on Foresight and future pathways of agricultural research through youth in India at NASC complex, New Delhi w.e.f. 1 to 2nd March, 2013

Dr B.L. Attri (Principal Scientist)

- Attended Vision Group Meeting (VGM) of Uttarakhand Council for Science and Technology (UCOST) on 25th May, 2012 and presented the salient points related to temperate horticultural crops to be included in the roadmap for next five year plan.
- Attended unveiling ceremony of Rinderpest eradication commemoration pillar and workshop on Emerging infectious and trans-boundary animal diseases: challenges for 21st Century organized by IVRI, Mukteshwar on 2nd June, 2012.
- Attended Scientific Advisory Committee (SAC) meeting of KVK, Kafligair (VPKAS, Almora) on 1st August, 2012.
- Attended group meeting with the farmers of different farmer's clubs organized by Humana People to People India (NGO) and NABARD at Kalapatal (Mukteshwar) on 8th Jan.,
- Attended meeting with Honble DDG (Hort.) and Secretary DARE/DG (ICAR) w.e.f. 12-13th March, 2013 at NASC Copmlex, New Delhi

Dr Anil Kumar (Scientist)

- Attended National Symposium on Emerging issues in Plant Health Management and Annual Meeting of Indian Phytopathological Society (IPS-NZ) held at Dr YSPUHF Solan w.e.f. 28-29th, Sep., 2012.
- Attended workshop on Molecular Diagnostic of Fungal and Viral diseases of Apple held at CSIR-Institute of Himalayan Bioresource Technology (Council of Scientific and Industrial Research) Palampur (HP) w.e.f 7-8th August, 2012.
- Attended International Conference on Plant Heath Management for Food Security organized by Plant Protection Association of India at Hyderabad w.e.f. 28-30th November, 2012.
- Attended unveiling ceremony of Rinderpest eradication commemoration pillar and workshop on Emerging infectious and trans-boundary animal diseases: challenges for 21st Century organized by IVRI, Mukteshwar on 2nd June, 2012.

Dr Arun Kishor (Scientist)

- Attended 21 days training on Applications of genomics in crop improvement at department of MBGE, college of basic sciences & humanities, G. B. Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) w.e.f. 27th Dec., 2012 to 16th Jan., 2013
- Attended unveiling ceremony of Rinderpest eradication commemoration pillar and workshop on Emerging infectious and trans-boundary animal diseases: challenges for 21st Century organized by IVRI, Mukteshwar on 2nd June, 2012.

List of Ongoing Projects

S.No	Title of the Project	Project Code	Duration	
			Date of initiation	Date of completion
I. Crop Improvement and Biotechnology				
1	Survey, collection, characterization and documentation of temperate horticultural crops	CITH-01	1998	On going
2	Breeding for development of superior varieties/ hybrids in Solanaceous vegetables	CITH-07	2000	On going
3	Evaluation of walnut genotypes in relation to floral biology and yield attributes	CITH-24	2008	Concluded
4	Development of superior cultivars/ hybrids in temperate fruits through conventional and non conventional methods	CITH-40	2009	2020
5	Studies on improvement and production of saffron	CITH-06	1999	On going
6	Standardization of micro-propagation of apple, walnut, saffron and lilium	CITH-48	2009	2014
7	Effect of bioregulators and physiological maturity of microshoots of apple rootstock MM-111 on rooting under *in vitro* conditions	CITH-52	2011	Concluded
II. Crop Production and Propagation				
1	Large scale multiplication of quality planting material and seeds of temperate horticultural crops	CITH-04	1999	Concluded
2	Standardization of efficient propagation techniques for production of quality planting material of temperate fruits and nuts	CITH-02	1998	Ongoing
3	Standardization of medium, medium high and high density orcharding in temperate fruits and nuts	CITH-03	1999	2014
4	Energy harvest through plant architectural engineering for increasing source and sink relationship in apple and other temperate fruit crops	CITH-31	2008	2013
5	Effect of integrated nitrogen management on yield and quality of almond and soil properties	CITH-34	2008	2015
6	Fertigation studies in almond	CITH-46	2009	2013
7	Evaluation of strawberry varieties under Kashmir conditions in different production systems	CITH-39	2009	Concluded
8	Enhancing blooming period of tulip using PGRs and different storage period.	CITH-42	2009	Concluded
9	Standardization of agro techniques for quality cut flower production both under poly house and open conditions	CITH-43	2009	Concluded
10	Management of physiological disorders in temperate fruits	CITH-32	2008	Concluded

S.No	Title of the Project	Project Code	Duration	
			Date of initiation	Date of completion
11	Effect of various training and pruining systems in Persian walnut	CITH-54	2011	2016
12	Antioxidant and pytonutrient characterization of minor temperate horticultural crops	CITH-53	2011	2014
13	Development of intensive cropping system involving almond and saffron	CITH-41	2009	2013
14	Characterization of soil and nutritional survey of temperate fruit crop	CITH-44	2009	2013
15	Integrated nutrient management in medium and high density orchards in apple	CITH-45	2009	2013
16	Standardization of integrated nutrient management of vegetables as intercrop in apple orchards.	CITH-57	2012	2014
III. Crop Protection				
1	Management of chilli wilt	CITH-21	2008	2013
2	Studies on gummosis of stone fruits and nuts and its management	CITH-22	2008	2013
3	Insect population dynamics on different varieties/ genotypes of apple , almond and apricot	CITH- 53	2011	2013
4	Management of major soil born diseases of apple	CITH-55	2012	2015
5	Development of spray schedule against major canker and foliar diseases of apple in Uttarakhand	CITH-56	2012	2015
6	Study on bioecology & management of aphid and mite	CITH-57	2012	2015
IV. Post Harvest Management				
1	Minimal processing, packaging and storage study of high value vegetables and fruits for quality maintenance and storage	CITH-30	2008	2013
2	Value addition, storage and sensory quality evaluation of different products of major and minor temperate fruits	CITH-49	2009	2013
3	Post harvest management of temperate fruits and nuts for storage and value added products	CITH-37	2009	2013
4	Enhancement of shelf life of different temperate fruits through post harvest chemicals interventions	CITH- 50	2009	2013
V. Development of technologies for mitigation of climate change				
1	Management of frost, drought and other abiotic stresses in almond and apple in changing climate scenario	CITH-33	2008	2013
VI. Rejuvenation of old senile orchard				
1	Sandardisation of technology for rejuvenation of old unproductive almond orchards in Kashmir valley	MM-2.45	2009	Concluded
VII. Development of cropping system involving horticultural and other allied crops				
1	Development of apple based cropping system with legume, spices, vegetables, medicinal and aromatic plants	CITH-38	2009	Concluded
VIII. AICRP/Network projects				
1	Network project on outreach of technologies for temperate fruit crops	Plan Project	2008	On going

S.No	Title of the Project	Project Code	Duration	
			Date of initiation	Date of completion
2	Network project on onion and garlic (co-operation centre-PI)	DOOGR	2008	On going
3	Survey, collection, evaluation and conservation of temperate pomegranate genotypes/ wild species/varieties under North Western Himalayan region	Inter Institutional Project	2010	2015
4	Intellectual property management and transfer/ commercialization of agricultural technology scheme	ICAR	2008	On going
IX. Validation of DUS Internaional guidelines under Indian conditions				
1	DUS on apple and pear	PPV & FRA	2008-09	Concluded
2	DUS on walnut and almond	PPV & FRA	2008-09	Concluded
3	DUS on apricot and cherry	PPV & FRA	2008-09	Concluded
4	DUS on strawberry	PPV & FRA	2011-12	2013
5	DUS on peach and plum	PPV & FRA	2011-12	2013
X	Biotechnological interventions for improvement of apple through virus and genetic fidelity certification and production	DBT	2011-12	Ongoing
XI	Establishment and strengthening of tissue culture facilities	DAC	2011-12	2014-15
XII	Horticulture Technology Mission Projects (15 Activities)	DAC	2005	On going

Research Review and Management Committees

Research Advisory Committee (RAC)

S. No.	Name of the Member	Capacity
01.	Dr. Jagmohan Singh Chauhan Ex. Vice-Chancellor, Dr. Y.S. Parmar University of Horticulture and Forestry Solan. (HP)	Chairman RAC
02.	Dr. S.N. Pandey Ex. ADG (Hort.), ICAR, New Delhi	Member
03.	Dr. D.P. Singh Ex. ADG (VC), ICAR, New Delhi.	Member
04.	Dr. N. Kumar Dean (Hort.), Tamil Nadu Agricultural University Coimbatore, Tamil Nadu	Member
05.	Dr. J. Kumar Prof. & Head, Div. of Plant Pathology G.B. Panth University of Agriculture and Technology, Pant Nagar, Uttarakhand.	Member
06.	Dr. A.K. Dhawan Prof. & Head, Div. of Entomology. Punjab Agricultural University, Ludhiana, Punjab	Member
07.	Prof. Nazeer Ahmed Director, CITH, Srinagar. J & K.	Member
08	Dr. W.S. Dhillion ADG, Hort I, ICAR, KaB II, Pusa, New Delhi	Member
09.	Syed Altaf Bukhari, Managing Director, FIL Industries,Kohinoor House, Srinagar, J&K	Member
10	Shri Thakur Randhir Singh Former Minister, 298 EP Flat Wazarat Nagar, Jammu-Tawi	Member
11	Dr. Desh Beer Singh Pr. Scientist CITH, Srinagar. J & K.	Member Secretary, RAC

Institute Management Committee (IMC)

S. No.	Name of the Member	Capacity
1.	Prof. Nazeer Ahmed, Director, CITH, Srinagar	Chairman
2	Asstt. Director General (Hort. I) ICAR, KAB-II, Pusa, New Delhi	Member
3.	Director Horticulture Govt. of J&K, Rajbagh, Srinagar (J&K).	Member
4	Director Horticulture & Food Processing Department of Horticulture, Chaubatti Ranikhet, Almora (Uttarakhand)	Member
5	Dr. M. S. Wani Prof. cum Chief Scientist Division of Fruit Science, SKUAST-K, Srinagar	Member
6	Shri Thakur Randhir Singh Former Minister, 298 EP Flat, Wazarat Nagar, Jammu -Tawi	Member
7	Syed Altaf Bukahri Progressive Orchardist and Managing Director, FIL Industry, Kohinoor House, Srinagar	Member
8	Dr. A.K. Singh Head, Division of Fruit and Horticulture Technology IARI, New Delhi - 110012	Member
9	Dr. Sanjay Kumar Dwivedi Joint Director, Defense Research and Development Organization (DRDO) CEPTAM, Metcalfe house, Delhi-110054	Member
10	Dr. Shant Lal Prof. and Head Horticulture, G.B. Pant University of Agriculture and Technology Pantnagar-263145 (Uttarakhand)	Member
11	Dr. R.K. Verma, Principal Scientist, CITH, Srinagar (J&K)-190007	Member
12	Finance and Account Officer, CIPHET, PAU Campus, Ludhiana-141004	Member
13	Asstt. Administrative Officer, CITH, Srinagar-190007, J&K	Member Secretary

Distinguished Visitors

1. Dr. M. Shekhargowda, Dean (Agric.) Rtd. and Member BOM, UAS Bangalore, visited CITH on 20th April 2012
2. Dr. S.B. Dandin, VC, UHS, Bagalkot visited CITH, Srinagar on 24th April 2012
3. Dr. B.V. Patil, VC, UAS, Raichur, Visited CITH Srinagar on 24th April, 2012
4. Shri Vishwanath Anand, Ex- Secretary, Ministry of Environment and Forests, Govt. of India. visited the Regional Sation Mukhteswar on 18th May, 2012
5. Dr. V.J. Shivankar, Director, NRC for Citrus, Nagpur visited CITH Srinagar on May 3rd, 2012
6. Dr. A.J. Shaikh, Director, CIRCOT, Mumbai, Visited CITH Srinagar on 20th May, 2012
7. Dr. Rajendra Presad, Project Director, Director of Seed Research, MAU (UP) visited CITH Srinagar on June 4th, 2012
8. Dr. V.K. Yadava, Plant Protection Advisor PPQI, Faridabad visited CITH Srinagar on June 4th, 2012
9. Utpal Kumar Singh, Jt. Secretary, (Plant Protection) DAC, Krishi Bhawan visited CITH Srinagar on June 4th, 2012
10. Ms. Uma Goel, Jt. Secretary DAC visited CITH Srinagar on June 4th, 2102
11. Mr. M.K. Jain, COE, ASRB, New Delhi visited CITH Srinagar on June 14th, 2012
12. Dr. S.K. Datta, DDG (CS), ICAR, New Delhi visited CITH Srinagar on 30th June 2012
13. Dr. K.R. Dhiman, V C, Dr. YSPUHF, Solan, Himachal Pradesh, visited CITH Srinagar on September 1st, 2012
14. Sh. K.S. Dhaliwal, Member G.B. ICAR, New Delhi, visited CITH Srinagar on September 10th, 2012
15. Dr. S.K. Pandey, Chairman, QRT (AICRP-Vegatable Crops) visited CITH Srinagar on 6th October 2012
16. Dr. Jagmohan Singh, Former V C and Chairman RAC, CITH, visited CITH Srinagar on October 17th, 2012
17. Dr. M. Kochu Babu, Principal Scientist (M&E), NAIP, KAB-II New Delhi-110012, visited CITH Srinagar on 22nd October, 2012

Dr S K Dutta, DDG (Crop Science) visiting technology park of CITH

Director, CITH discussing various technologies with Members of BOM of UAS, Banglore during their visit to CITH on 20th April 2012

Personnel

CITH Head Quarter, Srinagar

RMP

- Prof. Nazeer Ahmed, Director

Scientific

- Dr. R.K.Verma, Principal Scientist, Plant Pathology
- Dr. D.B.Singh, Principal Scientist, Hort-Vegetable Science
- Dr. Dinesh Kumar, Principal Scientist, Hort-Fruit science
- Dr. K.K. Srivastava, Senior Scientist, Hort-Fruit Science
- Dr. S.R. Singh, Senior Scientist, Hort-Vegetable Science
- Dr. O. C. Sharma, Senior Scientist, Hort-Floriculture
- Dr. Anil Shama, Senior Scientist ,Soil science
- Mr. J.I. Mir, Scientist, Plant Biotechnology
- Mr. Shiv Lal, Scientist, Hort-Fruit Science
- Mr. Ramesh Kumar, Scientist, Floriculture.
- Dr. G. Mahendiran, Scientist, Agri. Entomology
- Sh. Sarvendra Kumar, Scientist ,Soil Science

Director Cell

- Mrs. Shahida Rafiq, P.A. to Director

Technical

- Dr. Girija Shankar, T-6
- Eshan Ahad, T-5.
- Sh. Brijendra Kumar, T-5
- Sh. Muneer Ahmad Sheikh, T-4
- Sh. Diwakar Vithuji Sawaji, T-3.
- Sh. Mehraj-ud-din Bhat, T-3 (Driver)
- Sh. Farman Ali, T-3 (Driver)
- Ms. Mubeena, T-1 (Data/Computer operator)
- Sh. Ajaz Ahmad Wani, T-1 (Field Asstt.)

Administrative

- Sh. Ramesh , Asstt. Admn. Officer
- Sh. Fayaz Ahmad Dar, AF &AO
- Sh. Showket Ahmad Mir, Assistant.
- Sh. Reyaz Ahmad Mir, Assistant
- Sh. Mukhtar Ahmad Mir, Assistant
- Sh. Mehraj-ud-Din Meer, LDC
- Sh. Tariq Ahmad Mir, Jr. Stenographer

Supporting Staff

- Sh. Bashir Ahmad Dar,SSS
- Sh. Showkat Ahmad Dar, SSS
- Sh. Abdul Rashid Bhat,SSS.
- Sh. Bashir Ahmad Ganai, SSS.
- Sh. Zubair Ahmad Swathi, SSS
- Sh. Madan Lal, SSS.
- Sh. Khushi Ram, SSS

Regional Station, Mukteshwar

Scientific

- Dr B.L. Attri, Principal Scientist (Hort.- Fruit Science)
- Dr B. Das, Senior Scientist (Hort. – Fruit Science)
- Dr Anil Kumar, Scientist (Plant Pathology)
- Dr Arun Kishor, Scientist (Hort. Fruit Science)

Technical

- Sh. Vinod Chandra, T-5 (Technical Officer)
- Sh. Man Mohan Singh, T-3 (Driver)
- Sh. Puran Chandra, T-2
- Sh. Ishtiyaq Ahmad, T-1

Administrative

- Sh. Akhil Thukral, Asstt. Admn. Officer
- Sh. Diwan Chandra, Assistant
- Sh. Pushpendra Kumar, Junior Clerk

Supporting

- Sh. Narayan Singh, SSS
- Sh. Govind Giri, SSS

Staff of IVRI Regional Station attached at CITH

- Sh. G.A. Sofi, P.S. to Director.
- Sh. Mohammad Ramzan Wani, T-2
- Sh. Mushtaq Ahmad Khan, T-2
- Sh. Ghulam Hassan Mir, SSS
- Sh. Ghulam Hassan Gojaree, SSS
- Sh. Ghulam Ahmed Rather, SSS
- Sh. Abdul Rashid Dar, SSS
- Sh. Ghulam Nabi Bhat, SSS
- Sh. Ghulam Nabi Ganai, SSS

Appointments/ Promotions/ Transfers/ Retirements

Appointments

Sh. Akhil Thukral joined as Asstt. Admn. Officer on 23rd April, 2012 at CITH-RS, Mukteshwar.

Sh. Khushi Ram joined as SSS on 22nd Feb., 2013 at CITH, Srinagar.

Promotions

Sh. Riyaz Ahmed Mir, promoted as Assistant w.e.f 6th Feb., 2013.

Sh. Mukhtar Ahmad, promoted as Assistant w.e.f 7th Feb., 2013.

Sh. Muneer Ahmad Sheikh promoted as T4.

Transfers

Dr. B. Das (Senior Scientist), transferred from Regional Station Mukteshwar to ICAR Research Complex Tripura w.e.f. Oct. 2012.

Retirements

Sh. Ghulam Hassan Gojaree, SSS of IVRI, superannuated on June 2012.

Sh. Ghulam Nabi Ganai, SSS of IVRI, superannuated on June 2012.

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