वार्षिक रिपोर्ट
Annual Report
2005-2006

केन्द्रीय शुष्क बागवानी संस्थान

Central Institute for Arid Horticulture

Bikaner 334 006

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BEECHWAL, BIKANER 334 006

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Preface

THE Annual Report for the year 2005–06 has been compiled as per the guidelinesof ICAR. The major research achievements with special emphasis on germplasm utilization, crop management and integrated nutrients, pest and diseases management of major arid fruits and vegetables have been documented as main area of presentation. Additionally concise information about under utilized fruits also has been presented in the report.

The arid region covering about 12 per cent of total area is marked by weakness such as high and low temperatures, low and erratic rainfall, low relative humidity, high potential evapo-transpiration, low soil nutrients status etc., However, the region holds strengths such as ample sunshine, abundant solar energy, low incidence of pests and diseases etc., and therefore, arid region in the present form is highly suitable for commercial production of horticultural crops for the domestic and export market provided the adequate technological know-how are disseminated and adopted in this region. The institute came into existence in October 2000 with a Regional Station at Vejalpur (Godhra), Gujarat from the status of National Research Centre for Arid Horticulture, started on 1st April, 1993.

The research and extension work of the institute is being carried out at CIAH, Bikaner and its regional station after critical review by the external referees for projects, QRT and RAC for the institute as a whole during the year. Presently, a total of 48 research projects are under operation and its regional station in addition to one adhoc scheme. The plant genetic resources, 338 genotypes/strains of ber, 152 genotypes of pomegranate, of 50 genotypes of aonla and 55 of date palm in addition to large number of collections from arid vegetables are being maintained in national repository of germplasm. Most of the germpalsm of ber, aonla and pomegranate were severely affected by frost. Few of the genotypes were exploited for the improvement programme and promising varieties of ber and vegetables viz., *mateera* and bottle gourd are in pipeline for release.

Apart from this, propagation and micropropagation techniques of lasoda, ker and cactus pear have been developed for the rapid multiplication of arid fruits. Growth and development of studies on arid vegetable crops, standardization of production technology of aonla, integrated nutrient management with special emphasis on vermicompost, optimum use of water through soil and water conservation methods, integrated management strategies for the major pests and biological management of major diseases of arid and semi-arid importance were also worked out. In addition, processing techniques in *khejri*, dehydration methods for *Kachri* and maturity standards and packing techniques in aonla and ber were carried out. This institute is well equipped with modern equipments and infrastructure facilities.

This annual report is an outcome of the dedicated efforts of Dr P.Nallathambi, Dr O.P. Awasthi, Dr.R.Bhargava and Dr D.K. Samadia, Senior scientists of the publication committee. I am pleased to present with the hope that it will give useful and scientific information to all the stackholders related to arid horticulture.

(D.G. Dhandar)
Director

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चूर्णी फफूंद सहिष्णु संग्रहित एक जननप्रकार सहित बेर के 338 जननप्रकारों को राष्ट्रीय संग्राहलय में संरक्षित किया गया। इन जननद्रव्यों में थोर्नलेस एवं रश्मि किस्में सबसे लम्बी हैं। बेर के टिकड़ी एवं साईरिया (खवासपुरा) प्रकारों के अतिरिक्त अन्य किसी भी जननप्रकार में पाले के प्रति सहिष्णुता के गुण नहीं हैं। इनमें –1.5 डिग्री से. तक तापक्रम सहन करने की क्षमता देखी गई है। संवर्धन कार्यक्रम में सीआईएएच संकर–1 व सीआईएएच सलेक्शन–1 का मूल्यांकन किया गया। अनार के 150 जननद्रव्यों का संरक्षण किया जा रहा है। खेजड़ी, केर व खजूर जैसे फल–वृक्षों में कम तापक्रम/पाले को सहन करने की क्षमता है। यद्यपि इन सब में पाले से क्षति भी दर्ज की जा चुकी है। आंवला जननद्रव्य मूल्यांकन कार्यक्रम में नरेन्द्र आंवला–7 की औसत उपज 67 किग्रा. प्रति पेड़ दर्ज की गयी है।

आंवला के स्व–असामंजस्य अध्ययन में बहुत भिन्नता पायी गई है। बलवंत के साथ नरेन्द्र आंवला–7 के योग में अधिकतम फल (67.08:) बने और 36.76 प्रतिशत फल अंत तक बने रहे। कंचन के लिए चकैया सर्वश्रेष्ठ पराग देने वाली किस्म रही। साधारणतः स्वःपरागण की अपेक्षा खुले रूप से परागण करने में अधिक फल आए। खजूर में 58 जननद्रव्यों के अतिरिक्त जगलूल, सकलोती, अमीरी तथा अगलोनी नामक जननद्रव्यों का संग्रहण किया गया। जननद्रव्य मूल्यांकन प्रयोग में हलावी, दयारी, खूनैजी, मेडजूल, शामरान, खदरावी तथा जहीदी में नियमित रूप से फल आए। हलावी, सबीह, दयारी, जहीदी, बीकानेर लोकल तथा खदरावी में अधिकतम फल उपज दर्ज की गई। टीशू कल्चर पौधों में पौध का बनना अधिक दर्ज किया गया।

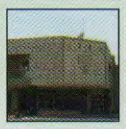
कुछ अवप्रयोगी शुष्क फलों पर भी संग्रहण एवं मूल्यांकन कार्य किए गए जिनमें बेल, करोंदा, फालसा, लसोड़ा, केर, इमली, नागफनी एवं काठाफल प्रमुख है। कुछ विदेशी फलों का भी संग्रह व रख–रखाव किया गया। इनमें मरूलानट में पौध वृद्धि अच्छी दर्ज की गई। करोब एवं अरगन के पौधों में पौध वृद्धि न्यूनतम रही । मरूलानट के पौधों पर पाले का प्रभाव देखा गया जबकि चाइनीज बेर, अरगन व करोब फल प्रजातियां पाले से न्यूनतम प्रभावित हुई। महुआ की लगभग 35 प्रजातियां गुजरात के विभिन्न भागों से संग्रहित कर लाई गई हैं। मूल्यांकन के सभी आधारों पर एमएच–2, 4, 8, 10, 14, 16 एवं 18 जननद्रव्य अन्य की अपेक्षा अच्छे पाए गए। इसी प्रकार चिरौंजी के 30 जनन प्रकारों को फलन, फूलन और गुणवत्ता के आधार पर मूल्यांकित किया गया।

सब्जियां

अर्द्धशुष्क क्षेत्र में कद्दूवर्गीय जननद्रव्यों पर उपज, गुणवत्ता तथा सूखा सहिष्णु किस्मों के विकास व इनको व्यावसायिक स्तर पर बढ़ाने हेतु कार्य किया जा रहा है। घीया के 20 जननप्रकारों को भी मूल्यांकित किया जा रहा है। कद्दू की सीएम–16, सीएम–36 तथा सीएम–40, लौकी की एलएस–6, करेला की एमसीसी–23 को चारित्रिक एवं चिन्हित विशेषताओं के आधार पर छांटा गया है। चयनित किस्मों से श्रेष्ठ गुणवत्ता वाली किस्मों का विकास करने हेतु बड़े पैमाने पर प्रयोग कार्य किया गया है।

जैव प्रौद्योगिकी तथा टीशू कल्चर

टीशू कल्चर कार्य में केर व गोंदा में सूक्ष्म प्रवर्धन तकनीकी द्वारा संवर्धन कार्यों की संभावनाओं का पता लगाया गया है। केर में तना प्रवर्धन में 13 सूक्ष्म तनों के विकास को दर्ज किया गया है। सब्जी वाली नागफनी की एक किस्म को सूक्ष्म प्रवर्धन



तकनीकी द्वारा कांटों रहित रूप में विकसित किया गया है।

फसल प्रबन्ध

आंवला आधारित बहुस्तरीय फसल प्रणाली विकसित करने के प्रयोग में प्रथम स्तर की फसल का प्रदर्शन अच्छा रहा है। मतीरा–काचरी मॉडल ने अन्य तीन मॉडलों से अपेक्षाकृत अच्छे परिणाम दिए हैं। वर्षा पर निर्भर स्थिति में आंवला आधारित फसल प्रणाली में लौकी को आन्तरिक फसल के रूप में उगाने पर अच्छे परिणाम प्राप्त हुए हैं।

पौधे से पौधे की दूरी 10×10 रखने पर नरेन्द्र आंवला–7 में सर्वाधिक उपज दर्ज की गई। अर्द्धशुष्क स्थिति में जैविक एवं अजैविक पलवार का प्रयोग वाष्पीकरण को रोकने में सफल रहा तथा इससे पौधे की बढ़वार पर भी अनुकूल प्रभाव दर्ज किया गया। अजैविक पलवार में काली पॉलीथीन सबसे बढ़िया रही, जबकि जैविक पलवार में धान की भूसी सबसे अच्छी दर्ज की गई। द्विपरतीय हैज प्रणाली में पौधे की बढ़वार उत्तम रही जबकि तना के घेरा, फैलाव आदि चतुर्भुज विधि से पौध रोपण में अधिक दर्ज किए। धान के भूसे की पलवार से पौधे की बढ़वार व फलन में अनुकूल प्रभाव दर्ज किया गया।

सहजन आधारित फसल प्रणाली में वर्षा–निर्भर स्वस्थानिक जल संग्रहण तकनीक से 1.5 गुणा 1.00 गुणा 1 मीटर के गड्ढे में 60 किलो गोबर की खाद देकर अच्छी उपज प्राप्त की गई। तौरई, कद्दू एवं सहजन के उत्पादन में उल्लेखनीय वृद्धि दर्ज की गयी। सहजन के साथ कद्दू, सेमफली तथा ग्वार की खेती में अधिक सफलता दर्ज की गई ।

समेकित पोषण प्रबन्ध

अनार में विभिन्न जैविक व अजैविक खादों/उर्वरकों के संयोगों द्वारा प्रयोग करने पर पाया गया कि केंचुवा तथा अजैविक खाद के संयोग में बेहतर परिणाम दर्ज किए गए। एन. पी.के. की अनुशंसित मात्राओं को आठ वर्ष की आयु के पौधों में प्रयोग किया गया। खाद की मात्रा, उनमें नाइट्रोजन की मात्रा आदि के आधार पर पौधों में उपज एवं फल भार का अध्ययन किया गया। विभिन्न प्रकार की खादों में फल भार व कुल उत्पादन में अन्तर स्पष्ट दिखाई दिया। उपज बढ़ने के साथ खाद की मात्रा के आधार पर ही फलों में मिठास व स्वादिष्टता की वृद्धि भी दर्ज की गई।

पौषक तत्वों की मात्रा के आधार पर पौधे के विकास, बढ़वार व उत्पादन के विभिन्न पहलुओं पर व्यापक अध्ययन किए गए।

जैविक कृषि

अनार के बढ़वार आयाम में विभिन्न चार प्रकार के पेड़ों के लीफ लिटर के प्रयोग से कोई उल्लेखनीय प्रभाव नहीं दर्ज किए गए। यद्यपि एनपीके की मात्रा में प्रभाव अवश्य दर्ज किया गया। चीकू में गोधरा उपकेन्द्र पर जैविक खाद के प्रयोग में कोई उल्लेखनीय परिणाम प्राप्त नहीं हुए। यद्यपि गोबर –मींगनी तथा मुर्गी की खाद से भीण्डी, बैंगन आदि सब्जियों में अवश्य उपज में वृद्धि दर्ज की गयी। सूक्ष्मपोषकों का एकल एवं योगिक छिड़काव अनार की उपज को बढ़ाने में सहायक रहा।

मृदा व जल संरक्षण

मृदा एवं जल संरक्षण हेतु कई प्रकार के प्रयोग व प्रयास किए गए। मिट्टी के बांध बनाकर उनमें वर्षा जल को संग्रहित किया गया। यह जल उस समय सिंचाई के लिए प्रयोग किया जाता है जब अन्य स्रोतों से जलापूर्ति बंद हो जाती है। उपकेन्द्र गोधरा पर जल एवं मृदा संरक्षण हेतु अनेक अन्य उपाय भी किए गए । जल संरक्षण के प्रभाव से भू–जल के स्तर में एक उल्लेखनीय बढ़ोतरी दर्ज की गई।

पादप कायिकी

तरबूज एवं मतीरे में पानी की कमी का दबाव और पानी की कमी की पूर्ति इन दोनों स्थितियों में प्रकाश संश्लेषण प्रभावों का अध्ययन किया गया। तरबूज में पानी की कमी का प्रभाव प्रारंभ से ही दिखाई देने लगा था। मतीरा (सूखा सहिष्णु किस्म) में पानी की कमी के दबाव को सहन करने की क्षमता विकसित हुई। दूसरी और तरबूज (सूखा सहिष्णु) प्रजाति में न तो पानी की कमी के दबाव को सहन करने की क्षमता विकसित

हुई और न ही पानी देने के बाद पुनःस्थिति लौटी। इन प्रयोगों में पाया गया कि मतीरा, काचरी तथा फूटककड़ी में सूखा सहन करने की अपार क्षमता है। आंवला में भी प्रकाश संश्लेषण के प्रभाव का अध्ययन किया गया।

कटाई उपरांत तकनीकी

आंवला किस्म नरेन्द्र आंवला–7 में फल पकने के तीस दिनों बाद भी उनमें कोई प्रतिकूल प्रभाव नहीं देखा गया। कैल्सियम क्लोराइड के दो प्रतिशत घोल से उपचारित फलों में फलभार अथवा अन्य किसी प्रकार से फल पर विपरीत प्रभाव नहीं दर्ज किया गया। आंवला को डिब्बा पैक करने में फाईबर अथवा लकड़ी कार्टन में समाचार–पत्र अथवा पॉलीथीन के साथ रखना सबसे अच्छा होता है।

खेजड़ी की सांगरी को सुखाने से पूर्व उपचारित किया गया। सूखी सांगरी को एक वर्ष तक रखा जा सकता है। सूखी सांगरी में किसी प्रकार के दुष्प्रभाव को जांचने के लिए किए प्रयोग में पाया गया कि साधारणतः सूखी सांगरी में किसी प्रकार के कीटाणु नहीं पाए गए। यद्यपि रासायनिक प्रक्रिया की जांच में नहीं के बराबर कवक आदि का प्रकोप देखा गया। छिलके सहित अथवा रहित एवं नमक के घोल का भी कोई विशेष प्रभाव नहीं पड़ता है। छिलके सहित सुखाई गई काचरी में पोषक तत्व अधिक पाए जाते हैं। ड्रायर से सुखाई गई काचरी में कवक आदि का प्रकोप न्यूनतम पाया गया।

समेकित कीट एवं व्याधि प्रबन्ध

कीट प्रबन्ध

बेर की गोला व उमरान किस्मों में कीटनाशी एण्डोसल्फॉन एवं कवकनाशी बेलिटोन व बेविस्टीन की अनुशंसित मात्राओं से फल मक्खी, फल छेदक एवं चूर्णी फफूंद रोग में नियत्रंण दर्ज किया गया। इसी प्रकार कीटनाशी के संयुक्त छिड़काव से रोग के प्रारंभ में नियत्रंण पाया जा सकता है। आंवला प्रजाति एनए–7 पर डाईमीथोट अथवा एण्डोसल्फॉन के साथ कवकनाशी बेविस्टीन के छिड़काओं से उपज में उल्लेखनीय वृद्धि दर्ज की गई है।

व्याधि प्रबन्ध

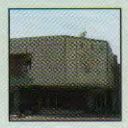
जीव नियंत्रकों को अखिल भारतीय शुष्क क्षेत्र फल समन्वित अनुसंधान परियोजना के माध्यम से बहु क्षेत्र में प्रयोग हेतु भेजा गया था। इन विभिन्न क्षेत्रों में इनके परिणाम भी अलग–अलग ही प्राप्त हुए हैं। पी.फलोरासेन्स से सीआईएएच–111, सीआईएएच–196 एवं सीआईएएच–311 तथा ट्राईकोडरमा से सीआईएएच–115 व 240 जीव नियंत्रक बनाए गए, जिनको चूर्ण रूप में बनाया गया। इनमें से उन्नत जीव नियत्रंकों (सीआईएएच–196 व सीआईएएच–240) को फलित कर बनाया गया। आरंभिक अवस्था में जब केराथीन 0.5 प्रतिशत के साथ सीआईएएच–196 को मिलाकर प्रयोग करने से सितम्बर में रोग का फैलाव 60.43 प्रतिशत था और नियत्रंण के परिणाम 83.56 प्रतिशत दर्ज किए। परन्तु यही उपचार जब दिसम्बर माह में किया गया तब नियंत्रण प्रभाव कम पाया गया।

बेलीटोन के तीन छिड़काओं से बेर के चूर्णी फफूंद रोग में नियंत्रण पाया गया। अनार के फल गलन रोग के विषाणु के जीवनियंत्रकों का अखिल भारतीय शुष्क क्षेत्र फल समन्वित अनुसंधान परियोजना से संग्रहण कर उस पर विभिन्न आयामों से अध्ययन किया गया। बेविस्टीन के दो छिड़काओं से अनार के पर्ण सर्कोसफेरा व फल धब्बे का प्रभावी उपचार देखा गया।

मतीरा, काचरी, लौकी, तौरई के साथ मिर्च, बैंगन और फूटककड़ी के जननद्रव्यों को व्याधि जांच प्रक्रिया में रखा गया। फूटककड़ी की 21 धाराओं में से कोई भी विषाणुजनित एवं पर्ण चकत्ते रोगों से रहित नहीं पाई गई। यद्यपि गलतौरई की एक धारा रोग से पूरी तरह रहित देखी गई। लौकी के पर्ण चकत्तों के रोग को मेनकोजेब के दो छिड़काओं से नियंत्रित किया गया।

कृषि विस्तार गतिविधियां

सघन सर्वे में पाया गया कि किसानों ने उन्नत किस्मों के फलों की खेती प्रारंभ कर दी है। बेर में सेब, गोला, उमरान, आंवला में एनए–7, एनए–6, चकैया, मतीरा में एएचडब्लू–65, एएचडब्लू–19, फूटककड़ी में एएचएस–10, एएचएस–82 तथा काचरी में एएचके–119 व एएचके–200 किस्मों की व्यावसायिक



खेती करना आरंभ कर दिया है। परन्तु अभी भी बीकानेर जिले के 56.8 प्रतिशत किसान मतीरा, काचरी व फूटककड़ी की पारम्पारिक खेती ही करते हैं। यद्यपि बेर, आंवला तथा अनार उत्पादक इनकी खेती आधुनिक तकनीकी से करने लगे हैं।

अर्द्धशुष्क क्षेत्र में किसानों द्वारा अपनाई जाने वाली समेकित बागवानी प्रौद्योगिकियों का एक अध्ययन किया गया। इसमें देखा गया कि इस क्षेत्र के किसान आंवला फलों के परिवहन में ट्रक का प्रयोग करते हैं। अधिकतर किसान आंवला फलों को पैक करने के लिए लकड़ी के बक्सों का प्रयोग करते है। प्रायः सभी किसानों ने सहमति जताई कि संसाधनों की कमी ही फल उत्पादन नहीं अपनाने का कारण है। इसमें छोटी–छोटी भूमि व आर्थिक दृष्टि से पिछड़ापन भी एक मुख्य कारण है। इस अवधि में वैज्ञानिकों ने विभिन्न स्थानों पर कैम्प लगाकर किसानों को विकसित तकनीकियों की जानकारी प्रदान की तथा उनके खेतों पर इनको प्रयोग करने की विधि समझायी। तकनीकियों का हस्तानांतरण किसान मेलों आदि द्वारा भी किया गया।

इस वर्ष संस्थान ने उप केन्द्र सहित फार्म उत्पादों की निलामी तथा पौधे विक्रय से 200615.00 रुपयों की आय अर्जित की।

Executive Summary

PLANT GENETIC RESOURCE MANAGEMENT

Fruits

A total of 338 *Ziziphus* genotypes including a powdery mildew tolerant type collected from Goa are maintained in the National germplasm repository. Cultivars Thornless and Rashmi were reported as tallest among these genotypes. Two cultivars Tikadi and Syria (Khavaspura) were tolerant to low temperature (–1.5°C) while rest of the genotypes were injured by frost. In improvement programme, CIAH-Hybrid-1 and CIAH-Selection-1 have been evaluated. In pomegranate 152 germplasms are maintained. The fruit crops like date palm, *khejri* and ker were tolerant to frost/low temperature. However, all others were susceptible to frost injuries. Similar trend was also seen in case of aonla. However, evaluation of aonla germplasm showed an average yield 67 kg per plant in cv. Narendra aonla 7.

Self-incompatibility studies in aonla showed differential response. Commercial variety NA-7 crossed with Balwant resulted maximum fruit set (67.08) and retention (36.76%). Cultivar Chakaiya was good pollinizer for cv. Kanchan. In general, all the cultivars with open pollination resulted in high fruit set and retention as compared to self pollination. In date palm, cvs. Zaglool, Sakloti, Amiri and Agloni were collected in addition to existing germplasm. Under germplasm evaluation, genotypes Halawy, Dayari, Khuneizi, Medjool, Shamran, Khadrawy and Zahidi attained regular fruiting. Fruits yield was better in Halawy, Sabiah, Dayari, Zahidi, Bikaner local and Khadrawy and maximum number of berry 20–22 per strand was in Bikaner local and Zahidi. It was observed that sucker formation was more in tissue culture plants than offshoots plantation. Early fruit maturity (doka stage), size (4.06 × 2.68 cm), weight (7.2 g) were recorded in cv. AV.Thomas while, cv. Khuneizi also yielded good quality fruits.

Germpalsm evaluation of bael (*Aegle marmelos*) karonda (*Carisa carandus*), phalsa (*Grewia subinaequalis*), lasora (*Cordia myxa*), ker (*Capparis decidua*), cactus pear (*Opuntia ficus indica* Mill.), wood apple, manila tamarind and some of the exotic fruit species like Carob, Chinese jujube, argan, marula nut are being carried out in the main centre, CIAH, Bikaner. Whereas in the regional station, some of the under utilized fruits like jamun, tamarind, bael, mahua and chiraunji are being maintained and evaluated. The reproductive biology, developmental pattern, fruit quality attributes and growth behaviour of these fruit crops have been studied. In jamun, based on the different reproductive attributes, panicle may be considered as one of the positive traits for screening elite genotypes. The elite genotypes are being multiplied to establish in the field. In tamarind, genetic variability and yield attributes indicated that genotype CPT-20 gave highest fruit yield per plant (195.00 kg). Bael genotypes exhibited significant difference in most of the growth characters. In Mahua, dry flower yield ranged from 27–48 kg/plant. However, fruit yield (98.00 kg/plant) and flower Juice (67.00%) were high in MH-32. In chiraunji, fruit set per panicle was positively associated with panicle length. Some of the genotypes viz., CPT 1, CPT 2, CPT 5, CPT 6, CPT 7, CPT 8, CPT 12 and CPT 30 were promising.

Vegetables

Various germplasm of muskmelon, kakadi, brinjal

and chilli were maintained. The vegetable lines viz., *mateera* (F6/a), bottle gourd (AHLS-Round-1), Indian bean (AHDB-03-AHDB-16), sword bean (AHSB-1) were tested under large scale. In order to improve the yield, snapmelon and kachri varieties were evaluated. In addition to these, seed production of mateera, sanpmelon, bottle gourd and clusted bean have been achieved. Breeding for yield, quality and biotic and drought resistance in cucurbitaceous vegetables resulted some of the promising genotypes for commercial cultivation under semi arid region. Genotypes CM-16, CM-36 and CM-40 of pumpkin, genotype LS-6 of bottle gourd, MCC-23 of bitter gourd are the promising lines. Among the F_1 progenies tested under summer season, CM-16 × CM-19 observed better for more number of fruits per plant (9.21) weighing 1.826 kg followed by CM-12 × CM-16 (6.79 fruits) with medium size. CM-4 × CM-15 and CM-19 × CM-4 observed to be bigger size fruits with 4.12 fruit each per plant. During rainy season, CM-22 × CM-15 for high yielding with smaller sized fruits and CM-17 × CM-18 for high yielding with moderately bigger sized fruits among the 35 F_1s evaluated and CM-16 × CM-19 observed high yielding among the 10 F_2 segregates evaluated.

Biotechnology and tissue culture

In tissue culture, refinement and improvement of micropropagation techniques for ker and gonda have been worked out. In ker shoot proliferation per explant was recorded upto 13 microshoot/explant. Micropropagation techniques for a thornless, vegetable type were developed through single bud explants of cactus pear.

CROP MANAGEMENT

Aonla based diversified cropping models under arid ecosystem resulted that the ground-storey crops performed well in the different cropping models without affecting the growth and development of main and component crops. Yield of ground storey crops viz., *mateera* (*Citrullus lanatus*), and *kachri* (*Cucumis melo*) grown in models 2, and 4 recorded an average yield of 3.44, and 20.0 qha^{-1}, respectively. Aonla based cropping system under rainfed conditions of semi arid region indicated that intercrop with bottle gourd in the four year old orchard of aonla planted at 10×10 m apart was showing maximum yield per ha as well as economic return. Out of various planting systems, an increase in yield (99.80%) and additional economic returns of Rs.8982/ ha was recorded in double hedgerow system in 4th year.

Investigations on high-density orcharding in aonla NA-7 resulted that maximum yield per plant in 10 × 10 m spacing while maximum yield was recorded in 5 × 5 m spacing with maximum net return. Organic and plastic mulching encouraged plant growth and reduced soil moisture evaporation in aonla. All organic mulches exhibited significant improvement on soil properties. Paddy straw mulch exhibited maximum plant height, nutritional and physical properties of soil compared to other organic mulches.

Crop combination under drumstick based cropping system under rainfed condition showed that maximum return of Rs 68922/ha net income with benefit: cost ratio of 1.92. from inter cropping of moringa + pumpkin+ cluster bean + cowpea (T13) as compared to other crop combinations. The highest benefit cost ratio (2.11) was observed in bottle gourd (sole crop) followed by okra (2.42). About 12% yield improvement was observed when cucurbits climbed on drumstick than ground trailing method. Among the vine crop tried, ridge gourd and bottle gourd performed better than the other vine crops at 5.0 × 2.5 m spacing. In Annual moringa, genotype PKM-2 was better for root growth and appearance in sand medium than the other genotypes. Spraying of urea 5.0% followed by KNO_3 at 3.0% increased the yield of drumstick two-year old crop (26.89 kg).

INTEGRATED NUTRIENT MANAGEMENT

The effect of various combinations of organic and inorganic fertilizers investigated in pomegranate revealed that application of vermicompost + inorganic fertilizer (50:50) influenced the maximum plant height (2.75) and increase in growth (52.8%). Maximum tree volume (7.60 m^3) was recorded in this followed by 7.3 m^3 in vermicompost 7.25 m^3 in sheep manure + vermicompost and 7.25 m^3 in cattle manure + vermicompost. Maximum fruit weight (275 g) was recorded in vermicompost + inorganic fertilizer (50:50). Vermicompost application resulted maximum P and K content in leaves. Among the micronutrients, Zn, Cu, Mn and Fe, zinc were ranging from 30 to 52 ppm and the vermicompost and cattle manure + vermicompost application resulted maximum (52 ppm) Zn content. The maximum P_N activity was recorded in cattle manure + vermicompost followed by vermicompost (0.7 mg CO_2 $m^{-2}s^{-1}$) and minimum stomata resistance was observed in fertigation with vermicompost. Additionally, maximum soil moisture (7.8 to 8.5%) was recorded by application of vermicompost at 40 cm depth of soil profile. Soil fertility builds up was substantially enhanced by application of vermicompost, sheep manure + cattle manure and sheep manure + vermicompost.

Investigation on fertigation schedules and water requirement of kinnow showed that maximum water use efficiency (1.30q/ha-cm) was observed at 0.75 CPE through drip irrigation followed in 0.75 CPE level through micro sprinkler irrigation system. In ber and pomegranate, maximum plant height was recorded in micro sprinkler at 1.00 CPE irrigation level. Biodynamic farming has been initiated for quality production of fruit and vegetable crops under arid ecosystem. DRIS norms for macro and micronutrients in aonla and sapota were developed under semi arid conditions.

Organic farming

Application of leaf litter of four tree species viz. subabool, neem, sunhemp and daincha @ 5 kg / plant on fresh weight basis had non-significant effect on growth characters of pomegranate. However, composition NPK content was significantly influenced by application of leaf litter. Soil moisture was highest in sunhemp and Subabool even before application of irrigation. Maximum fruit retention and yield was recorded in application of sunhemp. Organic manuring in Sapota cv. Kalipatti revealed that application of different fertilizers treatment had non significant effect on growth parameter but fruit retention and yield/ plant was significantly influenced. Replacement of chemical fertilizers with organic fertilizer improved of soil health in addition to 6.97 per cent increase in yield.

Micronutrients sprays on singly or in combination applied during the vegetative growth period of pomegranate. Maximum yield per plant in combination of micronutrients rather than applying them in single form.

Soil and water conservation

Water balance at micro-watershed under semi arid conditions showed that the maximum potential evapotranspiration and water deficit were observed in the month of May followed by June. A significant increase in the ground water levels varying from 3.35 to 3.85 m was observed in the well located below the water harvesting structures and minimum rise in water table was observed away from the water harvesting structures in the micro-watershed.

CROP PHYSIOLOGY AND POST HARVEST TECHNOLOGY

Crop physiology

Water stress on growth and physiological functions of *mateera* and watermelon indicated drastic reduction in all growth parameters like plant height, number of leaves and internodes length in watermelon when the stress was

imposed. *Mateera* was capable of maintaining dry matter distribution even under stress condition whereas, in watermelon it was hampered drastically demonstrating its inherent capability to tolerate water stress by internally balancing the dry matter allocation. It was demonstrated that the drought tolerant nature of *mateera*, *kachri* and snapmelon is due to their membrane stability even under low soil moisture conditions. Out of various parameters studied, plant height stress index, dry matter stress index and degree of leaf rolling could be used to screen cultivars for drought resistance.

Post harvest technology

There was no reduction in the fruit quality and shelf life of aonla cv. NA-7 fruits up to 30th day from the date of maturity. Fruits treated with calcium chloride (2.0%) recorded the least physiological loss in weight and spoilage loss during storage. In ber, corrugated fiberboard box with newspaper liner was most suitable and economically viable packing container during transportation. Fruits treated with calcium chloride (2.0%) recorded least physiological loss in weight and spoilage loss and exhibited 5 days of storage life

Khejri pods were imposed with different treatments and dried. The dried pods were having good quality dehydrated pods. The results of storage studies revealed that dehydrated pods could be stored upto 12 months without effecting quality and appearance. Sliced kachri fruit dipped in 2% salt solution for one minute and dried. There was no difference in drying duration in peeled, unpeeled and fruits dipped in salt solutions. The dehydrated kachri fruits were analyzed for calcium, sodium and potassium, fruits dried alongwith peel have higher nutrient content than peeled fruits.

INTEGRATED PEST AND DISEASES MANAGEMENT

Integrated pest management

The recommended doses of Endosulphan and fungicides viz. Bayleton and Bavistin effectively reduced the incidence of fruit fly, fruit borer and powdery mildew of ber cvs. Gola and Umran. Application of either Dimethoate (0.05%) or Endosulphan (0.07%) with Dithane M-45 (0.2%) effectively controlled thrips, borer and leaf and fruit spot infesting/ infecting in pomegranate. In case of aonla (cv. NA-7), either Dimethoate or Endosulphan in combination with fungicides viz. Bavistin sprays resulted maximum marketable yield. Cow urine and buttermilk also played a significant role in minimizing the incidence of fruit fly in case of bitter gourd.

Integrated disease management

Field trial in different centers of AICRP (AZF) depicted positive response of bioagents for ber powdery mildew management. Spray of 0.1% karathane recorded maximum disease control (PDC of 55.5) followed by use of bio-fungicide (50 PDC) either *P.fluorescens* (CIAH-196) @1% with 0.05% karathane or *P.fluorescens*-NR (CIAH-196) @1% with 0.05% karathane. Combined use of 0.05% karathane and 0.5% *P.fluorescens* (NR) resulted 34.3 PDC as compare to 66 PDC 0.1% karathane alone. PDC of ber powdery mildew was better in CHES, Godhra centre. Field trails implied that biocontrol agents or the biocontrol agents along with 50% reduced dose of Karathane could manage powdery mildew in ber. Seed treatment of *mateera* and *kachri* enhanced germination percentage in addition to plant growth and vigour. Bacterial isolates was isolated from soil and plant samples of ber, date palm, *mateera*, *kachri*, snap melon and *kakadi*. Advanced lines of *mateera* showed predominant incidence of virus diseases during evoluation.

Fungicides sprays were effective for the powdery mildew control. However, spray of both the salicylic acid as resistance inducing chemical can also be alternated with the fungicides to reduce number of sprays. In pomegranate, alternate sprays of fungicide (bavistin, mancozeb and blitox, neem oil or spray of *Trichoderma* spore suspension were also effective against anthracnose. In tomato, seed-dressing with

ridomil Mz (64% Mancozeb + 8% Metalaxyl) @ 2.5 g/kg seed was best providing maximum transplant plant with least mortality due to PEDO. *Trichoderma* also reduced the disease incidence and gave higher number of disease free and vigourous seedlings. Sunhemp as barrier crop reduced the leaf curl incidence in this crop. Additionally, *Trichoderma* successfully reduced the mortality of tomato seedlings caused by *Pythium* spp. and produced higher number of mere vigourous seedlings. Powdery mildew of *okra* was colonized by *Ampelomyces quisqualis* as mycoparasiste with in 8–10 days of application.

AGRICULTURAL EXTENSION

Investigation on horticultural development in arid region revealed that about 19.5% farmers grow improved varieties of *ber, aonla,* pomegranate, *Lasora, etc.*. During *kharif* season, 22.75% farmers grow brinjal, okra, chilli, bottle gourd, roundmelon; 28.80% farmers grow *mateera*, snapmelon, *kachri* and Indian aloe under irrigated conditions under arid region. Mixed cropping system is predominant in rainfed areas during *kharif* season. However, knowledge on arid horticultural technologies and their adoption is very poor among the farmers. An assessment of arid horticultural status in Bikaner district showed that 13–66% farmers grew improved and local varieties of ber, aonla, pomegranate, *mateera*, snapmelon and *kachri*, etc., Majority of the farmers practice mixed cropping system including local/ deshi varieties of horticultural crops during *kharif* season. Some farmers grow improved varieties of ber (Seo, Gola, Umran), aonla (NA-7, NA-6, Chakaiya), pomegranate (Jalore seedless, Ganesh), *mateera* (AHW-65, AHW-19), snapmelon (AHS-10, AHS-82) and *kachri* (AHK-119, AHK-200). However, these farmers are poor in technical knowledge and adoption in improved arid horticultural technologies.

Strategies for adoption of integrated horticultural technologies particularly for the insect pest management in *aonla* (*Emblica officinalis*) by farmers of Gujarat showed that they are following as integrated approaches for the better management. Similar was in case of mango for the pest management in mango. With respect to diseases management, powdery mildew was noticed by 80% of the farmers but only 25% farmers applied chemical spray of wettable sulphur. During rainy season, anthracnose and many minor leaf spots were seen but the farmers were not noticing them and no sprays were applied. Few farmers (5%) noticed dieback and gummosis and applied Bordeaux paste. During the reporting period, extension activities including visit of scientific groups/personalities, farmers, on and off-campus farmer's training programme, front line demonstration, popularization of arid horticultural technologies and participation in farmers fairs, RAWE and Krishi mela were carried out.

The nursery unit both in main and regional station has produced seed and planting materials and revenue of Rs 200,615 was realized from the sale of various farm produce. In addition to this, revenue of Rs 141,355 was realized from the sale of various plant materials by the revolving fund scheme. ❑

केन्द्रीय शुष्क बागवानी संस्थान

CENTRAL INSTITUTE FOR ARID HORTICULTURE

1

Introduction

The arid ecosystem, which is spread over nearly 12 per cent of the land area has strengths and weaknesses. This provides ample opportunity to develop this zone into a horticulture bowl of India. The conversion of this region into horticulture productive area will provide income, nutrition security and help in employment generation in the region.

MANDATE

1. To undertake basic and strategic research for developing technologies to enhance productivity and utilization of arid and semi-arid horticultural crops.
2. To act as national gene bank of arid and semi-arid horticultural crops.
3. To develop the multi-storey horticulture based sustainable cropping system under arid and semi-arid environment.
4. To act as national repository of scientific information related to arid and semi-arid horticulture.
5. To coordinate network research with State Agriculture Universities and line departments and act as centre for Human Resource Development in arid and semi-arid horticulture.
6. To provide consultancy in research and development of arid and semi-arid horticulture.

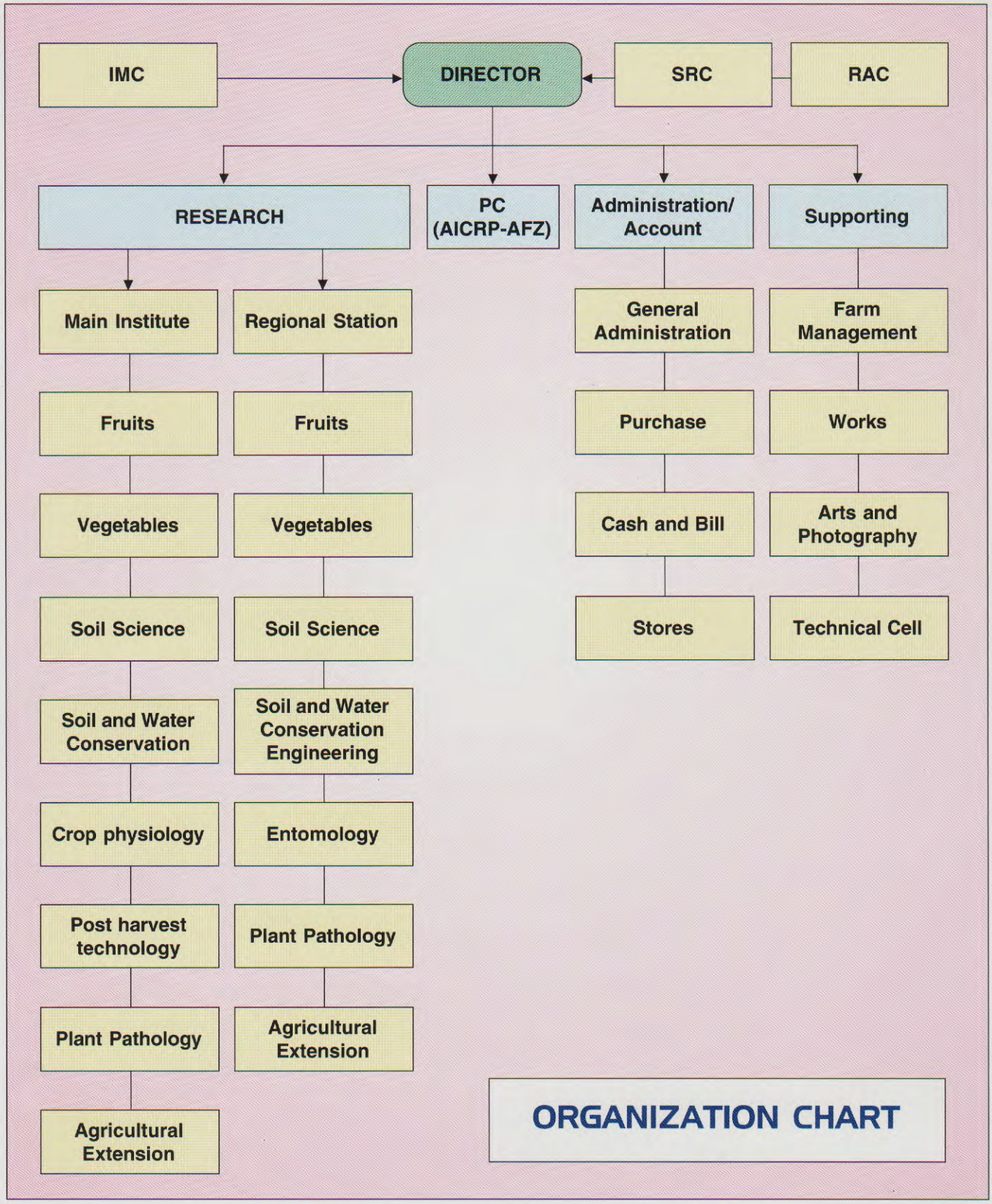
MISSION

- To introduce, collect, characterize, conserve and evaluate the biodiversity of horticultural crops under arid environment.
- To utilize the available biodiversity and improve the target fruit crops such as ber, pomegranate, aonla, date palm and cucurbitaceous, leguminous and solanaceous vegetables to develop high quality and productive types having tolerance to biotic and abiotic stresses.
- To study the factors related to rapid multiplication of propagules in case of established as well as new crops and the problems related to their growth and fruit development.
- To standardize agro-techniques with respect to efficient use of soil, water and nutrients for increased horticultural productivity involving water harvesting and conservation techniques under rainfed conditions, efficient use of the scarce irrigation water and nutrient management.
- To study the ecophysiological parameters of cropping system models for utilization of high temperature and radiation resources.
- To develop post harvest technology package for extended use of the horticultural produce of arid region.
- To develop integrated pest and disease management technologies for horticultural crops under arid environment.

Keeping in view of the mandate and objectives, research and extension woks have been carried out and the significant results from different projects are presented.

ORGANIZATIONAL SETUP

The research programmes of the institute are being carried out at the main institute at Bikaner and its regional station at Godhra, Gujarat under the administrative control of the



ORGANIZATION CHART

Director. The Institute Management Committee (IMC), Research Advisory Committee (RAC) assists in identifying the research theme areas, which are subsequently discussed and evaluated in SRC meeting. The research field and laboratories like germplasm conservation, biotechnology, fruit breeding, soil science, SWC, plant pathology, plant physiology and post harvest technology are well equipped with latest equipments and infrastructure facilities to meet out the RAC and QRT recommendations and strengthening the research activities.

SALIENT ACHIEVEMENTS

Evaluation of ber germplasm showed that out of 338 genotypes, Tikadi and Syria (Khavaspura) were tolerant to low temperature (–1.5°C). In improvement of ber, back cross hybrid, CIAH-H-1 and CIAH-Selection-1 have performed well during the current period of evaluation. Out 150 germplasms of pomegranate and 43 of aonla, all were susceptible to frost injuries under arid conditions. However, majority of the genotypes recouped after raise in the atmospheric temperature. In semi arid conditions, when the commercial variety NA-7 was crossed with Balwant, maximum fruit set and retention have been observed. Overall resulted in pollination studies showed that cv. Chakaiya was good for cv. Kanchan pollinization. In date palm, cvs. Zaglool, Sakloti, Amiri and Agloni were collected during this year. Fruits yield was better in Halawy, Sabiah, Dayari, Zahidi, Bikaner local and Khadrawy and maximum number of berry 20–22 per strand was in Bikaner local and Zahidi. Interestingly formation of offshoots was high in tissue culture plants than normal offshoots plantation. Tissue cultured plants (AV.Thomas) resulted early fruit maturity (doka) whereas, cv. Khuneizi yielded better quality fruits.

In addition to major fruit crops, evaluation on under utilized fruits like bael, karonda, phalsa, lasora, ker, cactus pear, wood apple, manila tamarind and some of the exotic fruit species including Carob, Chinese jujube, argan, marula nut are being carried out at Bikaner. Whereas, in the regional station, jamun, tamarind, bael, mahua and chiraunji are under evaluation. Out of these, some of the elite genotypes of jamun, tamarind (CPT 20) mahua (MH 32) and chiraunji (CPT-1, CPT-2, CPT-5, CPT-6, CPT-7, CPT-8, CPT-12 and CPT-30) were taken up for field evaluation. In tissue culture, refinement and improvement of micro propagation techniques for ker, cactus bear and Gonda have been refined and improved.

Breeding for yield, quality and stresses resistance in arid and semi arid vegetables resulted some of the promising genotypes for commercial cultivation. Promising lines like F6/a of mateera, AHLS Round-1 (bottle gourd), AHSG4 and AHSG4 (sponge gourd), F5 (brinjal), AHSB (sword bean), AHDB (Indian bean) and AHG-13 (cluster bean) have been identified from CIAH Bikaner. Breeding material of luffa gourd was evaluated. Nine elite selections of vegetable types of *khejri* were characterized for crop regulation practices. In semi arid conditions, CM-16, CM-36 and CM-40 (pumpkin) LS-6 (bottle gourd), MCC-23 (biter gourd) are promising hybrid lines have been developed.

Investigations on diversified cropping models under arid ecosystem resulted that the ground-storey crops performed well without affecting the growth and development of aonla. Yield of ground-storey vegetables recorded higher yield under arid conditions. Under rainfed conditions of semi arid region, inter crop with bottle gourd in aonla planted at 10 × 10 m showed maximum yield per ha as well as economic return. Double hedgerow system in aonla resulted an increase in yield (99.80%) with additional economic returns. Organic (paddy straw) and plastic mulching encouraged plant growth, significantly improved soil properties and reduced soil moisture evaporation in aonla. Crop combination under drumstick based cropping system showed maximum return of Rs 68,922/ha net income with benefit cost ratio of 1.92 from inter cropping of moringa + pumpkin+ cluster bean + cowpea. Sand medium influenced better growth and appearance of

root growth and appearance of in annual moringa (PKM-2) as vegetable.

Application of vermicompost + inorganic fertilizer (50:50) maximized plant height, maximum tree volume, fruit weight in addition to macro and micronutrients and leaf mineral compositions. Maximum water use efficiency was observed in kinnow at 0.75 CPE through drip irrigation through micro sprinkler system. While in ber, and pomegranate it was recorded at 1.00 CPE irrigation level. DRIS norms for macro and micronutrients in aonla and sapota were developed under semi arid conditions. Biodynamic farming has been initiated for quality production of fruit and vegetable crops under arid ecosystem. Studies on stress resistance in vegetables crops indicated that m*ateera* was capable of maintaining dry matter distribution even under stress condition with its inherent capability to tolerate water stress by internally balancing the dry matter allocation. It was further demonstrated that the nature resistance in *mateera*, *kachri* and snapmelon was due to their membrane stability. Out of different parameters, plant height stress index, dry matter stress index and degree of leaf rolling could be used to screen cultivars for drought resistance.

Research on post harvest technologies particularly on *khejri* and *kachri* dehydration methods showed that the dehydrated products of these crops under tray drier could retain better quality and nutritional content even after 12 months of storage under room conditions. The quality and shelf life of Aonla cv. NA-7 fruits were retained up to 30th day from the date of maturity. Fruits treated by 2% calcium chloride resulted least loss in weight and spoilage during storage. The corrugated fiberboard box with newspaper liner was most suitable and economically viable packing containers for ber fruits during transportation.

Combined spray of the recommended doses of Endosulphan, Bayleton and Bavistin effectively reduced the incidence of fruit fly, fruit borer and powdery mildew of ber. In pomegranate, endosulphan (0.07%) with Dithane M-45 (0.2%) effectively controlled thrips, borer and leaf and fruit spot infestation. Whereas, in case of aonla Endosulphan in combination with bavistin sprays showed maximum marketable yield. Field trials implied that *P.fluorescens* (CIAH-196) or its combination with 50% reduced dose of fungicide could manage powdery mildew in ber. Seed treatment of *mateera* and *kachri* enhanced germination percentage in addition to plant growth and vigour.

Fungicidal sprays are the best for the powdery mildew control. However, spray of both the salicylic acid as resistance inducing chemical can also be alternated with the fungicides to reduce number of sprays. In pomegranate, alternate sprays of fungicide (Bavistin, Mancozeb and Blitox, neem oil or pray of *Trichoderma* spore suspension spray were also effective against anthracnose. *Trichoderma* reduced the damping off in tomato Powdery mildew of *okra* was colonized by *Ampelomyces quisqualis* as mycoparasiste with in 8–10 days under semi arid conditions.

In agricultural extension, investigation on horticultural development revealed that about 19.5% farmers grow improved varieties of ber, aonla, pomegranate, Lasora, *etc.*. Mixed cropping system is mainly followed in rainfed areas during *kharif* season. However, knowledge on arid horticultural technologies and their adoption is very poor among the farmers. An assessment of arid horticultural status in Bikaner district showed that 13–66% farmers grew improved and local varieties of ber, aonla, pomegranate, *mateera*, snapmelon and *kachri*, etc. Some farmers grow improved varieties of ber (Seo, Gola, Umran), aonla (NA-7, NA-6, Chakaiya), and the arid vegetables released by the institute.

Farmers in Gujarat are following an integrated approaches for the management of pests in mango. Powdery mildew was noticed by 80% of the farmers but only 25% farmers applied chemical spray of wettable sulphur. Various extension activities on and off-campus farmer's training programme, front line demonstration, RAWE and Krishi mela were carried out. The nursery units of the institute have produced

seed and planting materials and revenue of Rs.2,00,615/- was realized from the sale of various farm produce. Revenue of Rs. 1,41,355/- was generated by sale of various planting materials through a revolving fund scheme at CHES Godhra.

STAFF POSITION

The institute has a total strength of 140 including Regional station headed by the Director. The total cadre strength is 35 scientific, 42 technical, 25 administrative and 37 supporting. The vacancy position (11) exists only in case of scientist (Fig. 1).

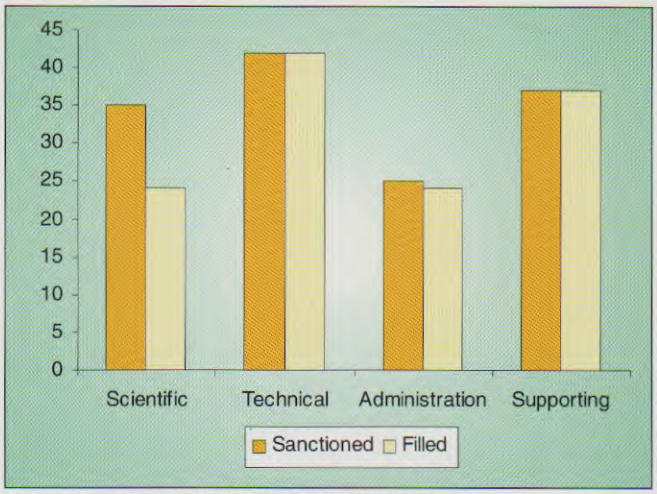


Fig. 1. Staff position of CIAH

FINANCIAL STATEMENT

Head	Plan			Non-Plan		
	B.E. 2005–2006	R.E. 2005–2006	Progress 31.3.2006	B.E. 2005–2006	R.E. 2005–2006	Progress 31.3.2006
Establishment	15.00	–	–	200.15	194.20	194.16
Wages (T.S)	0.00	–	–	42.00	45.38	45.37
OTA	0.00	–	–	0.15	0.15	0.15
T.A.	5.00	5.00	5.00	1.40	1.70	1.70
Other charges	135.00	88.16	88.15	27.00	32.00	1.40
Works	90.00	31.84	31.79	2.30	2.45	2.45
HRD	05.00	0.00	0.00	0.00	0.00	0.00
Land	0.00	0.00	0.00	0.00	0.00	0.00
Total	250.00	125.00	124.94	273.00	263.31	263.29
AICRP-AZF	120.00	120.00	132.00	-	295.69	295.60
Revenue Receipt						8.41

Plant Genetic Resource Management

- **Ber**
- **Pomegranate**
- **Aonla**
- **Date Palm**

Underutilized fruits

- Bael
- Karonda
- Phalsa
- Lasora
- Ker
- Cactus pear
- Wood apple
- Manila tamarind
- Jamun
- Tamarind
- Mahua
- Chiraunji

Arid Vegetables

- *Mateera*
- Snapmelon
- Round melon
- Bottle gourd
- Brinjal
- Sword bean
- Indian bean
- Cluster bean

Semi-arid Vegetables

- Pumpkin
- Bottle gourd
- Bitter gourd
- Annual moringa

2

Research Achievements

PLANT GENETIC RESOURCE MANAGEMENT

Collection, conservation, evaluation and improvement of Ber (CIAH, Bikaner)

A total of 338 *Ziziphus* genotypes/strains are maintained in the National germplasm repository of CIAH, Bikaner and these are being evaluated with black box approach. Seeds from identified ber plants tolerant to powdery mildew were collected from Goa for evaluation. Plant height was maximum in cv. Thornless (7.8 m) followed by Rashmi (7.00 m), while stem girth was maximum in cv. Gola (72.3 cm) followed by Thornless (70.13 cm). Fruit fly incidence and yield attributes could not be recorded due to severe frost-chilling injury during the month of January, which resulted in complete defoliation and dropping of fruits.

The occurrence of frost/chilling injury during first week of January 2006 gave interesting information on degree of frost tolerance among the genotypes. It was observed that cv. Tikadi and Syria (Khavaspura) were tolerant to low temperature (–1.5°C). However, cv. Seb followed by Gola, Mundia and Umran were earliest in recovering vegetative growth after a month of the injury. Pooled data of early pruning exhibited maximum and early bud sprout in ber cv. Gola followed by Mundia and Kaithali.

Among the germplasms, cv. Seb was the earliest to flower followed by Safed Rohtak and Gola. Late flowering was noticed in cv. Illaichi, Kaithali and Chhuhara. Fruit setting also observed in similar pattern being earliest in cv. Seb followed by Gola while it was late in cv. Chuhara, Umran and Sandura.

BC hybrid, CIAH-H-1 and CIAH-Sel-1

Observations on plant growth were recorded in all the improved genotypes. Plant height was 4.3 and 5.08 m in CIAH Hybrid-1 and CIAH Sel-1 respectively. Hybrids viz.,CIAH-H-1 and CIAH-Sel-1 initiated flowering during last week of August. Blooming was at its peak during10th September to 20th October in hybrids and 20th September to 25th October in selection-1. Fruit set in CIAH-H-1 initiated during last week of September and it was peak between Second week of October to last week of October. In Selection-1 fruit set initiated during the first week of October with its peak between 20th–05th November. Fruit ripening in the hybrid and selection initiated between 18–25 December 2005. The yield data could not be recorded due to chilling injury. Plants of these varieties were multiplied for evaluation and testing at AICRP centers under Multi Location Trial but due to the damage caused to the saplings by frost-chilling injury, the same could not be supplied.

Pomegranate

Pomegranate germplasms (152) is being maintained in the field repository. The height of plant varied from 1.00–3.00 m with 5–50 fruits/plant. All varieties including the genotypes collected from HP were affected by frost. Out of 17 *Anardana* types, few genotypes started flowering and fruit set however, the size and the number of fruits were small during early stage.

Aonla (CIAH, Bikaner)

Fourty three genotypes are maintained in field repository. Bud wood of seven (3 from Vindhyan Hills, one from Allahabad and 3 from Pratapgarh) genotypes

was collected and budded *in-situ* at field repository. Evaluation of aonla germplasm showed that the average yield/plant of cv. Narendra Aonla-7 was 67 kg and minimum in HP collection AKS/CIAH/EO8 (3.0 kg). Fruit weight was varied from10–76 g depending on genotypes and a maximum of 76 g was recorded in Krishna. TSS was varied from 12–21% in different genotypes of aonla. All the genotypes were severely affected by chilling / frost injury.

Self-incompatibility studies in aonla (CHES, Godhra)

The commercial cultivars NA 7 crossed with Balwant showed maximum fruit set and retention (67.08 and 36.76% respectively) followed by Banarasi (67.08 and 32.4). However, selfing resulted least percentage of fruit set (28) and retention (23.63) indicating the self-incompatibility. Similar trends were in Chakaiya was crossed with other cultivars, per cent fruit set and retention were low as compared to NA 7. Highest fruit set and retention was obtained where Chakaiya was crossed with Banarasi (57.35% and 30.16% respectively).

When Cv. Kanchan was crossed with Chakaiya, maximum fruit set and retention was recorded (63.3% and 33.46% respectively) indicating that Chakaiya is good pollinizer for Kanchan. In cv. Hathijhool, per cent set was very low. Crossing of Francis with Chakaiya resulted in highest set where as fruit retention was high in cv. Francis crossed with itself (54.41%). Cultivar Balwant when crossed with Chakaiya gave highest set of 31.28% where as retention was highest (31.75%) in Balawant × NA 7. In all the cultivars open pollination resulted in more fruit set and retention, where as, self-pollination resulted in lower set and retention. Poor set in bagging clearly indicated the level of self-incompatibility among various cultivars.

Date palm

Fifty eight date palm genotypes including exotic germplasm are maintained in field repository. Four varieties viz. Zaglool, Sakloti, Amiri and Agloni were collected from Date palm Research Center, RAU, Bikaner and planted for evaluation. Under *Phoenix* species collection, seedlings of *Phoenix sylvestris* were transplanted in the field. The survival of plants was good but growth of plant was slow during establishment stage. Survival was better in all varities except Chip chap. A seedling of *Phoenix dactylifera* (Introduction from Iran EC 517310) showed slow growth at initial stage of establishment.

Germplasm evaluation indicated that the height of plant varied from 2.0–4.0 m at an age of seven years. The maximum spread (N-S, E-W) was observed in cv. Muscat (4.80 × 4.92 m) followed by Sadami (4.30x 4.20 m) and Halawy (4.15 × 4.00 m). Maximum average trunk diameter (1.40 m) was recorded in cv.Sedami followed by Halawy (1.35 m). There was no effect of frost/low temperature on date palm plants. Spathe emergence was initiated from last week of January in cv. Halawy, Zaidi, Muscat, and Tayer and completed by the end of February. Out of total germplasm, spathe emergence and fruiting were observed in cvs. Halawy, Zahidi, Khadrawy, Braim, Chip chap, Sewi, Dayari, Shamran, Medini, Sedami, Muscat, Khuneizi, Hayani, Medjool, Bikaner Local, Nagal, Hamara, Umshok, Hetami and Tayer. Hand pollination was done after opening of spathe. However, regular fruiting was observed in cvs. Halawy, Dayari, Khuneizi, Medjool, Shamran, Khadrawy and Zahidi during the period of evaluation.

The average number of bunch per palm and fruits yield was better in Halawy, Sabiah, Dayari, Zahidi, Bikaner local and Khadrawy. More bunch formation (08) was observed in cv. Dayari. Maximum number of berry 20–22 per strand was in Bikaner local and Zahidi, due to formation of compact bunch and less dropping of immature fruits. Bunch weight (3.5–4.18 kg) was recorded in cvs. Halawy, Bikaner local, Dayari and Zahidi. Maximum drop of berry was noted in cv. Sedami. The large size berry was recorded in cv. Dayari (4.60 × 2.36 cm), Medini (4.40 × 2.23 cm) followed by Sewi (3.34 × 2.56 cm). The initiation of doka stage

was early in cvs. Halawy followed by Shamran, Khuneizi, Muscat, Tayer, Dayari, Sadami and Medini. Inter crops, viz. mustard and taramira were grown in interspaces of date palm plantation during *rabi* season and it can be taken with limited irrigation water.

Varietal trial

Field trial consisting of varieties like Halawy, Khalas, Zahidi, Medjool and Khadrawy varieties have been initiated. Mortality of suckers was more in offshoots of cv. Medjool and Halawy than cv. Zahidi.Plant growth was also better in Khalas and Halawy. Halawy, Medjool, Khalas and Zahidi varieties started flowering and fruiting after four year of planting. Three to four bunch/palm were produced during establishment stage. The initial performance showed that cv. Halawy and Khalas are better in plant growth, fruiting, yield and quality of fruits at doka stage. Fruit drop was high in cv. Khalas. The berry size was bigger in Khalas at doka stage.

Evaluation of tissue culture plants

Tissue culture plants of eight cultivars A.V. Thomas, Khasab, Khalas, Khuneizi, Nubsully, Yakoobi, Fard and Nagal were evaluated under field conditions. The height of plant varied from 1.7–3.0 metre after 6 years. Interestingly, sucker formation was more in tissue culture plants than offshoots plantation. The flowering and fruiting were observed in AV. Thomas, Khuneizi and Nagal. Average bunch weight was 500 g to 1000 g and number of bunch/plant was 2–3 in tissue culture plants. The length of bunch was also medium and the cv. AV. Thomas showed early fruit maturity (doka stage) during first week of July, size of fruit (4.06 × 2.68 cm), 7.2 g weight. Cultivar Khuneizi yielded good fruiting during first time and quality was better.

Arid vegetables (CIAH, Bikaner)

As per germplasm maintenance programme, the conserved landraces and genetic stocks of muskmelon, kakdi, brinjal and chilli were monitored for health, germination test and seed vigour index. The results indicated that the above said crop germplasm needs their regeneration within one or two years for further multiplication and conservation.

Mateera (watermelon)

To improve the drought hardy *mateera* varieties for better flesh quality and sweetness at par to the watermelon varieties, hybridization breeding work was started. On the basis of the results of advances trials of previous years, large scale varietal trials were assesses for performance of *mateera* F6/a in comparison to m*ateera* AHW 19.

The fruits are 2.65 to 4.21 kg in weight. The first marketable harvesting starts in 70–80 days from sowing. Average number of marketable fruits per plant ranged from 2.59 to 4.22 there by yield potential is 10 to 14 kg/plant (Fig. 2). The fruits are free from cracking

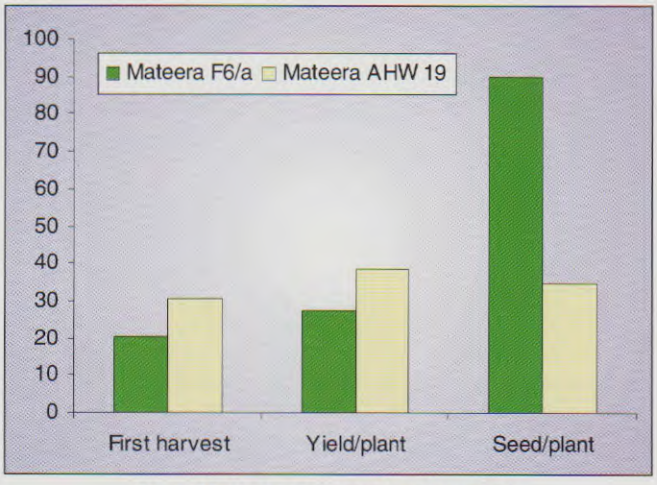


Fig. 2. Yield characters of *mateera* F6/a

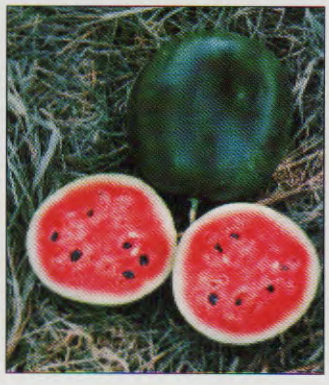


Fig. 3. Matured fruits of *mateera* F6/a

under extremes of aridity conditions. The fruits are oblong-round having dark green-green strips on the smooth rind. The flesh is red, solid (firm), and granular and has good sugar content (9.5–11.2% TSS). Low in seed content and the number of seeds in a fruit ranged from 160 to 266. The seeds are very big, bold and blackish in colour (Fig. 3).

Kachri

The results were not impressive with the application of treatments on the important crop characters such as days to first harvest, number of fruits / plant and number of seeds/fruit. However, mulching with dry hays and weeds in vine spread areas of crop gave better results. In general, the range for first harvesting was from 62 to 65 days. The number of fruits/plant and seeds/fruit ranged from 20–25 and 210–290, respectively.

Snapmelon

Highly significant and comparable results were obtained for days to first marketable harvest, number of fruits and fruit yield per plant. Under recommended open furrow (channels) system of crop cultivation the variety AHS 82 recorded an average yield potential of 235 q/ha. Whereas higher fruit yields of 22.5% under single line drip system and 17.5% with mini-sprinkler were recorded. Similarly, dry hay-weed mulching improved fruit yield by 24.8% and foliar application of GA3 by 18.2% as compared to control in snapmelon.

Bottle gourd

An experiment was conducted to assess the tender fruit and seed yield potential of bottle gourd AHLS Round 1 during summer and kharif season of 2005. Highly significant and stable results were obtained for crop performance. During the rainy season, studies were conducted to understand the growth and development of fruits for tender and seed production. A continuous picking of tender fruits weighing 400–500 g may result into the highest number (14.8) of fruit per plant. Besides regular harvesting of tender fruits, 4–5 fruits/plant were allowed for seed production from the settings of September, October, November or December month. The highest number of tender fruits (8.5) and seed yield of about 500 g per plant was obtained by allowing the October or November set fruits for seed production.

The round shape fruited (AHLS Round 1 derived form a cross combination of Banswara Local-1 × Gujarat Local-1) has been stabilized for uniform and higher fruit yield and very early harvest (Fig. 4). The vines are medium in growth habit. The marketable fruit picking starts 50–55 days after sowing. Tender fruits of 'A' grade in 9–11 days after fruit set (weighing 400–500 g, about 12–14 cm in length and 28–30 cm in girth) can be harvested for the hugest quality yields. On seasonal pooled basis, the number of marketable fruits ranges from 8.12 to 11.45 with an average yield of 4.83–5.78 kg/plant. Average yield per ha. was 240–300 q under arid conditions.

Fig. 4. Performance of AHLS Round-1

Luffa gourds

On the basis of characterization of landraces of sponge gourd, two lines AHSG 4 and AHSG 5 were identified. To incorporate some desirable characters and for developing hybrids, breeding work was initiated to assess the advance genetic material of sponge gourd (P_1, P_2, F_1 ($P_1 \times P_2$), $F_1(P_2 \times P_1)$, $F_2(P_1 \times P_2)$, $F_2(P_2 \times P_1)$ and BC_1). A wide range of variations was recorded for flowering and fruiting behaviour, fruit and yield component characters. High level of fruit fly infestation was noticed in the developed genetic material. Heavy

incidence of viral diseases was also recorded in this crop. However, AHSG 4 was superior for the early marketable fruit yield per plant. The advanced material of ridge gourd AHRG 8 was also tested for earliness and fruit yield potential.

Sword bean

AHSB 1: The crop was sown with first monsoon rain on July 07, 2005. Flowering and pod setting started with the end of September and ceased off as the temperature dips down to <10°C at night in December. Harvesting of tender pods starts from first week of October. Light green, tender pods of 20–28 cm length, 2.8–3.5 cm width and 50–60 g weight were better in quality and ready for picking in 12 to 18 days after setting. The yield was 1.28 kg /plant (Fig. 5).

Fig. 5. Sword bean – AHSB 1

Indian bean

Advance varietal trial: Three selected lines were tested for flowering and fruiting behaviour. The developed variety AHDB 16 exhibited superiority for earliness (first week of October) under high temperature conditions. It is high yielding, stable and potential for commercial cultivation. It took about 90 days in comparison to AHDB 3 and KSB 66/a (120 days) for harvesting. The crop was drastically affected due to early occurrence of frost.

Cluster bean

Large scale testing of vegetable type cluster bean AHG 13 was done. Observations on plant growth and yield parameters were recorded to assess the potentiality of the variety under both the situations. Over all, variable differences were observed between the crops of rainfed and with protective irrigation. Plant height (90–112 cm), pods (13–19/plant) and pod yield 185.8–268.4 g/plant were more in protective irrigation (Fig. 6).

Fig. 6. Performance of cluster bean – AHG 13

Khejri

Evaluation for *sangri* production Khejri trees producing better pod quality at tender stages for sangri production were identified under NATP on Plant bio-diversity programme of the Institute. The bud woods of nine elite seedling trees were collected and top worked in *khejri* germplasm plot for *ex situ* conservation and evaluation.

Vegetable seed production

In order to disseminate of new varieties and regular availability of seeds, vegetable seed multiplication programme is continuing at the Institute. During 2005–06, seed production of *mateera* (22 kg), snapmelon (50 kg), *kachri* (14 kg), bottle gourd (20 kg), cluster

bean (20 kg), *palak* (24 kg) and *sowa* (45 kg) was done. The seed was made available for sale to the farmers and state Government agencies.

Semi-arid vegetables (CHES, Godhra)

Pumpkin

The genotype CM-16 followed by CM-20 recorded the highest fruit yield and number of fruits per plant, lower sex ratio. Genotypes CM-36 and CM-40 are observed to be high yielding with big size fruits. The phenotypic and genotypic coefficient of variation for different characters ranged from 7.306–63.92 and 6.716–61.417, respectively. The highest PCV and GCV was observed for fruit weight and fruit yield per plant, coupled with higher value of heritability and greater genetic gain indicating these characters were governed by additive gene action and could be improved by direct selection method.

Bottle gourd

The genotype LS-6 followed by LS-20 recorded the highest fruit yield and fruits per plant lowest sex ratio and highest fruit set per cent. The phenotypic and genotypic coefficient of variation for different characters ranged from 6.270–34.045 and 3.749–30.732 respectively. The highest PCV and GCV were observed for fruit yield per plant, fruit length, no. of fruits per plant, sex ratio indicating the extent of variability based in these characters. High heritability coupled with higher genetic gain was observed for no. of seed per fruit, fruit length, no. of fruits per plant and yield per plant indicating the additive gene action.

Bitter gourd

The genotype MCC-23 recorded the highest no. of primary branches per plant, fruit yield per plot and fruit weight. The genotypic and phenotypic coefficient of variation for different characters ranged from 6.375–37.251 and 8.373–38.630 respectively. The highest PCV and GCV were observed for no. of female flowers per plant followed by fruit weight and no of primary branches per plant indicating the extent of variability based in these characters. High heritability coupled with greater genetic gain was observed for no. of female flowers per plant followed by fruit weight, no of primary branches per plant and yield per plot indicating the additive gene action.

Correlation and path analysis (Pumpkin)

The fruit yield per plant was positive and significantly associated with number of fruits per plant, fruit weight, fruit set (per cent), flesh thickness and main vine length. Days to first female flower anthesis, node to first female flower appears and days to first fruit harvest found to be significant and negatively correlated with yield. Therefore, these characters may be taken in to account for selection to improve the fruit yield per plant. The path analysis revealed that main vine length, fruit flesh thickness, 100 seed weight and Node to first female flower appears had strong positive direct effect on yield per plant.

Performance of F_1 progenies of pumpkin

Among the F_1 progenies tested under summer season, CM 16 × CM 19 observed better for higher number of fruits per plant (9.21) weighing 1.826 kg followed by CM 12 × CM 16 (6.79 fruits) with medium fruit size. CM 4 × CM 15 and CM 19 × CM 4 observed to be bigger sized fruits with producing 4.12 fruit each per plant. During rainy season, CM 22 × CM 15 for high yielding with smaller sized fruits and CM 17 × CM 18 for high yielding with moderately bigger sized fruits among the 35 F_1 generations evaluated and CM 16 × CM 19 observed high yielding among the 10 F_2 segregates evaluated. Some promising lines of pumpkin and bottle gourd were observed for major pest and diseases under field evaluation. In addition 5 and 7 successful cross of pumpkin and bottle gourd were selected and included for evaluation.

Correlation studies

Bottle gourd

The results revealed that the genotypic correlation

coefficients were higher than the corresponding phenotypic correlation coefficient indicating the characters are heritable. The fruit yield per plant showed strong positive and significant association with number of fruits, number of primary branches per plant, main vine length and fruit set per cent. Days to fruit harvest and sex ratio (M/F) displayed significant and negative correlation with yield. The path analysis revealed that no. of primary branches per plant, main vine length, number of fruits per plant, 100 seed weight and node of first female flower appeared had strong positive direct effect on yield per plant. Days to first female flower anthesis, sex ratio, fruit set per cent, fruit weight and fruit girth showed direct negative effect on yield

Bitter gourd

The fruit yield per plot had a strong positive and significant association with number of female flowers per plot, number of fruits per plot, fruit girth, fruit length, number of primary branches and main vine length. Node of first female flower appeared and days to first fruit harvest showed negative association with yield. The path analysis revealed that fruit length, 100 seed weight, number of female flower per plot, no. of fruits per plot, number of primary branches per plant and main vine length exhibited strong positive direct effect on yield per plot. Days to first fruit harvest, number of seeds per fruit, fruit girth had direct negative effect on yield.

Growth and development of drumstick roots

Three genotypes PKM-1, PKM-2 and pink types were tested to assess their performance of root growth as vegetable under clay, red and sandy soils. The genotype PKM-2 was better for root growth and appearance in the sand medium. Though, root growth was superior in sandy soil, the no. of lateral roots and colour were not appreciable for consumers. White roots as similar to radish were observed in clay soil.

Crop regulation in drumstick

Since flower drop is high and poor fruit development under rainfed condition, chemicals were tested to reduce flower drops and enhance fruits development. An increase in drumstick yield in 2 year old crop (26.89 kg) was observed with double spraying of urea 5.0% followed by KNO_3 at 3.0%. However, the treatment showed no significant effect due to leaf and flower drop under high and continues rainfall.

Under utilized fruit crops

Different under utilized fruit crops have been planted in the field for evaluation at Bikaner. In case *Bael* (*Aegle marmelos correa*), field survival rate was about 80 per cent. However, less soil moisture, very low temperature, weeds, wild animals, etc., affected the growth of plants. Maximum plants were affected by severe frost injury and low temperature (–2°C). The cluster bean var. RGC-936 was more suitable as an inter crop under rainfed cultivations. Root stocks were planted at 8 × 8 m in three rows for *in situ* budding for varietal trial under AICRP on arid fruits. In case of karonda (*Carisa carandus*) some genotypes were collected from Godhra and seedlings were raised. Seven genotypes were evaluated. However, 3 genotypes were completely dried and none of the karonda types were tolerant to frost. Evaluation of phalsa (*Grewia subinaequalis*) was carried out. The plants were pruned 10–15 cm above ground level during middle of December. Average growth was 1.0 to 1.5 m at the end of March. Flowering and fruit set was noted in all genotypes. However, irrigation is necessary for fruit development. In case of *lasoda,*(*Cordia myxa*), 65 collections are maintained in field gene bank. All have been severely affected by frost/ low temperature during the month of January and even in 4 years old plants, more than 50% growth was affected.

At Bikaner, ker (*Capparis decidua*) saplings were planted in the germplasm block and 4 genotypes are healthy. Most of the plants were tolerant to frost injuries. In case of cactus pear (*Opuntia ficus indica* Mill.), the clones 1269, 1270, 1271, 1280, 1281 and 1458 showed better growth. Clone 1270 and 1271 have performed well in growth, flowering and fruiting under arid conditions.

Seedling of new genotypes (IC 437338) have been raised and for planting and evaluation. The seedlings of wood apple were transplanted in the field for further evaluation. The seedlings of wood apple were observed with better growth initially but affected by frost.

Seeds of elite type Manila tamarind (*Pithecellobium*) was collected from Aruppukottai and sown in nursery to raise plants for transplanting. Exotic fruit species (Carob, Chinese jujube, Argan, Marula nut) are also maintained.. Better plant growth was also recorded in Marula nut (*Sclerocarryo caffra*). Survival as well as vegetative growth in Carob (*Ceratonia siliqua*) and Argan (*Argania spinosa*) plant was poor. Effect of frost was minimum in *Chinese jujube*; Argan and Carob fruit species while Marula plants were trained and pruned during spring for growth and canopy management.

Jamun

At CHES, Godhra, the reproductive biology was studied in 10 elite genotypes. Peak panicle emergence on February, peak flowering on March and peak anthesis at 8 AM–1 PM were recorded in all genotypes. Highest panicle length (16.2 cm) and fruit set per panicle (25) were recorded in GJ 19. Complete development of flower bud ranged from 20–26 days in GJ 26. Anther dehiscence commenced between 7AM to 4 PM with peak dehiscence at 9 AM–2 PM in all genotypes. The flower length varied from 9.2–13.2 mm (maximum in GJ 25). The stamen and style length varied from 5.2–9.0 mm and 7.2–8.9 mm (maximum in GJ 21). Pollen viability ranged from 9.2–98.5% (maximum in GJ 24). Pollen germination and pollen length ranged from 24.0–37.5% and 29.0–48.9 micron respectively. On the basis of different reproductive attributes, panicle may be considered as one of the positive traits for screening elite genotypes of jamun.

Promising genotypes of this crop have been established in the field. The average plant height ranged between 1.0–3.2 m, plant spread ie N-S- 1.2–3.1 m, and E-W-1.1 m–3.0 m and stem girth 10.0–42.0 cm. Apart from earlier collections, twenty new promising genotypes were selected and evaluated for their flowering and fruiting attributes. Individual fruit weight ranged from 08.0 to 20.0 g and pulp percentage 70.0 to 85.0. TSS per cent varied from 9.0 to 12.0 and vitamin C content 30.0 to 47.0 mg/100 g. Elite genotypes are being multiplied for field establishment.

Tamarind

Thirty promising genotypes were selected and evaluated for their flowering and fruiting attributes. Peak period of panicle emergence and flowering were recorded on July and August in majority of genotypes. It was early in CPT 1 followed by CPT 2, CPT 3, CPT 11 and CPT 13. Peak anthesis was recorded between 7–9 AM in all the genotypes during both the years. Anther dehiscence commenced after opening of flowers i.e. at 8 AM and continued till 12 noon. Peak period of dehiscence was recorded between 9-11 A M in all genotypes. Pollen viability (80.1–94.1%) and germination were (ranging 10.1–18.1%) high in CPT 3 (18.13%). Pollen diameter ranged from 34.12–42.14 micron. Pollen grain was spherical in shape having light yellow colour in all genotypes. CPT 13 recorded maximum panicle length (15.20 cm) and fruit set per panicle (16.80). The peak period of fruit set was recorded in the month of September in majority of genotypes. Developmental pattern of different genotypes was also studied.

Genetic variability for floral traits and yield attributes in tamarind depicted that pedicel length was varying from 7.1–12.5 mm. Number of perfect flowers per panicle was ranging from 9.50–19.50 (high in CPT 13). The flower length varied from 17.94–22.10 mm and maximum in CPT 6. The pistil length varied from 14.19–16.45 mm and maximum in CPT 21. Ovary length varied from 6.34–8.45 mm and maximum in CPT 18. The highest fruit yield per plant (195.00 kg) was recorded in CPT 20. Fruit yield per plant was 90.5 kg in CPT 1 and it was positively and significantly associated with these parameters and may be observed for their positive

behaviour while selecting superior genotypes. Promising genotypes of tamarind have been established in the field. The average plant height ranged between 1.20 m–3.30 m, plant spread i.e. N-S- 2.10 m–4.30 m, and E-W-2.00 m–4.10 m and stem girth 22.00 cm–43.00 cm. These genotypes are being further evaluated. Twenty new promising genotypes were collected and evaluated. Highest pod weight and length (27.0 g and 16.0 cm respectively) were recoded in collection No.40. However, maximum percentage of pulp was observed in collection No.38 followed by collection No. 45 and 46. TSS and total sugar were recorded in collection No.38. However, collection No.41 showed maximum acidity (14.00%). On the basis of overall performance collection no. 38,45 and 46 were promising.

Mahua

Mahua (*Bassia latifolia* Roxb) is scattered through out Gujarat. There was a wide variation among the genotypes. Flowering and fruit set were recorded during the month of March–April in different genotypes. Number of flowers (42) and fruit set per fascicle (9.5) were high in MH 2. Variable percentage of anthesis was registered in different genotypes. The pedicel length, pedicel thickness, bud length and breadth at flower opening varied from 4.2–5.5 cm, 2–3 mm, 1.3–1.8 cm and 1–1.2 cm respectively in different genotypes. The ovary and style length varied from 4.5–6.3 mm and 25–35 mm respectively. Pollen viability and pollen germination ranged from 90.00–98.50 and 26.50–40.20 per cent respectively being highest in MH 2. In all the genotypes, vitamin C increased during development and became constant till the harvest period. Fruits of MH 1 and MH 5 may be ready for harvest by 2nd week of May. However, MH 2 and MH 3 may be harvested by 3rd week of May and 1st week of June.

Ripening was observed earlier i.e. on 4th week of May in MH 21, MH 22 MH 27, MH 31 MH 32, and MH 33, while it was noted late (3rd week of June) in MH 23, MH 28, MH 34 and MH 35. Dry flower yield ranged from 27–48 kg /plant being highest in MH 32. Fruit yield was high in MH 32 (98.00 kg /plant). The flower Juice was high (67.00%) in MH 32. Total soluble solids, total sugar, reducing sugar and vitamin C content of flowers were the highest in MH 32. Fruit weight was maximum in MH 34. The seed per cent was maximum in MH 35 (42.91). The total soluble solids, total sugar and vitamin C contents of the fruits were maximum in MH 32. The kernel per cent varied from 74.13–82.68 with highest in MH 24. The highest protein and mineral contents were recorded in MH 34. With respect to all traits studied in these genotypes, MH 32, MH 34, MH 35, MH 26, MH 27, MH 23, and MH 23 were promising as potential parents to develop high yielding genotypes.

Chiraunji

Peak period of panicle emergence and flowering were recorded in January and February respectively and fruit set was on February in majority of genotypes. Highest panicle length (35.11 cm) and fruit set per panicle (36.20) were noted in CPT 1. Time taken for complete development of flower ranged from 16–20 days. Variable percentage of anthesis / dehiscence was noted in different genotypes. Anther dehiscence commenced after opening of flowers i.e. at 7AM and continued till 3 PM. Peak period of dehiscence was recorded between 8 AM–12 noon in all genotypes. The flower diameter varied from 5.1–6.3 mm (maximum in CPT 8). The stamen and carpel length varied from 1.97–2.12 mm and 1.2–1.3 mm, respectively (maximum in CPT 13). Pollen viability ranged from 54.5–70.4% (high in CPT 5). Pollen germination and pollen diameter ranged from 20–35% and 49.1–63.2 micron. Maximum stigma receptivity was recorded in CPT 5 (35.00%) on the day of anthesis. Fruit set / panicle was positively associated with panicle length and it may be observed while selecting elite genotypes. These genotypes are being further evaluated.

The fruit growth was faster initially and slow down towards maturity and followed sigmoid growth curve in all the genotypes. Deep purple colour appeared on fruit surface of different genotypes during peak period of

ripening. The specific gravity showed increasing trend (more than one) in all the genotypes during development. Total soluble solids, total sugar, reducing sugar and kernel protein increased as the fruits reached towards the maturity. Titratable acidity showed declined during development while, vitamin C increased and remained constant till the harvest period. Fruits of CPT 1, CPT 4 and CPT 5 may be harvested during first week of May and that of CPT 2, CPT 3 and CPT 6 by second week of May under semi- arid ecosystem of western India. Chiraunji showed wide genetic variabillity. Considering all desired horticultural characters, genotypes viz., CPT 1, CPT 2, CPT 5, CPT 6, CPT 7, CPT 8, CPT 12 and CPT 30 are promising and these were planted in the field for evaluation by vegetative propagation.

Wood apple

The soft wood grafting was the best method when one-year-old deshi rootstock was used for propagation in the month of February. Comparative performance indicated that growth parameters *in situ* soft wood grafting were more vigorous as compared to nursery grafting. Out of 5 accessions, CHES 2 showed better performance in plant height and stock diameter. Whereas scion diameter was big in CHES 4 under *in situ* grafting. Plant spread as high in CHES 2 among these accessions.

Bael

Bael genotypes viz, NB 5, NB 7, NB 9, Pant aparna, Pant sujata, Pant urvashi, Pant shivani, Dhara road and PB-1 were evaluated and the growth was maximum in CISH-1 while plant spread was recorded highest in NB-7. Leaf area was maximum in NB-7. All the genotypes exhibited significant difference on growth characters. Flowering and fruit set were noted in CISH-2 and Dhara road genotypes after 3rd year.

Biotechnology and tissue culture

Refinement and improvement of micro propagation of date palm, *ker* and *Gonda* and aonla

The protocol for lasoda was developed by using single node explant with direct root initiation in apical micro shoots derived from field grown mother plant. In *aonla* multiple shoot proliferating and rooting study is in progress. In *ker* shoot proliferation per explant was recorded upto 13 microshoot/explant. The micro shoot separated from multiple shoot clumps and rooted individually on MS medium supplemented with sucrose and different combination of IBA and NAA.

Micropropagation of Cactus pear

Micropropagation techniques of cactus pear for a thornless, vegetable type was developed through single bud explant. Physiologically mature buds resulted maximum multiple shoot (8 shoot/Explant) formation on MS medium supplemented with 3% sucrose, 8 g agar and 2 mg BA+ 0.1 mg NAA. Multiple shoot clump were further subjected to culture for shoot elongation medium. The elongated shoots were rooted under *in vitro* and *in vivo* conditions. However, rooting response in terms of root quality and period of root induction remarkably differ in both the conditions. The early and better quality roots in micro shoot was recorded under *in-vitro* conditions. The rooted plantlets were successfully acclimatized under three step hardening procedure (Fig. 7).

Fig. 7. Micropropagation of cactus pear

Improvement in plant hardening facility

Three step plant hardening technology with low cost alternatives of cooling pad made of ber biomass was developed (Fig. 8). This cooling pad was found comparable to imported cooling pad made of corrugated paper.

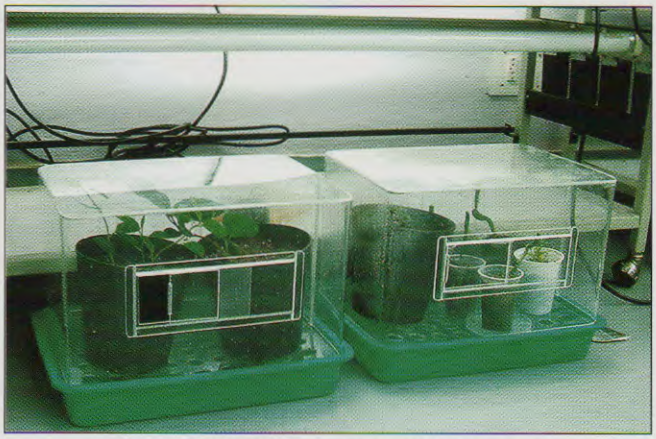


Fig. 8. Acclimatization of plantlets (*Lasoda*)

Development of advanced propagation facilities for clonal rootstock production

Controlled environmental conditions facilities were developed. Integrating fogging unit for root stock development and utilized for rootstocks production was devised.

CROP MANAGEMENT

Cropping System

Aonla based cropping models in arid eco-system

Four different aonla based cropping models, viz. Aonla-Khejri-Sewan (M_1), Aonla-Pomegranate-Mateera-Gram (M_2), Aonla-Lime-Clusterbean-Fenugreek (M_3), Aonla-Ker-Kachri-Cumin (M_4) started during 2003. *In-situ* budding on aonla resulted cent per cent establishment. However, severe chilling injury during the first week of January, 2006 caused in complete mortality of plants. Interestingly, under storey components crop, i.e *khejri* was not injured. Pomegranate and ker although were affected but recouped with the rise in temperature during the month of February. Infection of bacterial canker in lime resulted poor survival. Sewan grass did not germinate well due to competition of perennial weeds. The performance of ground-storey crops was better in the different cropping models. Yield of ground-storey crops viz., *mateera* (*Citrullus lanatus*), and *kachari* (*Cucumis melo*) grown in models 2, and 4 recorded an average yield of 3.44, and 20.0 qha^{-1}, respectively.

Aonla based cropping system in semi-arid eco-system

Five species of cucurbitaceous crops viz, pumpkin, bottle gourd, bitter gourd, sponge gourd and cucumber were intercropped in the 4 years old aonla orchard, planted 10 × 10 m apart under rainfed condition. Maximum yield per ha as well as economic return was recorded with bottle gourd inter crop.

High density planting

An experiment with five planting system revealed that the plant height (4.19 cm) was recorded highest in double hedgerow planting system after 4 years. Root stock girth (30.32 cm), scion girth (23.32 cm) and plant spread (E-W=2.76 m and N-S=2.68 m were recorded high in square system. Yield per ha (1,798.20 kg) was recorded high in double hedgerow system. Among the various planting systems, an increase in yield (99.80%) and additional economic returns (Rs 8,982/ha) over square system of planting were recorded in double hedgerow system during 4th year. The physico-chemical attributes of aonla were not influenced significantly by the different planting systems.

In the sixth year of high density planting, various growth parameters were recorded, plant height was found to be non significantly influenced where as stock, scion diameter and plant spread were significantly influenced. The maximum plant height, stock, scion diameter and plant spread were recorded in 10 × 10 m spacing.

Crop Management

Cropping System

- Aonla based cropping system in arid ecosystem
- Aonla based cropping system in semi-arid ecosystem
- High-density orcharding
- Cropping system in semi-arid vegetables

Integrated Nutrient Management

- Organic and inorganic fertilizers in pomegranate
- Leaf mineral composition
- Physiological actitivty
- Soil moisture fertility
- Micronutirents on pomegranate

Integraeted Water and Nutrient Management

- Fertigation schedules and water requirement
- Moisture extraction pattern
- Drip irrigation in aonla
- DRIS norms in aonla and sapota

Soil and Water Conservation

- Water management in arid horticultural crops
- Soil moisture conservation
- Soil water conservation and watershed management
- Water balance at microwatershed
- Water harvesting and augmentation

Organic Farming

- Organic and biodynamic farming
- BD 500 and BD 501
- Vermicompost
- Leaf litters on pomegranate yield

Observation on flowering and fruiting indicated that there were non-significant differences in respect of total no. of branch let/ shoot, Branchlet with female flowers and branchlet with no. flowers except in respect of no. of fruit set and retention. However, all the above parameters recorded were maximum in 10 × 10 m spacing.

With regard to yield and economics of the plantation, maximum yield per plant was recorded in 10 × 10 m spacing and maximum yield per ha. was recorded in 5 × 5 m spacing, giving a highest net return. The results indicated that up to 6th year of age. There is no adverse effect of close spacing on growth, yield and productivity of the Aonla cultivars NA 7.

Cropping system in semi-arid vegetables

Under drumstick based cropping system, ridge gourd was maintained as intercrop as well biomulch. The treatments maintained comparatively higher leaf area under stress conditions. Two sprays of 5.0% KCl enhanced yield. However, the treatments were not significant due to heavy rainfall and continuous stagnation of water in all the treatments.

Among the 16 different crop combinations tested comparing with traditionally method (pigeon pea+ Maize) as control, intercrops did not affect the productivity of base crop (Moringa).The net income from inter cropping of moringa + pumpkin+ cluster bean + cowpea (T 13) maximum of Rs 68,922/ha as compared to other crop combinations with benefit : cost ratio of 1.92. The highest benefit cost ratio (2.11) was observed in bottle gourd followed by Bhendi (2.42). Almost stable yield of moringa in sole and inter crops suggested that the inter crops may not compete with the main crop.

The vine growth and development was not affected by drumstick density. There was no significant reduction in the yield of main crop as well. When the drumstick starts flowering, harvesting the intercrops end. When cucurbits climbed on drumstick than ground trailing method 12% yield improvement was observed. Ridge gourd and bottle gourd performed well than the other vine crops at 5.0 × 2.5 m spacing.

Integrated nutrient management

Organic and inorganic fertilizers on pomegranate production (CIAH, Bikaner)

Various combinations of organic and inorganic fertilizers were investigated in 7 years old plants of pomegranate (cv. Jalore Seedless). The mean plant height was ranging from 1.80 to 2.75 m and maximum plant height (2.75 m) and increase in growth (52.8%) were recorded in vermicompost + inorganic fertilizer (50:50) followed by vermicompost (2.70 m and 11.0%) treatments. Similar trend was observed in case of tree volume also. Maximum tree volume (7.60 m^3) was recorded in this treatment followed by 7.3 m^3 in vermicompost, 7.25 m^3 in sheep manure + vermicompost and 7.25 m^3 in cattle manure + vermicompost. Data revealed that 65 to 75 per cent flowers resulted fruit setting in application of organic manures, while 45 to 50 per cent flowers resulted fruit setting by application of inorganic fertilizers and combinations. Fruit weight was ranging from 180 to 275 g and maximum fruit weight (275 g) was recorded in vermicompost + inorganic fertilizer (50:50). The fruit cracking was ranging from 15 to 20 per cent. Fruits cracking were mixed (vertical/horizontal/zigzag) in pattern.

Leaf mineral composition

Leaf mineral composition of pomegranate plants revealed that the nitrogen content was ranging from 1.70 to 2.55% and maximum N content (2.55%) was recorded in vermicompost and its combination with inorganic fertilizer. The P and K contents were ranging from 0.13 to 0.25% and 1.52 to 2.30% respectively. Vermicompost application resulted maximum P and K content in leaves. Among the micronutrients, Zn, Cu, Mn and Fe, zinc was ranging from 30 to 52 ppm and the vermicompost and cattle manure + vermicompost application resulted maximum (52 ppm) Zn content. Copper content was in the range of 5 to 7 ppm while iron content ranging from 35 to 85 ppm. The maximum

(85 ppm) iron content was observed in vermicompost, its combination with inorganic fertilizer and sheep manure + inorganic fertilizer. Manganese content (35 to 45 ppm) was more or less same in all treatments.

Physiological activity

The photosynthetic activity (P_N) was ranging from 0.4000 to 0.8000 mg CO_2 m^{-2} s^{-1}. The maximum P_N activity was recorded in cattle manure + vermicompost followed by vermicompost (0.7000 mg CO_2 $m^{-2}s^{-1}$) and, sheep manure + vermicompost (0.600 mg CO_2 $m^{-2}s^{-1}$). The transpiration rate was ranging from 1.500 to 1.700 mg H_2O m^{-2} s^{-1}. The mean maximum transpiration rate (1.700 mg H_2O $m^{-2}s^{-1}$) was observed in untreated control. However, cattle manure + vermicompost resulted maximum water use efficiency (53.33%). The stomata resistance was ranging 0.400–0.600 s cm^{-1}. Stomata conductance was in the range of 1.50 to 2.10 cm s^{-1}, which was inversely proportionate to resistance values. Minimum stomata resistance was observed in treatment with vermicompost.

Soil moisture and fertility

The maximum soil moisture (10.5–11.6% at 20 cm) up to was recorded in inorganic fertilizer, sheep manure, sheep manure + vermicompost. Soil moisture was 7.8 to 8.5% recorded in vermicompost at 40 cm depth. However, at 100 cm depth, moisture content was ranging between 15.5 to 16.0 per cent in all treatments. The maximum moisture depleted from 20, 30 and 40 cm soil layers in all treatments. The moisture was slow and gradual in organic fertilizers treatments.

Analysis on fertility build up resulted that the organic carbon reached up to 0.31 per cent after seven years from 0.09%. Other nutrients like N, P and K contents were also enhanced by application if organic fertilizers particularly vermicompost and its combinations. Available N was ranging between 135–205 kg/ha, P being 11–25 kg/ha and K content of 196–255 kg/ha in all treatments.

Micronutrient sprays on growth yield and quality of pomegranate (CHES, Godhra)

Two sprays on micronutrient singly or in combination applied during the vegetative growth period and another during the initial fruit development of pomegranate cv. Ganesh. The indicated that neither of the pure form or combination of sprays had significant influence on vegetable growth parameters of pomegranate cv. Ganesh. Data of yield and physico chemical analysis of the fruits indicated that all the characters like no. of fruit retained /plant, yield kg/plant, fruit length and diameter were significantly influenced except T.S.S. More number (79.5) of fruit were retained in treatment Boric acid with Zinc sulphate application followed Ferrous sulphate+ Boric acid (78.25). Fruit weight, length and diameter were height in the same treatment. Maximum yield per plant (about 11–11.5 kg/plant) was obtained where combination of micronutrients were applied rather than applying them in single form.

Integrated water and nutrient management

Fertigation schedules and water requirement

In Kinnow, maximum water use efficiency (1.30q/ha-cm) was observed at 0.75 CPE through drip irrigation followed in 0.75 CPE level through micro sprinkler irrigation system. In pipe (bubbler) and open channel systems water use efficiency did not differ much in respect of irrigation levels while in drip and micro sprinkler systems, WUE differed to each other. Increase in yield with excess nitrogen application (125% RDN) under drip and micro sprinkler was non-significant in comparison to the recommended doses of N (100% RDN) while lowering the dose than recommended doses of N, i.e. 75 and 50 recommended dose of N through drip and micro sprinkler irrigation system showed the decline in yield significantly. Thus application of recommended dose of N through drip and micro sprinkler in Kinnow fruit crop give the optimum yield higher with fertilizer use efficiency.

To standardize the fertigation technique and fertilizer and water requirement at different stages of crop growth under soil-climatic conditions of arid eco-region under micro-irrigation system, following parameters have been standardized. For ber, crop factor 0.6, pan factor; 0.7; planting distance, 6x6 meter, per cent area covered by foliage (wetted zone), 40 per cent have been standardized on the basis of crop stage. In 6 year-old pomegranate, pan factor, 0.7; planting distance, 5 × 5 meter, crop factor, 0.55, and wetting area, 25 per cent were standardized. In kinnow, (4 years old) pan factor, 0.7; crop factor, 0.6; planting distance, 6 × 6 meter; area to be wetted, 25 per cent have been standardized.

In ber, maximum plant height (3.20 m) was recorded in micro sprinkler at 1.00 CPE irrigation level. Ferti-irrigation levels also influenced the plant height and 100% recommended dose of N through drip and micro sprinkler, plant height was statistically at par. In pomegranate maximum plant height (2.10 m), tree volume (8.90 m^3) were recorded in 1.0 CPE through micro sprinkler and statistically at par with 1.0 and 0.75 CPE levels of drip irrigation. Maximum plant height 2.15 m was measured in 100% recommended doses of nitrogen and further reduction in nitrogen doses reduced the growth parameters significantly.

In Kinnow, maximum plant height (3.25 m) was recorded at 0.75 CPE irrigation level through drip. The tree volume estimation using torpedo formula showed the highest tree volume (17.50 m^3) in 1.00 CPE followed in 0.75 CPE level (16.45 m^3) irrigation level through drip. Further reduction in irrigation level in respective system reduced the fruit juice content significantly. The TSS and juice acidity did not differ significantly in different treatments.

Moisture extraction pattern

The maximum moisture was extracted at of 20 to 40 cm vertical depth and 30–50 cm horizontal distance from the main stem of Kinnow. While, maximum moisture depleting (18.6 to 7.8 per cent) at depths from 20 to 40 cm and reduction in moisture level was low at 10 to 20 cm (18.5 to 15.8 per cent) and at 40 to 100 cm (19.7 to 18.5 per cent) depth under drip and micro irrigation systems. Horizontal moisture depletion was observed only up to 40 cm. and beyond that moisture depletion from 40 to100 cm depth was 18.9 to 15.7 per cent. Thus, moisture depletion pattern revealed that plant extract the maximum moisture from 20 to 40 cm soil strata where feeder roots exist. Therefore, water should be given to plants through micro-irrigation systems at the vertical depth and horizontal distance of 20–40 cm from the main stem.

Drip irrigation in aonla (CHES, Godhra)

Studies were conducted on 4 years old plants of aonla with seven treatments comprising of three intensities (20, 40, and 60% wetted area) and two frequencies of drip irrigation (alternate and 4th day interval) and control. The maximum annual increase in the height of plant (0.82 m) from the plants of alternate day irrigation with 60 per cent wetted area. The increase in stem girth (9.15 cm) and plant spread (E-W-.54 m and N-S-0.52 m) was also observed maximum under alternate day with 60 per cent wetted area. Nutrient status in aonla shoots was also increased by the different frequencies of irrigation than control. Plants irrigated at alternate day with 60 per cent wetted area had the highest percentage of N, P, K, Ca and Mg in the leaves.

Nutrient trials in sapota

Experiment results from different doses of nitrogen (50 g N/ tree to 700 g N/ tree), phosphorus (50 g P_2O_5/ tree to 600 g P_2O_5 / tree) and Potassium (50 g K_2O/ tree to 700 g K_2O/ tree) showed that maximum yield (18.5 kg/tree) could be obtained from a dose of 600 g N/tree and 15.3 kg/tree by phosporus.

DRIS norms in aonla and sapota

DRIS norms for macro and micronutrients in aonla were developed. The optimum nitrogen concentration in the index leaf ranged from 1.1–3.07%, whereas

phosphorus, potassium, calcium, magnesium sulfur, iron, manganese, zinc and copper, ranged from 0.11–0.16%, 0.3–0.6%, 0.43–0.87%, 0.17–0.48% and 0.07–0.12%, 62.89–186.3 ppm, 19.97–46.57 ppm, 7.76–13.9 ppm and 5–11.63 ppm respectively. Similarly, DRIS norms for macro and micro nutrients in sapota showed that the optimum nitrogen concentration in the index leaf ranged from 1.25–2.38%, whereas phosphorus, potassium, calcium, magnesium sulfur, iron, manganese, zinc and copper, ranged from 0.05–0.17%, 0.36–0.77%, 1.01–2.04%, 0.48–0.92% and 0.38–0.82%, 18.9–147.43 ppm, 18.12–36.97 ppm, 7.89–16.57 ppm and 3.92–5.66 ppm respectively.

Soil and water conservation

Water management in arid horticulture crop (CIAH, Bikaner)

Fertility status of experimental soil shoed that all physical properties except saturated hydraulic conductivity of the soils were remain unchanged. Total available soil water holding capacity of the experimental soil in centimeters in the one meter soil profile was 2.74 cm. There were no significant changes recorded in chemical properties of soil. However, the little bit changes were observed in case of EC and available soil K status. The electrical conductivity of the soil was slightly increased. The remarkable change in soil K status was recorded in the treated plots. The treated plots recorded less soil K as compared to control.

Mulching on soil moisture conservation

The maximum soil water contribution was recorded under FYM mulched plots (20.80 mm) followed by cluster bean (*Cymopsis tetragonoloba*) residues (16.59 mm). The maximum soil moisture content at 15 cm soil depth during early crop growth period (August–October) was recorded under FYM. Custer bean residues mulch recorded highest soil moisture content even at 30 cm soil depth. FYM mulch was the best treatment by reducing the maximum soil temperature during early crop growth period while during fruiting period increased the minimum temperature by 2.0 to 3.5°C. The maximum concentration of N, P and K in brinjal leaf was recorded in the plots mulched with FYM (Fig. 9). The brinjal crop grown in FYM mulched plots experienced maximum water use efficiency followed by plots mulched with Cluster bean residues. FYM mulch also recorded three times more fruit yield followed by cluster bean residues mulch as compared to control. In case of Kachari these two mulches enhanced 41 and 34% more fruit yield as compared to control.

Fig. 9. Growth of brinjal by cluster bean straw and FYM mulching in arid soil

Soil and water conservation in watershed management

Water scenario in CHES, watershed

Micro- Watershed is located at an elevation of 110 to 115 m above mean sea level having a latitude of 73° 33' 22" N and longitude of 22° 41'38" E. Its topography is rolling to level surface located in the forks of Central Gujarat. All small drainage meets to the Ruparail Nalla and this Nalla meets to the Goma river and Goma river meets to the Mahi basin. Four small drainage flowing from main research farm area of watershed to the south to north direction. The soil type is varying as sandy clay loam in earthen dam, clay loam in loose

bolder structures, sandy clay loam in gunny bag filled with sand, sandy loam in permanent check dam_1 and sandy clay loam in Permanent check dam_2. The rainfall was 1,335 mm 90–120 rainfall intensity. The surface run off was 127 (mm) and soil loss was varying from 8–10 in earthen dam and 50–200t/ha in other structures.

Weather parameters at Micro-watershed

The mean monthly maximum temperature during the year is lowest (17.91°C) in the month of January and reached highest of 37.5°C in May. Monthly mean minimum temperature was lowest (6.55°C) in the month of January and highest (23.8°C) in May. Monthly mean sunshine values showed that maximum in the range of 3.7 hr / day to10.2 hr per day (fig.1) The values remain minimum during the period of July to September. The relative humidity remains lowest during the month of March and attains peak value during June to September. During June to September, relative humidity varies between 75 to 85 per cent. Values shows that driest month is March and June to September is the wet months. Mean monthly wind velocity varies between 2.15 to 10.9 km/hr.

Water balance at micro-watershed

Rainfall (in the form of surface run off and ground water), are the major sources of water available at CHES watershed. The water availability in the watershed was assessed on monthly basis through FAO 56 P-M model and shows in Fig. 10.

The maximum potential evpotranspiration and water deficit was observed in the month of May followed by June. The potential evapotranspiration of the area 1,687.90 mm, whereas actual evapo-transpiration taking place in the area is only 1,335.20 mm, thereby causing an annual water deficit to the extent of 352.7 mm. (during pre and post-monsoon). The area received annual rainfall 1,335.20 mm, which covers about 20.89 per cent of the annual evapotranspiration of 1,687.90 mm.

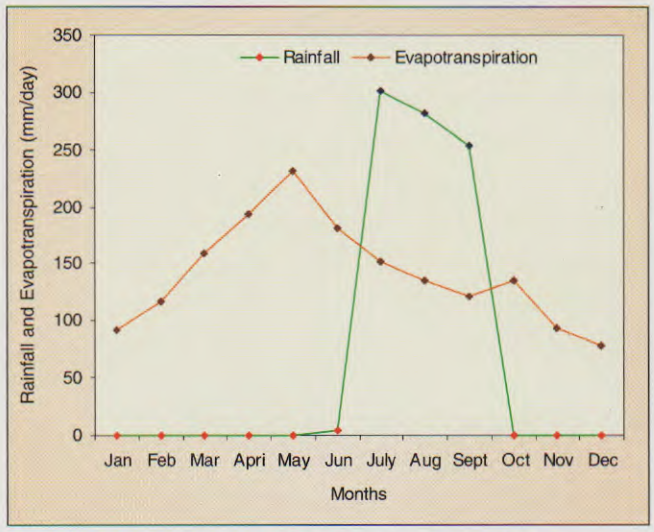


Fig. 10. Water balance at micro-watershed

Sub-surface water harvesting and ground water augmentation

Water table fluctuation was monitored. A significant increase in the ground water levels varying from 3.35 to 3.85 m was observed in the well located below the water harvesting structures and minimum raise in water table was observed away from the water harvesting structures in the micro-watershed (Fig. 11 Evaluated Universal Soil Loss Equation parameters (A=RKLSCP) through runoff plots under mango orchards).

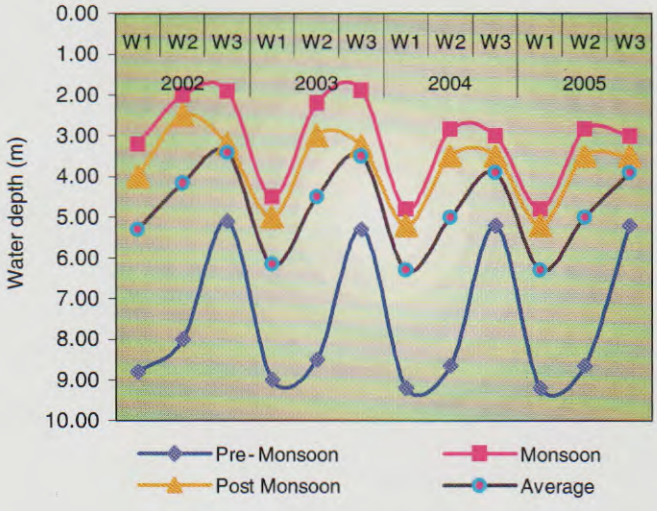


Fig. 11. Well observation and years

Organic farming

Organic and biodynamic farming (CIAH, Bikaner)

BD 500: The requisite quality and quantity of cow horn was collected from the local area and after cleaning, fresh cow dung was filled up in horns on 8th October 2005 as per biodynamic calendar and placed in the orchard soil. Keeping the surrounding wet throughout a period and on 23 March 2006, horns were taken out from the soil and material was taken out from the horns and kept in earthenware for storage. From each horn 25 to 30 gm BD 500 has been obtained.

BD501: The horns were filled with silica slurry and put in the orchard soil in the month of March and remained in the soil for six months and taken out in the month of October as per biodynamic calendar. The material received from the horns is white in colour and odourless. The material named as BD-501. In each horn about a6 to 25 gm BD-501 has been obtained.

Vermicompost: The vermicompost was prepared using the local available farm waste like neem, ardu, *khejri* and banana (from roadside waste) leaves and cattle manure. The vermicompost was prepared in different season and with different material. The data revealed that time for compost preparation was minimum (48 days) when it was prepared during September to November and it takes maximum 90 days during summer period

Leaf litters on yield and quality of pomegranate (CHES Godhra)

Application of leaf litter of four tree species, viz. subabool, neem, sun hemp and dhaincha @ 5 kg/plant on fresh wt basis had non-significant effect on growth characters Leaf relative water content (RWC) on 3rd day after irrigation indicated significant differences among treated and control plants Composition of NPK content was significantly influenced by application of leaf litter. Maximum N (2.4%) was recorded in sun hemp leaf application and similar trend was observed in respect of P and K content. The results indicated that application of leaf litter increased the nutritional composition of leaf.

Soil moisture was high in sun hemp and Subabool even before application of irrigation compared to control after application of irrigation moisture retention was highest (12.5%) where leaf litter was applied. There was reduction in soil PH values; electrical conductivity organic carbon content was however, increased indicating improvement in soil health. No of fruit set per plant was not influenced whereas fruit retention and yield plant was significantly influenced. Maximum fruit retention and yield was recorded in application of sun hemp closely fallowed by subabool leaf litter.

Application of biofertilizers

Application of bifertilizers improved the soil conditions while fertilizers influenced the growth of the plant. Plant growth was maximum with the standard dose of N, P and K (T_1) followed by FYM + St. dose of N, P and K and FYM+*Azotobactor*+ VAM.

Organic manure and fertilizers

Application of organic and inorganic sources of nutrient influenced the vegetative parameters of aonla. Plant height was maximum by applying FYM + St. dose of N, P and K followed by treatment FYM + half dose of N, P and K and Neem cake +FYM +CPP. The quality parameters did not vary significantly by these treatments.

Organic and plastic mulching

The organic and plastic mulching enhanced plant growth and reduced soil moisture evaporation. Soil moisture content was high in black polythene mulch followed by paddy straw. Among the organic mulches, paddy straw showed better response. The bulk density showed reversed trend and maximum bulk density was observed in no mulch conditions (1.40 g/cc) followed by rice husk (1.37 g/cc) and it was recorded lowest with paddy straw mulch (1.28 g/cc). Significant differences could not be observed in between maize

straw and subabool loppings. Hydraulic conductivity was highest in paddy straw (0.42 cm/h). All mulching material showed reduction in soil pH and ECe values as compared to control.

Black polythene mulching influenced maximum plant height (4.27 m) root stock girth (26.78 cm), scion girth (21.00 cm) and plant spread (E-W=2.65 m and N-S=2.56 m). Plant height (4.00 m), root stock (25.46 cm) scion girth (20.45 cm) and plant spread (E-W=2.49 m and N-S=2.41 m) were recorded maximum with paddy straw followed by maize straw, subabool loppings, and grasses.

Considerable differences were observed among treatments for the nutrient concentration in shoots of aonla. Nitrogen concentration was high in the plant treated with paddy straw mulch (2.78%). Similar trend was also observed with P and K content in aonla shoots. Calcium, Magnesium and Sulphur were high i.e.1.42, 0.73 and 0.25 per cent, respectively, in paddy straw mulched plants, followed by subabool lopping and maize straw, but the differences among the treatments could not reach the level of significance.

Organic manuring in sapota

Application of different organic manures with fertilizers treatment had no significant effect on growth parameter of sapota cv. kallipatti. However maximum no of fruits / shoot were retained (60 no/shoot) and yield /plant (92 kg /plant) in combined application of ½ FYM (50 kg) +1/2 through chemical fertilizer (N500 g P200 g K200 g/ plant). Maximum Nitrogen content of leaf was observed in application of nitrogen ½ castor cake + ½ fertilizer (2.67%N) closely followed by ½ groundnut cake + ½ fertilizers dose (2.62%). Potash content of leaf was also significantly influenced and was maximum in application fertilizers through FYM (0.82%). P content of leaf was not significantly influenced. Data on soil moisture retention indicated that maximum soil moisture (12.22%) on oven dry weight basis recorded in application of N through FYM. Highest organic matter content (1.11%) was also recorded in same treatments. Thus the results indicated that replacement of chemical fertilizers with organic fertilizer is certainly helpful in improvement of soil health and also resulted in 6.97 per cent increase in yield over control. Maximum yield of 92 kg/plant was obtained by ½ FYM+½ fertilizer application. The pH of soil was maintained below 7.0 while it was 7.44 in untreated soil. Similarly organic manuring influenced the EC and organic carbon content of the soil.

CROP PHYSIOLOGY AND POST HARVEST TECHNOLOGY

Crop Physiology

Water stress on *mateera* and watermelon

A field experiment was on water stress on plant morpho-metry and growth in *mateera* and watermelon depicted that there was drastic reduction in all growth parameters in watermelon when the stress was imposed. Reduction in plant height from 117.4 cm to 84.2 cm, number of leaves from 41.8 to 22.6, internodes length from 4.7 to 3.8 cm. However, in *mateera* the magnitude of reduction was marginal showing the plant height from 67.6 to 52.5 cm, number of leaves from 38.0 to 34.2 and length of internodes from 4.7 to 3.6. *Mateera* was capable of maintaining dry matter distribution even under stress condition whereas in watermelon it was hampered drastically. Stem dry weight was 2.63 g per vine in control as compared to 2.14 g under stress conditions. Similarly, the dry matter accumulation in leaves was 11.6 g and 11.6 g and that in root was 0.19 g and 0.21 g under irrigated and stress conditions, respectively. In case of watermelon, the dry weight of shoot per vine dropped from 8.9 g to 5.48 g with imposition of stress. Similarly, dry weight of leaves was reduced from 14.9 g to 9.6 g per vine and that of root from 0.34 g to 0.23 g under water stress. The above results demonstrate that *mateera* has inherent capability to tolerate water stress by internally balancing the dry matter allocation.

Crop Physiology and Post Harvest Technology

Crop Physiology

- Water stress on *mateera* and watermelon
- Membrane stability index
- Water stress on growth and development
- Physiological adaptations to water stress

Post Harvest Technology

- Dehydration of *khejri*
- Dehydration of *kachri*
- Vaccum packaging
- Value added products
- Storage studies in aonla
- Postharvest treatments in aonla and ber

Membrane stability index as screening parameter

The membrane stability index was studied in *meteera*, watermelon, muskmelon, bottle gourd, and *kachari* for screening material for resistance to water stress. Results revealed that drought tolerant plants viz. *mateera*, snapmelon and *kachari* had good membrane stability index as compared to drought susceptible ones. It is concluded that the drought tolerant nature of *mateera*, *kachari* and snapmelon is due to their membrane stability even under low soil moisture conditions.

Water stress on seedling growth and development

The effect of water stress on seedling growth and development in *mateera* and watermelon was studied under pot culture. The results presented in table 4 depicted that under control conditions the length of shoot and root increased with the duration of germination.

In *mateera* the length of shoot declined (at 7 DAS declined from 18.02 cm to 17.56 cm, at 10 DAS from 24.18 to 22.06 cm) marginally at all the growth stages. However, in watermelon, the decreased is up to 15%. Similarly, the root length increased in *mateera* when the seedlings were exposed to water stress. It is illustrated by the fact that at (7 DAS the root length was 3.82 in control and 4.44 cm) under stress. However, in watermelon, the root length on 10DAS was 4.04 cm in control that declined to 3.78 cm under stress. The fresh weight of seedling showed a general trend of decrease in fresh weight when the seedlings were exposed to water stress in both the test materials.

Screening parameters for drought resistance

Out of various parameters studied, plant height stress index, dry matter stress index and degree of leaf rolling could be used to screen cultivars for drought resistance.

Physiological adaptations to water stress in arid fruit crops

The effect of water stress and subsequently the recovery from water stress in kinnow revealed that the receding soil moisture level reduced the magnitude of photosynthetic rate in plants. By 15th day the photosynthetic rate declined very low. On re-watering, the plants started to revive but even after 10 days, the rate of photosynthesis could not reach the original value (Fig. 12).

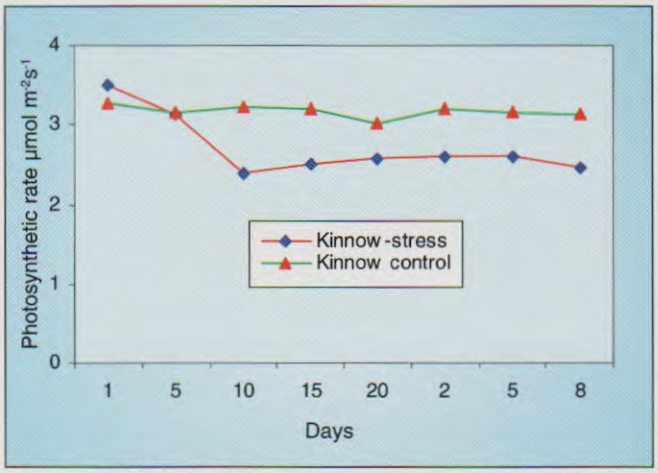


Fig. 12. Effect of water stress on photosynthetic rate

Variation in photochemical efficiency in kinnow under different light intensity

This study was conducted in irrigated plants of kinnow. Data on chlorophyll fluorescence was measured using ADC Plant Stress Monitor. The Fo, Fv and Fv/Fm values were calculated at different light intensity. The results revealed that the photochemical efficiency was high with the light intensity of 1500 µE

Post harvest technology

Dehydration of *khejri*

At CIAH, Bikaner the tender pods after 10–15 days of fruit set were harvested by using a harvester and by climbing the tree. Pods were sorted and graded to different sizes and good quality pods were imposed with three treatments and dried under seven different methods of drying (Fig. 13). The pods were periodically observed for moisture loss and colour change. The overall results showed variation in colour of the

Fig. 13. Maturing stages of *khejri* for dehydration

dehydrated pods in all treatments. Sun dried pods were black, while shade and wooden dried pods retained green colour. Tray-dry pods resulted good quality dehydrated pods.

The recovery per cent did not vary significantly among the treatments while duration of drying varied significantly i.e. sun dried took minimum time, while pods dried in room took the maximum hours. The nutrient content was same in all the treatments. However, unbalanced pods have higher nutrient content compared to blanched pods. The tray dried pods retained maximum nutrient followed by sun-dried pods. The tender pods have higher crude protein and less crude fibre as compared to medium matured and matured pods.

Microbial population in the dehydrated pods revealed that was invisible in naked eyes under normal conditions, but when the pods were for colonization cultured in media, contaminants was minimum in the pods dried in tray drier. The pods could be stored up to 12 months without affecting the quality and appearance under normal room temperatures.

Dehydration of *Kachri*

Colour changes, fruit firmness, TSS and acidity were taken as a harvest index. All horticultural parameters were recorded. The matured pale yellow colour fruits at right stage were harvested for dehydration purpose. The fruit were cut into slices and subjected into four treatments with peel and without peel and dipped in 2% salt solution for one minutes and dried under three methods. The result revealed that the sun dried fruits took minimum time for drying followed by tray dried and shade dried respectively. There was no difference in drying duration in peeled, unpeeled and fruits dipped in salt solution. The fruits were dried in freeze drier to estimate the quality changes. Fruit slices were observed with minimum nutrient loss, best in colour and appearance, when compared with other methods of drying.

The fresh fruits were analysed for nutrients, some of the minerals like TSS, Acidity and pH. The dehydrated *kachri* fruits were also analysed for calcium, sodium and potassium. The fruits dried along with peel have higher nutrient content when compared to peeled fruits. Microbial population was tested in the dehydrated *kachri* fruits. The result revealed that pathological infections were invisible in naked eyes under normal conditions. However, in cultured media, fruits dried in tray drier showed minimum infection. The result of storage studies revealed that the *kachri* slices and powder could be stored upto 12 months without affecting its quality and appearance under normal room temperatures.

Vacuum packaging in aonla

The four varieties of aonla were harvested and cleaned to remove the adhering dust. The fruits are sorted into uniform size and subjected to vacuum packaging treatments with a control. The result revealed that the physiological loss in weight was very less in vacuum packed fruits. NA-7 and NA-6 stored for longer periods.

Value added products

Aonla

The fruits of NA-7, NA-6 krishna and kanchan were processed into different products like segmented candy, aonla murabah etc., aonla shreds were prepared with different treatments. It can be stored upto six months with little quality changes (Fig. 14).

Fig. 14. Aonla product (muraba)

Bael

The fruits are harvested and processed into juices, squash and shake, which were organoleptically tested for acceptance. The same were kept for storage studies and tested for their keeping quality. It was observed that product was good upto ten months without affecting the quality.

Pomegranate

The fruits were evaluated for Anardana purpose. Cracked fruits were prepared into RTS beverage.

Frost-damaged fruits

Experiments were carried out to find out the utility of frost-damaged fruits both for drying and for preservation. The fruits got infected with fungal, other pathogens and found unfit for processing purpose.

Storage studies in aonla and ber Aonla (CHES, Godhra)

Aonla cv NA-7 was evaluated for their fruit quality and storability while retaining on the tree itself after maturity. It was observed that there was no reduction in the fruit quality and shelf life of fruits up to 30th day from the date of maturity.

Increase in physiological loss in weight (PLW), spoilage percentage, total soluble solids, total sugar and reducing sugar and decrease in acidity, ascorbic acid with advancement of storage period were general phenomena in all the post harvest treatments. Fruits treated with calcium chloride 2.0% recorded the least physiological loss in weight and spoilage loss during storage, which was at par with the fruits treated with 1.5% Calcium chloride.

Ber

Packing containers on shelf life and fruit quality of cv. Gola indicated that increase in physiological loss in weight (PLW), spoilage percentage, total soluble solids, total sugar and reducing sugar and decrease in acidity, ascorbic acid with advancement of storage period were general in all the treatments. Minimum spoilage loss was recorded in the fruits kept in corrugated fiberboard box with newspaper liner followed by corrugated fiberboard box with polythene liner. Same treatment also showed lowest respiratory activity and exhibited 4 days of storage life, while control had 2 days life under ambient conditions. Highest respiration rate was recorded in the control on 7th day of storage. Corrugated fiberboard box provide appropriate atmosphere and ventilation inside the box and also strong to stand heavy stack loads and can be recycled as pulp or paper. It is concluded that corrugated fiberboard box with newspaper liner was most suitable and economically viable packing container during transportation of ber fruits under ambient conditions and may be followed for the benefits of both consumers and processors.

Fruits treated with calcium chloride 2.0% recorded least physiological loss in weight and spoilage loss and exhibited 5 days of storage life, it was at par with the fruits treated with 1.5% Calcium chloride while untreated control had 3 days economic life under ambient conditions.

Integrated Pest and Diseases Management

Pests management

- Fruit fly and borer in ber
- Thrips and butterfly in pomegranate
- Borer complex in aonla
- Fruit fly in bitter gourd
- IPM in bitter gourd and pumpkin

Diseases management

- Biological control of ber powdery mildew
- PGPR in arid conditions
- Diseases reactions in vegetables
- Mycotoxins in aonla
- Aflatoxins in pomegranate
- IDM in pomegranate
- IDM in tomato

INTEGRATED PEST AND DISEASES MANAGEMENT

Pests management of fruit fly and fruit borer in ber (CHES, Godhra)

Spray schedule involving applications of insecticides viz. Endosulphan and fungicides viz. Bayleton and Bavistin at recommended doses effectively reduced the incidence of fruit fly (*Carpomyia vesuviana*) Costa, fruit borer (*Meridiarchis scyrodes*) and powdery mildew of ber cvs. Gola and Umran in a field trial. Combination of insecticide with either Bayleton or Bavistin @ 0.1% effectively minimized the disease incidence as measured in terms of PDI 55.19 in untreated control and 5.73 in treated plants.

Management of thrips and anar butterfly in pomegranate cv. Ganesh

Spray schedule involving application of either Dimethoate (0.05%) or Endosulphan (0.07%) with Dithane M-45 (0.2%) effectively controlled thrips (*Scirtothrips dorsalis*) Hood borer (*Virachola isocrates*) and leaf and fruit spot infesting/ infecting pomegranate cv. Ganesh. Combined sprays of insecticides and fungicide are essential to get healthy and marketable fruits of pomegranate.

Management of borer complex in aonla cv. NA-7

Spray schedule involving application of either Dimethoate or Endosulphan in combination with fungicides viz. Bavistin gave maximum marketable yield of aonla cv. NA-7. The incidence of borer (*Virachola isocrates* and *Meridarchis* spp.) ranged between 16–20% during September and October. Fruit rot due to *Penicillium indicum* was also effectively checked by application of Bavistin as pre harvest spray and reduced the per cent incidence from 17.22 to 2.3.

Management of fruit fly in bitter gourd

Trials on management of fruit fly *Chaedacus cucurbitae* in bitter gourd cv. Vivek revealed the effectiveness of Endosulphan (0.07%) and Fenvalerate (0.005%). The application of cow urine and buttermilk also played a significant role in minimizing the incidence of fruit fly. The overall incidence of fruit fly ranged between 18.0% to 42% wityh a considerable damage during the month of October based on picking of fruits during each harvest. The incidence of Cercospora leafspots and downy mildew was brought under control by sprays with Blitox (0.3%) and Mancozeb (0.2%).

Integrated pest management in bitter gourd and pumpkin

Studies on seasonality of fruit fly, *Bactrocera cucurbitae* infesting bitter gourd indicated maximum infestation during second fortnight of September and continued till the second fortnight of November. The infestation ranged between 17.0 to 50% in a crop grown during Kharif season. The marketable yield of bittergourd varied between 9.0 kg/plot in control to that of 14.0 kg/plot in treatment.

Diseases management (CIAH, Bikaner)

Mass multiplication of bioagents

The promising isolates of *P.fluorescens* and *Trochoderma* were sub-cultured periodically from the stock cultures. Some of the effective isolates viz., CIAH-111, CIAH-196 and CIAH-311 and one isolate of *P.fluorescens,* which is non-resistant to karathane, were mass multiplied in respective medium (King's B). Subsequently, liquid cultures were used for preparation of formulation and tested under field conditions. The isolate of *Trichoderma* sp. CIAH–240 and an isolate of *Trichoderma* sp.CIAH–NR which is non resistant to karathane were also mass multiplied and formulated using talc powder as a carrier.

Management of ber powdery mildew

The promising isolates were prepared in the form of talc based formulation and forwarded to different

centers including Bawal, Jobner, S.K.Nagar, Rahuri, Faizabad and Anatapur and CHES, Godhra. Out of 23 treatments data from different centers depicted positive response over the usage of bioagents. The per cent control efficacy of *Trichoderma* isolates was also worked out. In Anantapur centre, reduction in disease severity over control was 31% due to *Trichoderma* sp.CIAH-NR spray, which was significantly higher and at par with the *P.fluorescens* CIAH-NR + karathane treatment. At Rahuri, Maximum PDC (50.0%) over control was achieved by spraying with *Trichoderma* sp. CIAH-240 + Karathane 0.05% and the yield were also at par with Karathane spray. The results of the field trails implied that biocontrol agents with reduced dose of fungicide can be used to manage the powdery mildew to some extend in ber.

Management of virus diseases of arid vegetables

The arid vegetables were sown under field conditions for the evaluation of efficacy of *P.fluorescens* isolates. Out of various treatments viz., seed treatment, foliar spray and combination of both, seed treatment influenced high rate of seed germination. Among the vegetables, germination per cent was high in *mateera* followed by *kachri*. In general, growth and yield attributes have been positively influenced by use of bacterial antagonist in addition to suppression of diseases though significant result could not be arrived as compared to untreated plants.

Isolation of PGPR from arid conditions

Soil and plant samples from ber, arid vegetables (watermelon, *kachri*, snap melon and *kakadi*) and date palm were used for isolation. Total bacterial population from samples was isolated. Pure cultures of bacteria suspected to be plant growth promoting strains (*Bacillus* spp and *P. fluorescens*) are being maintained in their respective medium.

Diseases reactions in arid fruits and vegetables

Majority of fruits of ber and aonla were affected by frost. The progeny lines of pomegranate were free from diseases except the lines OP/AHPG/S4b- L2 and L3 where the incidence of curvularia leaf spot was recorded. Virus diseases were predominant with varying proportion during various growth and development stages of plants of mateera. Majority of the lines were free from bacterial diseases and few were infected by leaf spots and blight in addition to wilt or root rot or combination of both. During rainy season, bottle gourd lines were affected with powdery mildew incidence.

Detection of mycotoxins

Infected fruits of aonla cv. NA-6, NA-7, Chakaiya and Krishna were taken for detecting toxins. Infection due to *Aspergillus* spp. It was maximum (33.2%) in cv. Krishna followed by cv. NA-6 (17.8%). Four pathogenic isolates of *Aspergillus* spp. were tested for the mycotoxins (Aflatoxins: B_1, B_2, G_1 and G_2) production in growth media and fruits as well. Presence of different compounds besides, aflatoxins was also detected from mycelial discs through thin layer chromatogram (TLC). Isolates from NA-6 and NA-7 showed some compounds with prominent yellow fluorescence spots (R_f 0.51) and aflatoxin B_2 whereas, such compounds were not detected from rest of the isolates (Fig. 15).

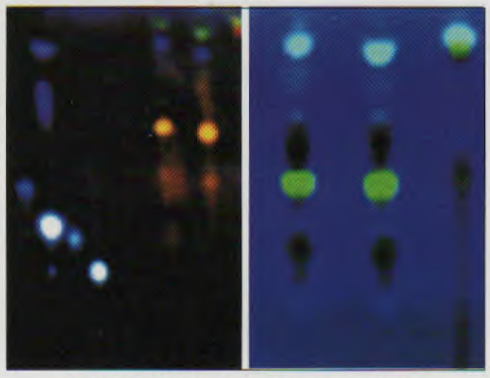


Fig. 15. Aflatoxins from aonla fruits

In pomegranate, infection by *Aspergillus* occurred particularly in injured or naturally cracked fruits at pre and post harvest stages. Detection of aflatoxins in pomegranate arils by agar plugs method showed positive response. Aflatoxin B_2 was secreted by all

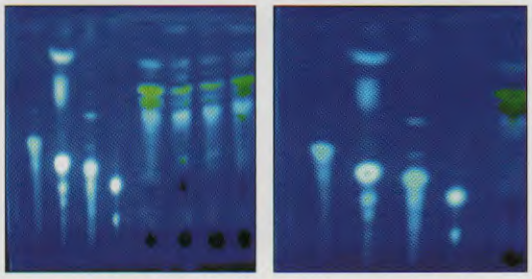


Fig. 16. Aflatoxins from pomegranate arils

isolates in growth media and infected arils. Additionally, yellow fluorescence spots at R_f values of 0.16, 0.47, 0.52, 0.58, 0.59, 0.64, 0.65, and 0.70 were more prominent (Fig. 16).

Integrated disease management in semi-arid horticultural crops (CHES, Godhra)

Ber

The results of experiments involving spray with 2 fungicides viz. Sulfex and Bayleton along with 2 SR (systemic resistance) inducing chemicals viz. SA (salicylic acid) and MKP (Mono potassium phosphate) revealed that although the fungicidal sprays are the best treatments for the disease control, both the SR inducing chemicals can also be alternated with the fungicides and reduce the number of sprays. The minimum disease intensity (PDI) was recorded in the treatments involving 0.1% Bayleton (Tridemefon, 25 WP) sprays (PDI-7.39, PDC=87.19) and Bayleton sprays alternated with sulphur (Sulfex 80 wp,0.2%) sprays(PDI= 9.94 PDC=82.77). Efficacy wise, these treatments were further followed by sulphur (alone) sprays that recorded about 57.71 PDI. When these fungicidal sprays (1 No.) were alternated with SA and MKP spray, the disease control was found to range between 69.77(MKP) and 43.94(SA). All these treatments were superior in yield over control.

Pomegranate

In integrated disease management of *Pseudocercospora* leafspots and anthracnose of pomegranate showed that natural incidence of cercospora leaf spots was very low and erratic in plant pathology field. However, the anthracnose incidence was recorded in the field IDM strategies offered the best control with PDC=92.30. All other treatments recorded PDC ranging between 85.47 and 34.61, the best being bavistin (85.47), mancozeb (84.16) and blitox (84.18) sprays. Alternate sprays of fungicide and Neem oil (79.05) and solo spray of *Trichoderma* spore suspension (34.61) were also effective in varying degree. Cultural control and biological control without any fungicidal spray were inadequate for disease management. The disease was also found to be reduced by MKP-fungicidal spray combination.

Integrated management of damping-off of tomato

The results of experiments revealed that among 6 different treatments (including fungicidal seed-dressing, soil-drenching, soil solarization, incorporation of spores of *Trichoderma viridae* isolated from local soil, fumigation with 1% formalin, etc.) seed-dressing with Ridomil Mz (64% Mancozeb + 8% Metalaxyl) @ 2.5 g/kg seed was best treatment which provided maximum transplant yield with least mortality due to PEDO. *Trichoderma* also reduced the disease incidence and gave higher number of disease free and vigourous seedlings. Soil solarization of pre-moistened seedbeds covered with double layered thin (100 gauze) LDPE first time during May first week for 10 days and second time (after one week of uncovering) for one week rendered complete freedom from PEDO and provided higher transplant yield as compared to control.

Estimation of losses in Okra due to YVMV

Tomato plants were tagged and examined fortnightly for natural occurrence of YVMV. Till the end of the season, 63.53% of total population was affected. Out of these, 9.53% be infected between 15–30 days after sowing (DAS), 15.38% between 31–50 DAS, 24.46% between 51.65 DAS and 14.15% between 65–80 DAS. The cumulative yield loss was estimated to 35.66%.

Barrier crops reduce leaf curl incidence

Out of the four barrier crops used (maize, sunhemp, Juwar and marigold) the maize and sunhemp were found to reduce the disease incidence from 48.09% in control to 14.42 in maze and 18.27 in sunhemp. In Jwar, it was 23.94%. Marigold was not found suitable owing to its slow growth and late flowering.

Management of diseases of bottle gourd and sponge gourd

Both these cucurbitaceous crops were studied for disease development. Bottle gourd was affected with Cercospora leaf spots since August 2nd week and powdery mildew since last week of August. In the end of the season systemic virus disease (mosaic) was also recorded. The sponge gourd was not affected with any major diseases, although mild infection category of downy and powdery mildews and cercospora was recorded.

The powdery mildew was best controlled by bavistin (PDI=2.3) as compared to control (11.3). Cercospora leaf spots disease was found to be reduced by 2 sprays with Bavistin (5.7), Blitox (2.2) and Dithane M-45 (8.42) as compared to control (23.44). Neem oil spray was also found effective (PDI=14.1). The crop grown on mandap was found relatively less affected (PDI+16.3) with Cercospora as compared to control (2.5).

Biological control of damping off

The *Trichoderma* isolate from the local soil was incorporated in the seedbed and was compared with the conventional disease control methods. The results revealed that the antagonist was successful in reducing the mortality due to PEDO incited by *Pythium* spp. and produced higher number of mere vigourous seedlings.

Control of powdery mildew of okra using *Ampelomyces quisqualis* (AQ) culture

The mycoparasite was isolated from powdery mildew of okra and was cultured on potato broth, PDA and Czepek Dox Agar. For growth, Potato broth was found the best followed by PDA. The culture was diluted 10 times in sterile distilled water and sprayed on powdery mildew colonies. The results revealed that the powdery mildew was colonized by the mycoparasiste with in 8–10 day. However, at that stage, the disease had already reached to the damaging stage and it was not found suitable for powdery mildew management.

AGRICULTURAL EXTENSION

Horticultural development in IGNP area of Bikaner district (CIAH, Bikaner)

One hundred and fourty one farmers and secondary sources were contacted to collect the information of horticulture based cropping system. Cumulative analysis of data revealed that 19.5% farmers grow improved varieties of ber, aonla, pomegranate, Lasora, etc. During *kharif* season, 22.75% farmers grow brinjal, Okra, chilli, bottle gourd, round melon; 28.80% farmers grow *mateera*, snapmelon, *kachri* and Indian aloe under irrigated condition.

Mixed cropping system is pre dominant in rainfed areas during *kharif* season. The major crops in this system include pearl millet, seasemum, cluster bean, groundnut, cowpea, moth bean, *mateera*, snap melon, *kachri*, round melon, bottle gourd, ridge gourd, *khejri* and their combinations. Few farmers grow improved varieties of ber, aonla, pomegranate, *mateera*, snap melon, Kachri, etc. During *rabi* season, cumin, pea, green fodder, mustard, cauliflower, cabbage, wheat, gram, brinjal, chilli, etc. as sole crop as well as intercrop in ber and aonla/pomegranate orchards are grown. Some of the above-mentioned vegetables are grown under irrigated conditions. The knowledge on arid horticultural technologies and their adoption is very poor among the farmers. However, they are interested in getting training on improved package of practices. Most of them receive information from fellow farmers and media in addition to friends and CIAH, Bikaner.

The majority of the horticultural crop growers get/

Agricultural Extension and Tranfer of Technologies

Agricultural Extension

- Horticultural development in IGNP area
- Assessment of arid horticulture
- Strategies for adoption of integrated horticultural technologies

Tranfer of Technologies

- Farmers visit
- Field demonstrations
- Organization of training programme
- On farm visit
- Dissemination through mass media
- *Krishi mela*
- Exhibitions

purchase inputs from local markets/district headquarters, CIAH-Bikaner, private nurseries etc. The farmers are getting very good yield and profits from horticultural crops. The marketing pattern/system of horticultural crops was traditional concerned with heavy loss to farmers and poor adoption of horticultural crops. Due to the adverse climatic conditions and long practical experience/knowledge, the farmers use various ITKs in horticultural crop production.

Assessment of arid horticultural status in Bikaner district

In continuation to survey work of the previous year, data were collected from 153 more farmers and secondary sources. Cumulative analysis of data revealed that 13–66% farmers grew improved and local varieties of ber, aonla, pomegranate, *mateera*, snap melon and *kachri*, etc., Majority of the farmers grow *khejri* (*Prosopis cineraria*). More than one fourth population of the farmers grow brinjal, bottle gourd, ridge gourd, round melon, chilli, cluster bean (vegetable), Indian aloe, etc. during *kharif* season and more than one third population of the farmers grow brinjal, cauliflower, cabbage, spinach, tomato, carrot, radish, fenugreek (green leaves), etc. during Rabi season. The cumin and fenugreek (seeds) were grown by > 30% farmers at large scale during the *Rabi* season under irrigated conditions. Most of the farmers grow local/*deshi* varieties of the above crops. They purchase the seeds from local markets/fallow farmers/friends and grow them on their fields.

The majority of the farmers practice mixed cropping system including local/*Deshi varieties* of horticultural crops during *kharif* season. Some of the farmers grow improved varieties of *ber* (Seo, Gola, Umran), *aonla* (NA-7, NA-6, Chakaiya), pomegranate (Jalore seedless, Ganesh), *Mateera* (AHW-65, AHW-19), Snap melon (AHS-10, AHS-82) and *kachari* (AHK-119, AHK-200). However, these farmers are poor in technical knowledge and adoption in improved arid horticultural technologies.

Constraints

Lack of location specific technologies, very high/low temperature, salinity in ground water, drought, non availability of other inputs, poor rainfall and soil conditions in addition to sand dunes, ineffective plant protection measures, lack of inputs for reasonable costs and insecurity on crop failure are major constraints in horticultural production in this district.

Strategies for adoption of integrated horticultural technologies

Insect pest management in *Aonla* (CHES, Godhra)

Majority of the *aonla* farmers (54%) reported the infestation of shoot-gall maker. They cut and burnt the affected shoots. Forty nine per cent *aonla* farmers reported the infestation of bark-eating caterpillar. Thirty per cent farmers adopted the practice of dipping monocrotophos in cotton and kept inside the hole and plugged the hole with cow dung. Even though monocrotophos was effective in controlling the pest, its usage had been banned in fruit crops. Nineteen per cent farmers did not take up any control measures. Fourteen per cent *aonla* farmers reported the incidence of mealy bug. Few farmers (11%) reported the incidence of fruit borer in *aonla*. They sprayed dimethoate (0.2%) thrice at tri-weekly interval. Nine per cent *aonla* farmers reported the incidence of hairy caterpillar. They sprayed dimethoate. Nineteen per cent *aonla* farmers reported the incidence of aphid and they sprayed monocrotophos.

Pest management in Mango

Majority of the farmers (82%) noticed the leafhoppers infestation as an important pest but only 20 per cent of the farmers sprayed Dimethoate, whereas 62 per cent farmers did not spray any chemicals. Majority of the farmers (49%) reported the infestation of termite. Twelve per cent farmers sprayed quinalphos on stem and applied drenching around collar region. Few farmers (12%) reported the incidence of fruit fly

and followed the practice of trapping the adults by using methyl eugenol combined with dichlorvos. Few farmers (20%) noticed the infestation of leaf gall midge and sprayed quinalphos. Few farmers (8%) reported the incidence of red tree ant and did not spray any chemicals.

Diseases

All farmers reported the incidence of floral malformation. All farmers were cutting and burning the affected inflorescence. Majority of the farmers (82%) reported sooty mould infection. Few farmers (20%) sprayed Dimethoate. Powdery mildew was noticed by majority of farmers (80%) but only 25% farmers applied chemical spray of wettable sulphur. During rainy season, anthracnose and many minor leaf spots were seen but the farmers were not noticing them and no sprays were applied. Few farmers (5%) noticed dieback and gummosis and applied Bordeaux paste. Few farmers (10%) reported the incidence of giant mistletoes. They did not spray any chemicals.

COMPUTER APPLICATIONS

In order to develop website for CIAH, Bikaner as per the DARE, DARE Format was analysed to

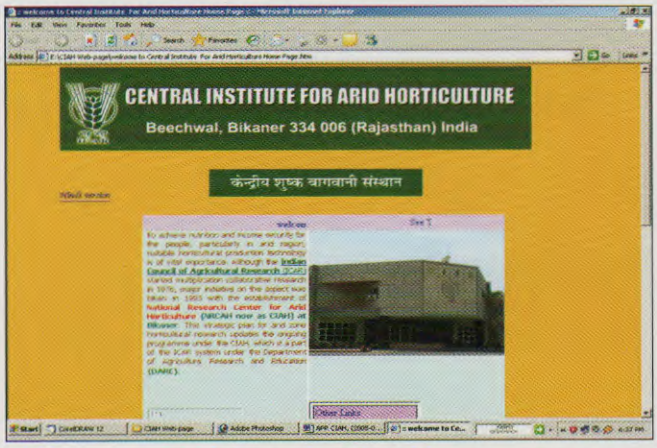


Fig. 17. Home page English version

Design website. DARE format contains many sub menus. The web site was designing using Microsoft Front page and sub menus are designed using Java Script and Active Server Pages. Home page contains brief information about CIAH and some important visuals of CIAH with scrolling effect. Vertical scrolling board is also designed for the home page using JAVA script to display important events of CIAH. A counter for visitors is also placed in the home page to count number of visitors browsed the website. Search Engine is placed to search local, global sites and different mail engines. Hindi version of home page is also designed by downloading Hindi fonts from CDAC web site.

3

Transfer of Technology

First line extension education

Training

The main institute and the regional station have organized different training programmes and field days, on farm demonstrations etc., and disseminated the technologies of arid and semi arid fruit and vegetables cultivations as below.

Farmers visit

About 1100 farmers and 70 B.SC(Ag.) students from different parts of the country visited the Institute's farm/experimental blocks and research laboratories to acquaintthe technical knowledge on arid horticulture (Fig. 18).

Fig. 18. Farmers discussion

Visit of scientific groups/personalitie

Various scientific groups and dignitaries came from various SAU's, ICAR research center and NGOs, etc., have visited the Institute and the pertained information on arid horticulture and extension activities of the Institute were provided.

On farm visit of CIAH scientists

Various visits of scientists team led by extension scientist have been made to farmer's field to identify their problems on production of arid horticultural crops. The scientific team has guided the farmers to overcome farmers problem in accordance with their available resources. These farmers were also guided through telephonic medium.

Organization of training programmes

Six on and off-campus farmer's training programme were organized to impart them with improved package of practices of arid fruit and vegetable crops.

Field demonstrations

Field demonstrations/front line demonstration (No. 7) on newly released varieties of *mateera,* snap melon and *kachri* and improved varieties of ber and aonla were conducted on farmers field to show the beneficial effect and popularization of these varieties (Fig. 19).

Fig. 19. Field demonstration to students

Popularization of arid horticultural technologies

The arid horticultural technologies like improved varieties of *mateera*, *kachri*, snap melon, aonla, ber, pomegranate, lasora, bael, phalsa and their agro-techniques were popularized among the farmers/clients through personal contact, demonstration, exhibition, farmer's, meetings, group discussion, news papers and other channels of the mass media. The functional linkage were also maintained with KVKs, Directorate of Extension, and ATIC of RAU, Bikaner; state Govt. Department of agriculture/horticulture and NGOs for popularizing and disseminating of CIAH technologies and arid horticultural development.

Distribution of seed and planting materials

The Institute provided seeds of improved varieties of vegetables like *mateera,* snap melon, *kachri* etc. and planting materials of improved varieties of ber, aonla, bael, phalsa, lasora, pomegranate to the various farmers of arid region, extension functionaries, ICAR institutions, SAU organizations and NGOs, etc.

Distribution of extension literature

Literature on improved package of practices of arid fruit and vegetable production were provided to a large number of farmers and extension functionaries for better understanding and encouragement on adoption of these package of practices.

Participation in farmers fair

The Institute played leading role in participation of in farmer's fair organized by Urmul Setu Sansthan Lunkarnsar, Bikaner during this period.

Farm visit

During 2005–2006, 1630 persons visited the station farm. Out of them, 832 were farmers, 488 were farm women, 200 were students, 10 were scientists, 93 were extension functionaries, and 7 were VIPs at CHES, Godhra.

RAWE

Third batch of Rural Agricultural Work Experience (RAWE) programme of B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat comprising 74 students of seventh semester of B.Sc. (Agriculture) degree course, visited the station (Figs. 20 and 21).

Participated in the State level Farm Science Mela cum Exhibition organized by Jawaharlal Nehru Krishi Vishwa Vidhalay, Krishi Vigyan Kendra, Jahbua, Madhya Pradesh, during 30th January – 1st February 2006. Put up a stall of the station in the Exhibition, displayed charts, photographs, specimens, fruits, vegetables, etc., explained the station activities to the visitors and distributed station publications.

The station participated in the kisan Mela at Jhabua

Fig. 20. Visit of students

Fig. 21. Nursery demonstration to students

Fig. 22. Interaction of Governor (MP) with scientists

(M.P.) during 30–31 January, 2006. Farmers visited the stall and accordingly their problems pertaining to fruit production were solved (Fig. 22).

Bank of Baroda, Godhra organized Mega Credit Mela on 02 March 2006 at Rajput Samaj Bhavan, Godhra. The station put up a stall of the station in the Exhibition, displayed charts, photographs, specimens, fruits, vegetables, planting material, etc., explained the station activities to the visitors and distributed station publications.

Transfer of technologies through media

Dr. B.D. Sharma has delivered radio talk on Bagaon mei urvarko ka prayog, AIR, Bikaner, dated 23.09.2005. He also delivered talk on Sichai jal hi upyogita evam prabandh, AIR, Bikaner, dated 3.01.2006.

Dr. D. Singh delivered a TV Talk on Role of Zero energy cool chamber in hardening of plants on 9.8.05

KVKs/Others

Dr. B. D. Sharma, Phaslon mei vermicompost ka upyog, KVK, RAU, Bikaner, 12 November 2005.

Dr. B. D. Sharma, Jaivik kheti, KVK, RAU, Bikaner, 30-02-2006.

Dr. D.Singh delivered a lecture on Cultivation of Vegetables in farmers Training Programme organized by State Agriculture Department held at KVK, RAU,Bikaner on 27.1.2006. He also delivered a lecture on Fruit cultivation in arid regions in farmers training programme at CIAH, Bikaner sponsored by Horticulture Mission organized by KVK, Nagaur on 22.3.2006.

Dr.S.S.Hiwale Delivered lecture on Horticulture development in watershed projects. Lecture delivered at Central Soil and water conservation research and training institute, research Center Vasad on 15/06/05.

Dr. S.S.Hiwale Delivered a lecture on the topic production technology of aonla on 'Horticulture technology for tribal development' for 20 farmers and officials from Jhabua on 7thMarch, 2006 organized by K.V.K., Vejalpur, Pannchmahals, Gujarat.

Dr. S.S.Hiwale also delivered talk on Prospects of Dry land horticulture in watershed areas at WALMI Anand on 17.09.05.

Dr.S.S.Hiwale delivered a lecture on 'Improved techniques of Fruit crops cultivation and plant protection' to 51 farmwomen trainees at Farmers Training Centre, Govt. of Gujarat, Dahod, on 22.09.2005.

Dr. S.S.Hiwale Delivered a lecture on the prospect of processing in different fruit crops on 23/02/06 at GIDC, Godhra. He also delivered a lecture on the topic production technology of aonla on 'Horticulture technology for tribal development' for 20 farmers and officials from Jhabua on 7th March, 2006 organized by K.V.K., Vejalpur, Pannchmahals, Gujarat.

4

Education, Training and Awards

EDUCATION AND TRAINING

Shri A.Nagaraja has taught a postgraduate teaching course (HOR-637: Post Harvest Technology of horticultural crops (2+1)) for the M.Sc (Hort.) students of RAU, Bikaner during July to December 2005.

Dr. I.S.Singh attended a 21 days summer school training on *'Advances in Frontier Approaches to Increase Nutrient Use Efficiency in Crop Production'* from 22nd July – 11th August, organized at Indian Institute of Soil Science, Bhopal.

AWARDS AND RECOGNITIONS

Dr. P. Nallathambi received Best Paper Award

This award with a certificate was given by the Indian Society of Mycology and Plant Pathology, Rajasthan College of Agriculture, Udaipur for the research paper entitled "Post Harvest Rots and Aflatoxins in Pomegranate (*Punica granatum* L.) Fruits" authored by P. Nallathambi., C. Umamaheswari., A. Nagaraja, D. G. Dhandar. It was given during the Second Global conference on plant health-global wealth, organized by ISMPP, MPUAT, Udaipur on November 25–29, 2005.

Shri A.Nagaraja received Second Best Paper Award

This award with a certificate was given by the Indian Society of Mycology and Plant Pathology, Rajasthan College of Agriculture, Udaipur for the research paper entitled "Mycotoxins production in Aonla (*Emblica officinalis* Gaertn.) fruits authored by P. Nallathambi., A. Nagaraja, D. G. Dhandar and C. Umamaheswari. It was given during the Second Global conference on plant health-global wealth, organized by ISMPP, MPUAT, Udaipur on November 25–29, 2005.

5

Externally Funded Projects

AONLA BASED MULTISTOREY CROPPING SYSTEM (AP CESS FUND)

Establishment, growth and survival of main and component crops

Aonla based multistorey cropping system with component crops in a set of four different cropping model viz. Aonla-Ber-Brinjal-Mothbean-Fenugreek (M_1), Aonla-Bael-Karonda-Mothbean-Gram (M_2), Aonla-Khejri-Saji-Mothbean-Mustard (M_3) and Aonla-Drumstick-Senna-Mothbean-Cumin (M_4) is being investigated.

In cropping model 1, where aonla and ber are perennial crops, survival percentage was cent per cent in both the crops. In cropping model 2, the survival was 91.66 per cent in case of bael (*Aegle marmelos*), and aonla. The survival percentage of the perennial components viz., aonla and *Prosopis* in model 3 was recorded to be cent per cent. In cropping model 4 cent per cent survival was recorded in drumstick whereas it was comparatively lower in case of main crop aonla i.e. 91.66 per cent. Better survival of plants during the year under report was also recorded in control plots.

Although establishment and survival was better in all the perennial crops up to December 2005, due to frost-chilling injury during first week of January, aonla was severely affected. Some of the plants although recouped during February with the rise in temperature but did not survive due to secondary infection and more than 80 per cent mortality was recorded in aonla. The other perennial crops were also affected but recovered during the month of February-March with rise in temperature.

Growth studies

Observations on growth characters revealed that the plant height of main crop (aonla) was varied between 100.25 cm in control to 140.55 cm in model 4, while in model 1, 2, and 3 it was 124.00, 142.36 and 127.90 cm, respectively. Among the second tier crops, maximum plant height was recorded in drumstick, 250 cm grown in model 4 followed by ber, 115.23 cm in model 1, bael, 80.86 cm in model 2. Minimum plant height was recorded in khejri, 80.34 cm in model 3.

Stem girth of aonla in different cropping models ranged between 6.22 cm in control to 9.75 cm in model 2, 7.20 cm in model 3, 8.00 cm in model 4 and 8.66 cm in model 1. However, comparatively higher stem girth was recorded in drumstick (M_4) followed by ber (M_1). Stem girth of karonda (M_2) was recorded to be 7.52 cm while in Saji (M_3), it could not be recorded due to bushy nature of the crop. Plant spread (NS-EW) was recorded to be maximum in drumstick followed by ber, bael and *khejri*. Among the third tier crops, it was more in saji (*Suaeda fruticosa*) followed by karonda. Aonla showed more upright growth. Among different models maximum spread for aonla was recorded in models 2 and 3 followed by marginally lower spread in models 1 and 4.

Production of main and under-storey component crops

Aonla grown as an over-storey component yielded for the first time with an average yield of 08.0 kg/plant. Among the under-storey crops ber cv. Seb in model 1 recorded an average yield of 20.7 kg/plant, which was significantly higher than control. Bael grown as component crops in model 2 are still in their juvenile

phase, Karonda in the same model flowered for the first time and had set fruit but data was not recorded.

Prosopis cineraria grown in combination with aonla–*suaeda*–mustard (M_4) as an understorey component recorded an average yield of 0.5 kg/plant. Saji (*Suaeda fruticosa*) yield was 0.80q ha^{-1} in model 3 as compared to 0.50-q ha^{-1} in control. In model-4 the performance of drumstick pods (PKM-1) was best, it flowered and fruited twice in a year Feb-March and Sept- Oct. and gave an average yield of 10.0 kg/plant/ season (Fig. 23).

Fig. 23. Multi-storey component crops

Production of ground-storey seasonal crops

Moth bean (*Phaseolus acontifolius*) was grown as ground-storey crop during *kharif* season in all the four cropping models. Seed yield of moth bean varied from 3.50 qha^{-1} (control) to 4.65 qha^{-1} in Model 2. Brinjal, gram, cumin and mustard were grown as ground storey *rabi* crops in models 1, 2, 3 and 4 respectively. Senna (*Cassia angustifolia*) was also grown between aonla trees in model 4 and fenugreek in model 1. Among the ground-storey crops, the performance of mustard (M_4) was best followed by gram (M_2) and cumin (M_4) thus recording an average yield of 6.0 5.00 and 4.25 qha^{-1} respectively. Fenugreek grown as ground-storey crop however did not perform well during the year under report. Growth and development of over-storey component was not affected by the ground-storey components during the second year of experimentation.

Allelopathic influence of drumstick (*M. olerifera*) on ground-storey crops

The allelopathic influence of *Moringa oleifera* was studied on germination and early growth of gram (*C. aretinum*), mustard (*B. compestris*) and wheat (*T. aestivum*) in Petri dishes and plastic pots under laboratory condition. The seed germination of wheat was significantly inhibited (52.00%) over control, while minimum and no inhibitory effect of leaf extract on seed germination was recorded in gram (82.00%) and mustard (80.05). The response of drumstick leaf extract on different seedling component was more on root growth compared to shoot growth. More than 25% reduction in root growth was observed in wheat, followed by mustard and gram. The other vigour parameters like number of roots, number of leaves/plant, root: shoot ratio and vigour index also exhibited the same trend. It was found that water soluble allelochemicals of *Moringa oleifera* had maximum inhibitory effect on wheat and minimum on gram and mustard with respect to seedling germination, seedling vigour and seedling phytomass.

Diurnal changes in leaf temperature, light and stomatal conductance were measured on established trees under different cropping models. The observations were recorded using a portable porometer. The leaf temperature was lower than air temperature in all the perennial plants. Stomatal conductance mmol/m^2/s was recorded to be minimum in karonda (42–225) followed by bael (48–139). Maximum stomatal conductance was recorded in drumstick (188–666) and ber (490–539) during different periods of investigation.

Soil moisture content in different cropping models was also studied. The moisture content recorded by TDR meter indicated that the moisture retention was up to 30 cm soil depth.

6

AICRP on Arid Zone Fruits

The work on arid zone fruits was initiated under the ad-hoc Scheme entitled, " Research on some selected fruits of the arid and semi-arid areas in India" financed by the AP Cess Fund of ICAR in 1976 and it was merged during the Sixth Five Year Plan to All India Coordinated Fruit Improvement Project (AICFIP) in 1978. During the Seventh Five Year Plan, it was restructured to form an independent as AICRP on Arid Zone Fruits. There are 13 centres located in different parts of the country with financial outlay of Rs.140.00 lakhs. The broad mandates of this project are

- To develop suitable and sustainable technologies for growing fruit crops like *ber*, date palm, aonla, pomegranate, fig, custard apple, bael, tamarind etc.
- Evolving cost-effective disease and insect/pests management practices.

Germplasm collection and evaluation

The survey in different parts of the country resulted that Bawal Selection-1 which is tolerant against fruit fly and resistant to powdery mildew and has been registered as a promising line of *ber* by NBPGR, New Delhi on proposal of the Bawal centre. Aruppukotai centre identified one local country *ber* (*deshi* type) for high yield, while in *aonla* four trees were identified for high yield, big size fruits having good quality. Ten strains of *ber* having better fruit quality and showing resistance against fruit fly and powdery mildew were collected from Uttar Pradesh by Bawal centre. NA-25, NA-26 in aonla, ND/AH 8, 9, 10, 11, 12, 16, 17, 18 and 21 in *bael*, NJ 5 in *Jamun* grown in different tracts of Uttar Pradesh have been identified by Faizabad centre. In *Lasoda* (*Cordia* spp), 10 promising types were identified by Jobner centre having distinct characters like broad leaves, big size of fruits, pickling characters etc. In annona and fig, good collections have been made by Rahuri centre. In date palm thirty elite palms have been identified by Mundra centre in different villages of Kachch.

The Faizabad centre reportecd that the performance of NA-15 aonla was significantly superior with respect to yield at recording an high yield of 68.0 kg/tree during 2005. At S.K.Nagar, Selection-11 of aonla yielded 101.25 kg/tree. At Rahuri cultivar NA-10 is reported to be an early bearer but cv. Kanchan was best in respect to yield i.e 174.00 kg/tree. In case of ber, cv. Kaithali and Gola of ber recorded maximum yield of 10.59 and 9.20 kg/tree. The NDUAT, Faizabad recorded that *Ber* Selection 1, 2 and 4 were excellent in performance under sodic soil conditions. In Pomegranate cultivar Bhagawa and Phule Arakta have been recommended for its cultivation in Maharashtra by Rahuri centre. In case of tamarind at Anantapur, fruit length was high in ATPS-2 (17.0 cm) followed by ATPS-1 and Vellore-2 (16.0 cm each). In bael, NB-15 was promising at Faizabad centre. The yield was highest in APK (Ca) 1 with an average fruit weight of 160.00–182.67 g, pulp weight of 98.00–110.13 g and TSS of 28° Brix and hence is being recommended for cultivation by Aruppukottai centre. Out of 8 fig cultivars, cv. Poona fig resulted high yield of 34.17 K/ tree followed by Dinkar 29.68 kg/tree. In case of custard apple, Selection 9 was promising at S.K.Nagar. In date palm cultivars, Halawy, Barhee, Khuneizi, Zahidi and Kharawy were suitable for fresh consumption while Medjool is suitable for chhuhara (dry dates). Variety Barhee was best with respect to high yield and market price of fruits at Mundra.

Crop Improvement

Thirteen hybrids (F-1 of Gola × BS-1, Kaithali × BS-1 and their reciprocals) have been evaluated for their growth performance and resistance against fruit fly and powdery mildew at Bawal. At IIHR, Bangalore, the core collection of pomegranate varieties useful in breeding is being maintained in the field gene bank. Ganesh, Daru, Nana, Double flower and Kabul yellow are being extensively used for breeding pomegranate varieties for tolerance to moisture stress and bacterial blight. For bacterial blight, the 4 cross combinations (G×D)×R, (G×N)×R, {(G×N)× (D)}× R, (G×D) × (G×N) a total of 27 crossed fruits were harvested and 8285 hybrids were raised. Altogether, 4102 hybrid seeds of these crosses were sown. APK (Ca)1 of Custard apple has been released by Aruppukottai centre. At IIHR, Bangalore *A. squamosa* pollen gave the best fruit set, size and shape in both dry and wet years without significantly affecting the fruit quality at IIHR Bangalore. Code 1 hybrid of custard apple (IG × 2/1) at Rahuri showed high pulp percentage and lower seed content as compared to other crosses. Efforts to evolve new line through seed propagation in date palm at Mundra centre is in progress.

Integrated nutrient management

Nutritional requirement studies in arid fruits are in progress at different centers. Nutritional survey of *ber* orchards by Jobner center from different areas indicated that the average N, P and K were maximum in Bharatpur followed by Jaipur. At Faizabad, best results were obtained when 50% of the nutrients were applied through chemical fertilizers and rest through biofertilizers and FYM and it resulted significantly high yield (95.00 kg/tree) in case aof ber. In case of rain fed custard apple at Anantapur, it suggested that top 1–3 leaves can be used for determining N, P, K and micronutrient nutrients analysis. The treatments including 50% NPKS + Biofertilizer + FYM, while foliar application of micronutrients i.e. (0.5% $ZnSO_4$ + 0.1% thiourea) was better in have been found better aonla Cv. NA-7. In date palm cv. Halawy at Bikaner, NPK + biofertilizers + FYM and foliar application of micronutrient recorded increased growth and fruit yield.

Plant propagation, planting system and weed control

Maximum plant growth and yield were recorded in *ber* Cv. Kaithali on *Z. rotundifolia* while *Z. nummularia* rootstocks imparted dwarfing effect at Bawal. At Faizabad, scion cultivars of Umran and Gola showed vigorous growth on *Z. rotundifolia*, whereas fruit yield was maximum on *Z. mauritiana* var. Sukhawani. Under Jobner conditions shoot dry weight, leaf area and relative water content decreased significantly in *Z. rotundifolia* and *Z. nummularia*. Maximum height and canopy spread were recorded in *ber* at 8 × 8 m spacing in Aruppukottai. Weed management by the same centre revealed that application Atrazine + paraquat gave nearly 52% control in ber orchard. At Jobner, 6 hand weeding in a year exhibited maximum growth and yield with high TSS of aonla fruits.

Pests management

Screening at S.K. Nagar revelaed that cv. Seb and Sukhawani were free from fruit fly and borer infestation. At Jobner minimum damage was recorded in country aonla (*Deshi*) against stem capsule caterpillar, *Betousa stylophora*. *Ber* fruit borer was effectively managed by two foliar sprays with Endosulphan 35 EC (0.07%) at 20 days interval starting first spray when fruits are above marble size at Anantapur. Biological control of scale insect with *Chilocorus nigritus* was found to reduce the population. At Jobner centre *Chilocorus nigritus* was potential predator of *Parlatoria scale*. Out of twenty varieties of date palm screened for lesser date moth, maximum damage was recorded in Cv. Medjool (7.90%) while it was recorded to be minimum in Cv. Zahidi. at Bikaner and endosulphan (0.7%) was effective.

Diseases management

The survey and surveillance of diseases revealed that the bacterial fruit spot caused by *Xanthomonas auxonopodis* pv. *punica* was the major disease of pomegranate at Anantapur. At Aruppukotai, powdery mildew in tamarind was predominant and application of 0.1% carbendazin was effective in of this disease. Application of 3% neem oil 60 EC also effectively reduced powdery mildew. Soil application of *Trichoderma viride* (10 g/kg) reduced root rot incidence. Aonla rust was major diseases in eastern part of Uttar Pradesh (Faizabad) and Jobner.

Epidemiological studies at Anantapur revealed that per cent disease index (PDI) of powdery mildew on cv. Gola was significantly and negatively correlated with maximum and minimum temperature positively correlated with relative humidity. At Rahuri, it was maximum (62.12 PDI) in 49th meteorological week. The maximum temperature (31°C) and minimum temperature (18.8°C) with 87–91% RH were favourable powdery mildew development. Leaf and fruit spots are very common and serious diseases on pomegranate and at Rahuri it was high during 40th meteorological week, when maximum and minimum temperatures ranging between 33.0°C and 19°C with morning and evening relative humidity of 87 and 45 per cent respectively.

Varietal screening against Alternaria leaf spot of date palm at Bikaner revealed that cvs., Sriganganagar, Nagal hilai and Medjool free from this disease. Other cultivars Hatemi, Agolani and Amri were observed to be field resistant against fruit rot. *Aspergillus niger* was major fungus associated with spoilage of *ber* and aonla fruits (post harvest stage) at Aruppukottai. Leaf spot caused by *Cercospora sp.* and fruit rot caused by *Rhizopus sp.* were reported to be serious disease of custard apple at Aruppukottai. Sprays using Defenconazole (Score), Propiconazole (Tilt) and Carbendazim (Bavistin) @ 0.1% resulted more than 90% control of both the leaf and fruit spot of pomegranate under Rahuri conditions.

Biological management of ber powdery mildew using bioagents (CIAH, Bikaner)

AICRP (AZF) centres have evaluated two isolates of bioagents (CIAH-196 of *P.fluorescens* and CIAH-240 of *Trichoderma*) developed by CIAH for the management of ber powdery mildew under field conditions. These two isolates were compared with non resistant isolates of both bioagents. Culture of CIAH-196 in combination with 50% less concentration of karathane (0.05%) recorded 19.25 PDC at Aantapur. Performance of *Trichoderma* isolate CIAH-240 was reported to be better at Rahuri centre. ❑

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Publications

Research Papers

Saroj, P.L., Awasthi, O.P. and Tomar, D.S. (2004). Evaluation of peach based Agri-Horti system in degraded foothills of the Himalayan subtropics, *Tropical Agriculture*, 81 (3): 1–8.

Awasthi, O. P., Singh, J. and Saroj, P. L. (2005). Yield and economics of mango based multi species cropping system in Bastar plateau of Chattisgarh, *Indian Journal of Agroforestry,* 7 (2): 10–14.

Awasthi, O. P., Saroj, P. L. and Dhandar, D. G. (2005). Standardization of time on success of patch budding in tamarind (*Tamarindus indica*) under arid conditions. *Progressive Horticulture*, 37 (2): 294–297

Awasthi, O. P., Shukla, Anil, K. and Shukla, Arun. K. (2004). Tamarind Propagation- A Review, *Range Management and Agroforestry,* 25 (2): 113–119.

Awasthi, O. P., Singh, I. S. and Bhargava, R. (2005). Allelopathic influence of aonla (*Emblica officinalis*) on ground story crops. *Range Management and Agroforestry*, 26(1): 36–40.

Awasthi, O. P., Singh, I. S. and Sharma, B. D. (2006). Effect of mulch on soil hydrothermal regimes, growth and fruit yield of brinjal under arid conditions. *Indian Journal of Horticulture*, 63 (2):

Nallathambi, P., C. Umamaheswari and Singh R. S. (2005). Foot rot (*Phytophthora nicotianae*) in cactus pear (*Opuntia* spp.) genotypes under arid conditions. *Annals of Arid Zone*, 44(1):59–63.

Shukla, Arun Kumar, Samadia, D.K, Shukla, Anil Kumar and Dhandar, D.G. (2005). Genetic Resources of aonla-A review. *Indian J Plant Genetic Resources,* 18(2): 188–193.

Singh, I. S. and Agrawal, H. P. (2005). Characterization, genesis, and classification of rice soils of eastern region of Varanasi, Uttar Pradesh. *Agropedology,* 15(1): 29–38.

Singh, Sanjay and Singh, A. K. (2005). Studies on genetic diversity in Mahua (*Bassia latifolia*) under semi-arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences,*75 (8): 219–223.

Singh, Sanjay and Singh, A. K. (2005). Genetic variability in Jamun (*Syzygium cumini*) in Gujarat. *Progressive Horticulture*, 37: 44–48.

Singh, Sanjay and Singh, A. K. (2005). Studies on variability in tamarind (*Tamarindus indica* L) from Gujarat. *Progressive Horticulture,* 37: 280–284.

Singh, Sanjay, Singh, A. K and Joshi H. K. (2006). Prolong storability of Indian gooseberry (*Emblica officinalis*) under semi arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences,* 75 (10): 647–50.

Published in proceedings

Apparao, V. V., S. Raja. H. K. Joshi, D. T. Meshram, B. G. Bagle and Dhandar, D. G. (2006). Efficiency of biofertilizers integrated with different sources organic matter on growth and yield of brinjal (*Solanum melongena* L.) under semi arid conditions. *Proceeding on National seminar on Appropriate Technologies for Sustainable Horticulture* organized at Department of Horticulture, Annamalai University in Tamil Nadu, from March 20–21, 2006. p. 91.

Apparao,V. V., S. Raja. H. K. Joshi, D. T. Meshram, B. G. Bagle and D. G. Dhandar (2006). Effect of efferent sources of organic matter and biofertilizers on growth and yield of Bhendi (*Abelmoschus esculentus.L.*) under semi arid condition. *Proceeding on National seminar on Appropriate Technologies for Sustainable Horticulture* organized at Department of Horticulture, Annamalai University in Tamil Nadu, from March 20–21,2006. pp. 90–91.

Awasthi, O. P. and Gupta, C. R. (2005). Influence of guava canopy shade on yield and yield attributes of coffee. Paper presented in *First International Guava Symposium* held at Lucknow from 5–8 December, pp. 59–60.

Awasthi, O. P. Singh, I. S. and Meena, S. R (2006). Aonla based multi-species cropping system for sustainable productivity under arid eco-system of western Rajasthan. *Proceedings of National symposium on" Livelihood security and diversified farming system in arid region* "organized by Arid Zone Research Association of India

at CAZARI, Jodhpur, from 14–16 January 2006, pp. 18–19.

Awasthi, O. P., Singh, I. S. and Dhandar, D. G. (2005). Aonla based multitier cropping system for sustainable production in western Rajasthan. *Proceeding on National Seminar on Globalisation of aonla* organized by Aonla Growers Association of India held at Madurai, Tamilnadu from 7–9 October, p. 44.

Choudhary Meenakshi, Singh D., Shukla A. K (2005). Prospects of dehydration of fruits and vegetable as micro-enterprise in arid region of Rajasthan. In *Proceeding of National Seminar on entrepreneurship development for livelihood security-Experiences, Prospects and Strategies for rural India,* from 30 November to 1 December, p. 2.

Dhandar D. G. and Shukla A. K. (2005). Varietal improvement in aonla. *Proceeding on National Seminar on Globalisation of aonla* organized by Aonla Growers Association of India held at Madurai, Tamilnadu from 7–9 October, p. 4.

Dhandar, D. G., Nagaraja, A and Singh, Sanjay (2005). Possibilities and potential of value added products in arid fruits. *Proceeding on National Symposium on stress management in arid and semi arid ecosystems for productivity enhancement in agriculture* on sustainable basis organized by S.D.A.U, S.K Nagar, Gujarat on April 11–13, 2005, p. 16.

Dhandar, D. G., R. S. Singh and Bhargava, R. (2005). Fodder Resources for Livestock from Arid Horticultural crops. Abstract In. *National Seminar on Conservation, processing and utilization of Monsoon Herbage for Augmenting Animal production* held at CSWRI, Arid Region Campus, Bikaner on17–18 December 2005, p. 176.

Dhandar, D. G., Sharma, B. D. and Bhargava, R. (2006). Effect of micro-irrigation on water use efficiency, growth and yield of kinnow under arid condition of Western Rajasthan. *Proceeding on National Symposium on Citriculture*: *A Road map* held at ICAR Research Complex for NEH Region, Umiam Meghalaya during 22–23 Feb., 2006.

Joshi, H. K. (2005). Control of powdery mildew of chillies caused by *Leveillula taurica*_using foliar spray of phosphates and bicarbonates. *Proceeding on National Seminar on Stress Management* on 11–13 April,2005 at SK Nagar.Gujarat.

Meena, S. R., Awasthi, O. P., Shukla, Arun Kumar and Dhandar, D. G. (2006) Fruit crops based cropping system in Arid Eco-system of Bikaner district of Rajasthan: An Evaluation. *Proceeding on National Symposium on Livelihood Security and Diversified farming Systems for Arid Region*, held during 14–16 January at CAZRI, Jodhpur, p. 10.

Meena, S. R., Nagaraja, A., Singh, R. S. and Dhandar, D. G. (2005). Environmental risk of agro- chemicals in ber based cropping system in western Rajasthan: Farmer's *Proceedings of National Seminar on "Green to evergreen: challenges to extension education"* organized by ISEE at IARI, pusa New Delhi, December 15–17, 2005. p. 100.

Meena,S.R, Shukla A.K., Dhandar D.G. and Singh I.S. (2004). An appraisal of vegetable based farming system in hot arid ecosystem of western Rajasthan. *Proceeding on National Conference on Resource Conserving Technologies for Social Upliftment* 7–9 Dec.2004 at New Delhi.pp. 649–653.

Nagaraja, A., Nallathambi, P. and Dhander D. G. (2005). Microbial population in *kachari* (*Cucumis callous*) products prepared under different dehydration methods. *Proceedings on National Seminar on Food Quality and Safety Standards of Agricultural Raw and Processed Produce*, organized by Central Institute of Post Harvest Engineering and Technology, Ludhiana-141004, April, 26–27, 2005. p. 149.

Nagaraja, A., Nallathambi, P., Dhandar D. G. and Umamaheswari, C. (2005). Microbial population in aonla (*Emblica officinalis* Gaertn.) and its products. *Proceeding of second Global conference on plant health-global wealth*, organized by Indian Society of Mycology and Plant Pathology, MPUAT, Udaipur-313001.November 25–29, p. 148.

Nallathambi,P., Nagaraja, A Dhander, D. G. and Umamaheswari C. (2005). Mycotoxins production in aonla (*Emblica officinalis* Gaertn.) Fruits. *Proceeding of second Global conference on plant health-global wealth*, organized by Indian Society of Mycology and Plant Pathology, MPUAT, Udaipur-313001.November 25–29, p. 53.

Nallathambi, P., B. B. L.Thakore and Umamaheswari, C. (2005). Variation in production of toxin (s) and symptoms by ber fruit rot pathogen. *Proceeding of second Global conference on plant health-global wealth*, organized by Indian Society of Mycology and Plant Pathology, MPUAT, Udaipur-313001. November 25–29, p. 148.

Nallathambi,P., C. Umamaheswari., A. Nagaraja, Dhandar D. G. (2005). Post harvest rots and aflatoxins in pomegranate (*Punica granatum* L.) Fruits. *Proceeding of second Global conference on plant health-global wealth*, organized by Indian Society of Mycology and Plant Pathology, MPUAT, Udaipur-313001. November 25–29, p. 147.

Raja. S, B. G. Bagle and Dhandar D. G. (2006). Development of a new cost saving drumstick based cropping system for poor farming community under dry land conditions. *Proceeding in* 8th *Agricultural scientists and farmers congress* held at Banaras Hindu University from 21–22nd February, p. 124.

Samadia, D. K. (2006). Utilization of genetic resources of arid zone cucurbitaceous crops. *Proceeding on National Symposium on Livelihood Security and Diversified Farming Systems in Arid Region*. Arid Zone Research Association of India, CAZRI, Jodhpur from 14–16, January, pp. 2.5:31.

Samadia, D. K., Pareek, O. P. and Purohit, A. K. (2006). Techniques for annual harvesting of *sangri* and *long*—An approach to popularize *khejri* as a horticultural crop. *Proceeding on National Symposium on Livelihood Security and Diversified Farming Systems in Arid Region*. Arid Zone Research Association of India, CAZRI, Jodhpur., from 14–16, January. pp.5:30.

Sharma, B. D., Dhandar, D. G. and Bhargava, R. (2006). Moisture extraction pattern by kinnow (*Citrus reticulata* Blanco) in aridsols of western Rajasthan. *Proceeding on National Symposium on Citriculture*: *A Road map* held at ICAR Research Complex for NEH Region, Umiam Meghalaya during 22–23 February, 2006.

Shukla A. K,Dhandar, D. G. Singh D. and Meena S. R. (2005). Genetic variability of aonla in Eastern UP. *Proceeding on National Seminar on "Globalization of Aonla"* organized by Aonla Growers Association of India, Madurai from 7–9 October 2005 p. 23.

Shukla Anil Kumar, Shukla Arun Kumar, Singh D., Dhandar D. G. Vashishtha B. B. Bhargava, R and Rathi Y. S (2005). Performance of ber Germplasm under hot arid ecosystem *Proceeding on International Conference on Plasticulture and Precision Farming* at New Delhi 17–21, Nov.2005, p. 306.

Shukla Anil Kumar, Singh D and Shukla Arun Kumar. (2005). Ber based entrepreneurship opportunity in Rajasthan, *Proceeding of National Seminar on entrepreneurship development for livelihood security-Experiences, Prospects and Strategies for rural India., from* December- 1 December, p. 6.

Shukla Arun K. and Dhandar D. G. (2005). Prospect of Guava cultivation under hot arid ecosystem. *Proceeding International Guava Symposium* at CISH, Lucknow. p. 5

Shukla Arun Kumar (2005). Effect of plant density and Nitrogen on papaya. In *International Symposium on papaya* at MARDI, Malaysia p. 76

Shukla Arun Kumar, Dhandar D. G. Shukla Anil Kumar, Saroj, P. L and Meena, S. R. (2004). Germplasm resource conservation of aonla (*Emblica officinalis*). In *Proceeding on National Conference on Resource Conserving Technologies for Social Upliftment* at New Delhi. pp.151–153.

Shukla Arun Kumar, Dhandar D. G., Shukla Anil Kumar, Saroj P. L. and Meena S. R. (2005). Germplasm Resource Conservation of Aonla (*Emblica officinalis Gaertn.*) *Proceeding on National Conference on Resource Conservation Technologies for Social Upliftment*, pp. 151–153.

Shukla, A. K., Awasthi, O. P., Singh, D and Singh, R. S. (2005). *In-situ* orchard establishment of aonla in arid regions for precision cultivation. *Proceeding International conference on Plasticulture and Precission farming*, organized by National Committee on Plasticulture Applications in Horticulture (NCPAH), New Delhi, from 17–21 November, p.128.

Singh D, Shukla A. K. and Rathi Y. S (2005). Polyhouses for diversification, intensification and improvement in farming system of north India-Perspective based on field experience. *Proceeding International conference on Plasticulture and Precission farming*, organized by National Committee on Plasticulture Applications in Horticulture (NCPAH), New Delhi, from 17–21 November, p. 47

Singh, D, Singh. R, Shukla. A. K, and Rathi Y. S (2005). On- farm processing enterprise for livelihood support and sustainable income- A viable case study, *Proceeding of National Seminar on entrepreneurship development for livelihood security-Experiences, Prospects and Strategies for rural India*, held at IVRI, Bareilly, from 30 November – 1, December. p. 8.

Singh Sanjay, Singh, A. K Apparao, V. V. D. T. Meshram and Bagle B. G. (2006). Heat unit summation-an index for predicting fruit maturity in aonla (*Emblica officinalis* Gaertn) under semi-arid tropics of western India. *Proceeding on* 8th *Indian Agricultural Scientist and*

Farmer Congress held at BHU, Varanasi from March, 21–22, p. 123.

Singh Sanjay, Singh, A. K Apparao, V. V. Meshram D. T. and. Bagle B. G. (2006). Developmental pattern and maturity indices in mahua (*Bassia latifolia*) genotypes under semi-arid ecosystem of Gujarat. *Proceeding on 8*th *Indian Agricultural Scientist and Farmer Congress* held at BHU,Varanasi March, 21–22, p. 123.

Singh Sanjay, Singh, A. K, and Joshi, H. K. (2005). Effect of pre harvest spray on storability of Indian Goose Berry (*Emblica officinalis* Gaertn) under semi-arid ecosystem of Gujarat. *Proceeding on 12*th *Vasant Rao Naik Memorial National Agricultural Seminar on Value Addition to Agri - Horti- Medicinal Produce and its Marketing* held at College of Agriculture. Nagpur, October17–19 p. 37.

Singh, A. K, Singh Sanjay, Apparao, V. V. and Meshram, D. T. (2006). Effect of mulching on growth and chemical composition of aonla shoots cv.NA-7 under semi-arid ecosystem. *Proceeding on National Symposium on Livelihood Security and Diversified Farming System in Arid Region* held at CAZRI, Jodhpur, from14–16 January, p. 47.

Singh, A. K, Singh Sanjay, Apparao, V. V. Meshram D. T. and Bagle B. G. (2006) Effect of organic mulches on soil temperature and moisture and growth of aonla Cv. NA-7 under rainfed conditions. *Proceeding on 8*th *Indian Agricultural Scientist and Farmer Congress* held at BHU, Varanasi, on 21–22, p. 123.

Singh, D. Mohammed. S and Shukla A. K. (2005). Micropropagation of guava as influenced by season, source and pretreatment to explant *Proceeding of International symposium on guava* at CISH, Lucknow.

Singh, D., Dhandar, D. G., Shukla, A. K., Bhargava, R. and Awasthi, O.P. (2005). Low-cost Energy Efficient Hardening Facility for Tissue- cultured Plants under Hot Arid Agro-ecosystem. *Proceeding on International conference on Plasticulture and Precision farming, organized by* National Committee on Plasticulture Applications in Horticulture (NCPAH), New Delhi during, from 17–21, November, p. 89.

Singh, I. S. and Agrawal, H. P. (2005). Characteristics and Nutritional Status of rice Soils of Varanasi Region. In. *National Seminar on Land Resource Appraisal and Management for Food Security,* at NBSS and LUP, Nagpur from 5–6, April, p. 100.

Singh, I. S., Awasthi, O. P., Dhandar, D. G. and Meena, S. S. (2005). Plastic and organic mulching in brunjal. *Proceeding on International conference on Plasticulture and Precission farming*, organized by National Committee on Plasticulture Applications in Horticulture (NCPAH), New Delhi, from 17–21 November, p. 501.

Singh, R. S., R..Bhargava, B. D..Sharma and Dhandar D.G., (2006). Performance of inter crops with ber (*Ziziphus mauritiana*) under hot arid eco-system. *Proceeding on National symposium on Livelihood security and diversified farming systems for arid region* held at CAZRI, Jodhpur on 14–16 January, p.18.

Singh, R.S., Dhandar, D. G and Awasthi, O.P. (2005). Horti-pastoral system in development of arid lands. *Proceeding on National Seminar on Conservation, processing and Utilization of monsoon herbage for augumenting animal production*, organized by Central Sheep and Wool research Institute, Bikaner, from 17–18, December p. 198.

Singh, R. S., R. Bhargava, D. G.Dhandar and Nagaraja, A. (2005). Problem and Prospects of Under utilized fruits cultivation in arid eco-system. *Proceeding on National workshop on Under utilized fruits species for Nutrition Security and Enhanced Rural Livelihood* held at BAIF, Warje, Pune from September, pp. 14–17.

Books and Chapters

Dhandar, D. G and R. S. Singh, (2005). Grasses /fodder under Horticulture plantations in semi arid and arid region.. Book chapter In. Feeds for Livestock in Dry regions (Ed. Pathak,P.S. and Kundu, S. S.), I. B. D. Co, Lucknow, pp. 57–68.

Saroj, P. L. and Awasthi, O. P. (2005). Propagation of Amla and nursery management. *In Amla in India* (Mehta, S.S. and Singh, H.P. eds.) Aonla Growers Association of India, Salem, Tamil Nadu, pp. 50–57.

Popular articles

मीना, षिवराम (2005). "दैनिक जीवन और बागवानी"। *मरू बागवानी*। प्रथम अंक : 49–52.

शुक्ला, अरूण कुमार; शुक्ला अनिल कुमार एवं मीना, षिवराम (2005). षुष्क क्षेत्र में आवंला उत्पादन की सम्भावनायें। *मरू बागवानी*। प्रथम अंक : 34–37.

शुक्ला अरूण कुमार, षुक्ला अनिल कुमार एवम् मीना षिवराम (2005). शुष्क क्षेत्र में आंवला उत्पादन की संभावनायें। *मरू बागवानी,* 1: 34–37.

सिंह इन्दू शेखर, अवस्थी ओम प्रकाष, सुनील पारीक, शुक्ला अरूण कुमार एवम् ए. नागराजा, (2005). जल प्रबंधन। *मरू बागवानी,*

1: 53–54.

शुक्ला अनिल कुमार, शुक्ला अरूण कुमार, डी. जी. धन्दर एवम् सिंह इन्दू शेखर, (2005) राजस्थान के शुष्क क्षेत्र में बेर की खेती। *मरू बागवानी,* 1: 27–30.

शुक्ला अरूण कुमार, सरोज, पी.एल. शुक्ला अनिल कुमार एवं अवस्थी ओ.पी., (2005). आंवला में पाले की समस्या। *कृषि चयनिका* June-August 26: 21.

शुक्ला अरूण कुमार, सरोज, पी. एल. शुक्ला अनिल कुमार एवं अवस्थी ओ.पी., (2005). आंवले को पाले से बचाएं। *फल–फूल* 27(3–4) 21–22.

Shukla, Anil Kumar Dhandar, D.G Shukla, Arun Kumar and Awasthi O.P. (2006) conserving *ex -situ* genetic variability in ber. *Indian Horticulture*, 51 (1): 33–35

अवस्थी, ओ. पी., शुक्ला, अनिल कुमार, पारीक, सुनील., (2005). फलदार वृक्ष लगाने की विधियां, *मरु बागवानी* प्रथम अंक: 31–33.

सिंह, आई. एस., अवस्थी, ओ. पी., पारीक, सुनील, शुक्ल, अरूण कुमार एवं नागराजा ए., (2005). जल प्रबन्धन, *मरु बागवानी* प्रथम अंक: 53–54.

शुक्ला, अरूण कुमार, सरोज, पी.एल., शुक्ला, अनिल कुमार एवं अवस्थी., ओ. पी., (2005). आंवला को पाले से बचाए, *फल–फूल.* 27 (3–4): 21–22.

शुक्ला, अरूण कुमार, सरोज, पी. एल., शुक्ला, अनिल कुमार एवं अवस्थी, ओ. पी., (2004). आंवले में पाले की समस्या, *कृषि चयनिका.* 26 (3): 20–46.

Shukla, Anil. Kumar., Dhandar, D.G., Shukla, Arun. Kumar and Awasthi, O.P. (2006). Conserving *ex-situ* genetic variability in ber, *Indian Horticulture*, 51(1): 33&35.

Lenin,V. and V.V.AppaRao. (2003). Biodiversity—need of today. *Agricultural Extension Review.* 15(4): 14–15.

Singh, R.S. and P. P. Pareek (2005). Shushk kshetra Vikas mein—Bagwani ka yogdan (Hindi), KARABH Patrika, NRCC, Bikaner pp. 58–62.

Samadia, D. K. and D. G. Dhandar (2005). Sword bean: A potential genotype for crop diversification in hot arid regions. ICAR NEWS 11(4): 12–13.

Samadia, D. K. Pareek, O. P. and Vashishtha, B. B. (2005). AHS 10 and AHS 82: New snapmelons. *Indian Horticulture* 50(2): 10–11.

Samadia, D.K. (2006). Technology for cucurbitaceous crop cultivation in arid regions. *Intensive Agriculture,* 44(1–2): 3–7.

Popular articles in Hindi

सिंह आई. एस., अवस्थी ओ. पी., पारीक सुनील, शुक्ला अरूण कुमार एवं नागराजा ए., (2005). जल प्रबंधन। *मरू बागवानी,* खण्ड–1, पेज– 53–54.

अवस्थी ओ. पी.; सिंह आई. एस., षुक्ला अनिल कुमार तथा नागराजा ए., (2005). शुष्क क्षेत्रों में बागवानी फसलों में पलवार की उपयोगिता। *फल–फूल,* (स्वीकृत).

अवस्थी ओ. पी., सिंह आई. एस., शुक्ला अरूण कुमार, (2005). लवणीय भूमि के लिए वरदान है – साजी (*सुवेडा फ्रूटीकोसा*)। *फल–फूल,* (स्वीकृत).

मेसराम डी. टी. एवम् सिंह आई. एस., (2005). जल संपदा और संरक्षण। *मरू बागवानी,* खण्ड–1, पेज– 41–43.

शुक्ला अनिल कुमार, शुक्ला अरूण कुमार, धन्दर डी. जी. एवं सिंह इन्दुष्शेखर, (2005). राजस्थान के शुष्क क्षेत्र में बेर की खेती। *मरू बागवानी,* खण्ड–1, पेज– 27–30.

सिंह आई. एस., अवस्थी ओ. पी., पारीक सुनील, शुक्ला अरूण कुमार एवं नागराजा ए., (2005). जल प्रबंधन। *मरू बागवानी,* खण्ड–1, पेज– 53–54.

अवस्थी ओ. पी., सिंह आई. एस., शुक्ला अनिल कुमार तथा नागराजा, ए., (2005). शुष्क क्षेत्रों में बागवानी फसलों में पलवार की उपयोगिता। *फल–फूल,* (स्वीकृत).

अवस्थी ओ. पी., सिंह आई. एस, शुक्ला अरूण कुमार, (2005). लवणीय भूमि के लिए वरदान है – साजी (*सुवेडा फ्रूटीकोसा*)। *फल–फूल,* (स्वीकृत).

मेसराम डी. टी. एवम् सिंह आई. एस., (2005). जल संपदा और संरक्षण। *मरू बागवानी,* खण्ड–1, पेज– 41–43.

शुक्ला अनिल कुमार, शुक्ला अरूण कुमार, धन्दर डी.जी. एवं सिंह इन्दु शेखर, (2005). राजस्थान के शुष्क क्षेत्र में बेर की खेती। *मरू बागवानी,* खण्ड–1, पेज– 27–30.

Chapters published in compendium

Samadia, D. K. (2006). Strategies for conservation of fruit bio-diversity in arid eco-system. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November. pp. 104–110.

Arun Kumar Shukla Dhurendra Singh, Anil Kumar Shukla and Meena S. R. (2005) *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 203–207.

Awasthi, O. P. (2005). Production technologies of tamarind and drumstick under semi-arid conditions. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner

from 9–29 November, pp. 282–285.

Awasthi, O. P. and Meena, S. R. (2005). Management of aonla based cropping system in Horti-Agri system of arid region for sustainability. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 277–281.

Bhargava, R. (2005). Drought Tolerance Mechanisms in Plants. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November.

Bhargava, R. and Meena, S. S. (2005). Role of plant growth substances in improving seed germination and yield of seed spices. In *Compendium of Winter School on Seed Spices*, held at NRCSS, Ajmer.

Meena, S. R., Singh, I. S., Shukla, Arun Kr. and Nagaraja, A. (2005). Sustainable arid horticulture: Dimensions and components. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 68–73.

Nagaraja, A. and Meena, S. R. (2005). Emerging trends in processing technology with special reference to arid crops *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 273–274.

Nagaraja, A., Singh, I. S. and Meena, S. R. (2005). Role of hurdle technology in food preservation. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 368–372.

Sharma, B. D., Singh, I. S. and Awasthi, O. P. (2005). Use of mulches and antitranspirants for enhancing productivity and quality of arid fruits. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 208–217.

Sharma, B. D., Singh, I. S. and Awasthi, O. P. (2005). Use of mulches and antitranspirants for enhancing productivity and quality of arid fruits. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 208–217.

Shukla Anil Kumar Singh, D and Shukla, Arun Kumar. (2005). Germplasm management and sustainable production of ber *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 194–202.

Shukla Anil Kumar; Singh, D., Shukla Arun Kumar and Meena, S. R. (2005). Plant genetic resource management and sustainable production of ber. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 194–202.

Shukla Arun Kumar D Singh and Anil Kumar Shukla. (2005). Sustainable Production Technology of Aonla under Fragile Arid ecosystem. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 203–207.

Shukla Arun Kumar; Singh, D., Shukla Anil Kumar and Meena, S. R. (2005). Sustainable production technology of Anola under fragile arid ecosystem *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions*, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 203–207.

Singh D, Shukla Arun Kumar and Shukla Anil Kumar. (2005). Opportunity of micropropagation in fruits for arid regions. *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile*

Agro-Ecosystem of Arid Regions, Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 111–119.

Singh, I. S., Awasthi, O. P., Shukla, Arun Kumar and Meena S. R. (2005). *In-situ water harvesting for sustainable production in arid Eco-system. Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions,* Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November, pp. 251–260.

Singh, R. S. and Yadav P. K. (2005). Prospects of exotic fruits under fragile Arid eco-system In. Compendium of Winter School on Strategies for Sustainable fruit production in fragile arid eco-system, RAU, Bikaner. pp. 91–97.

Yadav, P. K., R. S. Singh and Raj Kumar. (2005). Exploitation of under utilized friuits specially Lasoda and Ker in arid regions *Compendium of Winter School on "Strategies for sustainable fruit Production in fragile Agro-Ecosystem of Arid Regions,* Organised by Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner from 9–29 November.

Lecture delivered through different media

Dr.D.Singh deliver a lecture on Micropropagation and basic requirement in Refresher course for Lecturer of Biology,organized by Teacher Training College, Bikaner during 05.8.05. He also deliver a lecture on Principles of Plant Tissue Culture in Refresher course for Lecturer of Agriculture, organized by Teacher Training College, Bikaner on 5 August 2005.

Dr. S.S. Hiwale delivedred a lecture on Horticulture development in watershed projects. Lecture delivered at Central Soil and water conservation research and training institute, research Center Vasad on 15/06/05. He also delivered the following lectures.

- Prospects of Dry land horticulture in watershed areas. Lecture delivered at WALMI Anand on 17/09/05.
- Nursery management in Pomegranate. Paper presented in seminar on pomegranate organized by Pomegranate growers association at Solapur Maharashtra on 25/09/05.
- Improved techniques of Fruit crops cultivation and plant protection' to 51 farmwomen trainees at farmers training centre, Govt. of Gujarat, Dahod, on 22.09.2005.
- The prospect of processing in different fruit crops on 23/02/06 at IDC, Godhra.

8

Research Programmes and Projects

Code	Title	Investigators	
	CIAH, Bikaner		
B1.	Introduction, collection, characterization, conservation and evaluation of Arid fruit crops under hot arid environment.	Investigators	Dr. D. G. Dhandar Dr. R. S. Singh Dr. O. P. Awasthi Dr. Arun K. Shukla
B.1.1	Introduction, collection, characterization, conservation and evaluation of *Ziziphus* spp. under hot arid environment.	Co-PI	Dr. Anil K. Shukla Dr. O. P. Awasthi Dr. D. Singh Dr. P. Nallathambi
B.1.2	Introduction, collection, characterization, conservation and evaluation of pomegranate under hot arid environment.	P.I. Co.PI	Dr. R. S. Singh Dr. S. S. Hiwale Dr. C. Umamaheswari Shri. A. Nagaraja
B.1.3	Introduction, collection, conservation and evaluation of date palm (*Phoenix* sp.) under hot arid region	PI Co.PI	Dr. R.S.Singh Dr. R.Bhargava
B.1.4:	Introduction, collection, characterization, conservation and evaluation of aonla under hot arid environment.	PI Co PI	Dr. Arun Kr. Shukla Dr. P.Nallathambi
B.1.5	Introduction, evaluation and improvement of indigenous and exotic fruits of arid region.	Investigators	Dr. R. S. Singh Dr. O. P. Awasthi Dr. D. K. Samadia Shri. A. Nagaraja
1.6	Introduction, collection, characterization, conservation and evaluation of bael (*Aegle marmelos* Correa.) under arid conditions.	PI Co.PI	Dr. R. S. Singh ShriA. Nagaraja
B.2.1	Introduction, collection, characterization, conservation and evaluation of cucurbit vegetable crops under hot arid environment.	PI Co.PI	Dr. D.K. Samadia Dr. P. Nallathambi
B3	Improvement of arid fruits by selection and hybridization under arid environment	Investigators	Dr. D. G. Dhandar Dr. R.S. Singh Dr. Anil K. shukla Dr. C.Umamaheswari

Code	Title		Investigators
B 3.1	Improvement in ber	PI Co.PI	Dr. Anil K. Shukla Dr.C. Umamaheswari,
B 3.2	Improvement in pomegranate by selection and hybridization	PI Co.PI	Dr. D. K. Samadia Dr. C.Umamaheswari
B 4	Improvement in vegetable crops under hot arid environment	PI Co.PI	Dr. D. K. Samadia Dr. P. Nallathambi
B 4.1	Improvement in cucurbitaceous vegetables under hot arid environment	PI Co.PI	Dr. D.K.Samadia Dr. P.Nallathambi
B5	Evaluation of aonla based diversified cropping models in arid eco-system	PI Co.PI	Dr. O.P. Awasthi Dr. D.G Dhandar Dr. R. Bhargava Dr. Arun K. Shukla Dr. I.S. Singh
B6	Standardization of plant propagation and root stocks in arid fruits	PI Co.PI	Dr. P. L. Saroj Dr. B. D. Sharma Dr. O.P.Awasthi
B7	Standardization and commercialization of micro-propagated techniques of horticultural crops under arid agro-eco-system	PI Co.I	Dr. Dhurendra Singh Dr. A. K. Shukla Dr. R.Bhargava Dr. O.P.Awasthi
B8	Studies on growth and development in some cucurbitaceous crops under water stress	PI	Dr. R. Bhargava
B9	Studies on physiological adaptations to water stress in arid fruit species	PI	Dr. R. Bhargava
B10	Response of substitution of manures and fertilizers with vermicompost in the growth and production of some fruit crops	PI Co.PI	Dr. B. D. Sharma Dr. R. Bhargava
B11	Integrated approaches involving organic and biodynamic farming for quality production of some fruit and vegetable crops under arid ecosystem	PI Co.PI	Dr. B. D. Sharma Dr. D. G. Dhandar Dr. R.Bhargava Dr. P. Nallathambi Dr. D. K. Samadia Dr. I. S. Singh
B12	Identification of *in-situ* water conservation measures for increasing the production potential of vegetable crops (Brinjal and Kachari) grown under arid conditions.	PI Co.PI	Dr. I. S. Singh Dr. O. P. Awasthi Dr. B. D. Sharma
B13	Studies on biological control of major diseases of arid zone fruits and vegetables	PI Co.PI	Dr. C. Umamaheswari Dr. P. Nallathambi Dr. H. K. Joshi

Code	Title		Investigators
B14	Exploitation of PGPR for diseases suppression, growth promotion and field establishment of planting material of arid fruit and vegetable crops	PI Co.PI	Dr. P. Nallathambi Dr. D.G.Dhandar Dr. C. Umamaheswari Dr. D. Singh Shri. A. Nagaraja Dr. I. S. Singh
B15	Post harvest handling and processing studies in arid zone horticultural crops.	PI	Shri. A. Nagaraja
B15.1	Studies on processing techniques in khejri (*Prosopis cineraria*).	PI Co.PI	Shri.A. Nagaraja Dr. P. L. Saroj
B15.2	Dehydration of *Kachri* (*Cucumis calosus*)	PI	Shri.A. Nagaraja
B16	An assessment of arid horticultural status in Bikaner district of Rajasthan	PI Co.PI	Dr. S. R. Meena Dr. R. S. Singh Dr. Arun K. Shukla Dr. I. S. Singh
B17	Study on horticultural development in IGNP area of Bikaner District	PI Co.PI	Dr. S. R. Meena Dr. D. G. Dhandar Dr. O. P. Awasthi

CHES, Godhra

G1	Collection, introduction and evaluation of germplasm of wood apple and other fruits	PI	Dr. S. S. Hiwale
G2	Collection, introduction and evaluation of under exploited fruits (jamun, tamarind, bael, mahua and chiraunji)	PI Co.PI	Sanjay Singh Dr. A.K.Singh
G3	Standardization of production technology of Aonla (*Emblica officinalis* Gaertn)	PI Co.PI	Dr. A.K.Singh Dr. Sanjay Singh Dr. D.T.Meshram
G4	Standardization of Agro-techniques on some semi arid fruits-ber, pomegranate and phalsa	PI Co.PI	Dr. S. S. Hiwale Dr. Sanjay Singh Dr. A. K. Singh
G5	Breeding for yield, quality, biotic and drought resistance in cucurbitaceous crops	PI Co. PI	Shri S. Raja Dr. B. G. Bagle Dr. H. K. Joshi
G6	Crop regulation in moringa and Inter cropping system under semi-arid condition	PI Co.PI	Shri S. Raja Dr B. G. Bagle Dr. V. V. Apparao
G7	Nutrient management in fruit crops-aonla and sapota	PI	Dr. V.V. Apparao

Code	Title		Investigators
G8	Soil and water conservation management in water shed management.	PI Co.PI	Shri D.T.Meshram Dr. V.V. Apparao
G9	Storage studies in aonla and ber	PI Co.PI	Dr. Sanjay Singh Dr. A.K.Singh Shri H.K.Joshi
G10	Standardization of organic farming in some semi arid fruits	PI Co.PI	Dr. S.S. Hiwale Dr. V. V. Apparao
G10.1	Organic farming in vegetable crops in semi arid system	PI Co.PI	Dr. V. V. Apparao Shri H. K. Joshi Shri. S. Raja
G11	Integrated pest management in cucurbits (bitter gourd and pumpkin)	PI Co.PI	Dr B. G. Bagle Shri H. K. Joshi Shri S.Raja
G12	Integrated orchard management (ber, pomegranate and aonla	PI Co.PI	Dr B. G. Bagle Shri H. K. Joshi
G13	Integrated disease management in semi-arid horticultural crops	PI Co.PI	Shri H. K. Joshi Dr B. G. Bagle
G14	Biological control of diseases of semi-arid fruits and vegetables.	PI Co.PI	Shri H. K. Joshi Dr B. G. Bagle
G15	Strategies for adoption of integrated horticultural technologies	PI	Shri V. Lenin
	Externally funded projects		
EF1	Adhoc scheme: Aonla based cropping system under arid ecosystem	PI	Dr. O. P. Awasthi

9

RAC, IMC and SRC Decisions

STAFF RESEARCH COUNCIL (SRC)

Chairman

Dr. D.G. Dhandar
Director

Members

All scientists of the institute

Member Secretary

Dr. P. Nallathambi
Senior scientist (Plant Pathology)

IMPORTANT RECOMMENDATIONS

The SRC meeting was held on 24th to 26th October, 2005 in the committee room of the CIAH, Bikaner under the chairmanship of Dr D.G. Dhandar, Director, CIAH, Bikaner. All scientific staff members have attended the meeting and following are the important decisions taken during the meetings.

- The SRC recommended to prepare the work plan in accordance with those recommendation of RAC so that there will not be any pending issues.
- Importance of SRC was emphasized for implementing various programmes and technical recommendations of other advisory committees i.e., QRT and RAC of the institute.
- It was decided to conduct research as per the approved technical programmes, so that the overall objectives on dissemination of technologies for arid horticulture development could be achieved.
- Submission of RPFs as the case may be in stipulated time is very essential by individual Principal investigator, so that the pending issues on this matter from Central Audit can be settled otherwise, concern scientist would bear the responsibilities in delay or non submission of their RPFs. Research project works and its documentation in their RPFs, which is essentially required to the office and personal records of concern scientists.
- Financial provisions for the purchase of essential items and its rational utilization for the research activities.
- The principal investigators of different schemes can have sanction power of Rs 5000 and they can also use their powers for activities of the scheme within the guidelines of ICAR and other funding agencies.
- Different opinion of the scientist on conducting different experiments in germpalsm block and it was decided that only maintenance and evaluation work would be carried out in germplasm. Scientists will maintain separate block for other experiments.
- In order to regularize the SRC meeting in the Months of June-July every year, Director advised member secretary to arrange the RAC meeting in time. AICRP on AZF may also be conducted in the Month of February, 2006.
- Scientists have brought the issue on authorship in research papers publication quoting examples in some cases, that the associates of the concern project have not been given authorship while other scientists have been included in the

publication. The chairman reviewed and decided that the co-workers should be given credit for their contribution in the project work but it is not mandatory to include all associates in all publications in that particular project.

- As a significant decision, the work done on development of new varieties by the institute and advised concern scientists to submit proposal for the release 2 each of Ber and Vegetable varieties at institute level. They were also informed to prepare all the documents and plant materials as per the requirement for variety release committee, so that it can be done smoothly.

RESEARCH ADVIOSRY COMMITTEE (RAC)

Chairman

Dr.S.P.Gosh, Ex-DDG (Hort.)

Members

Dr. O,P.Pareek, Ex-Director, CIAH, Bikaner
Dr.Y.R.Sarma, Ex-Director, IISR, Calicut
Dr. G.C.Srivastava, HD,Plant Physiol.
IARI, New Delhi
Dr. Samarjit Rai, Emeritus scientist,IIVR, Varanasi
Dr.S.N.Pandey, ADG (Hort.), ICAR, New Delhi
Dr.D.G.Dhandar, Director, CIAH, Bikaner.

Member Secretary

Dr.R.Bhargava
Senior scientist (Plant Physiology)

GENERAL RECOMMENDATIONS

1. The number of technical staffs has not increased and none of the laboratory is having technical staff. RAC felt that provision of skilled manpower in each laboratory is very urgently required so that the experiments could be conducted. It was therefore recommended that till such time, the posts sanctioned in IXth Plant are created. Skilled manpower may be engaged on contractual basis to undertake the laboratory works.
2. Emphasis should be given on Training of trainers from official from State Departments for skill upgradation and faster spread of technologies developed by the Institute. Besides farmers training and field days may be organized on limited scale periodically.
3. RAC recommended that CIAH will concentrate research on crops such as Ber, Pomegranate, Date palm, Aonla, Sweet orange, local cucurbit, chillies and some leguminous crops whereas CHES, Godhra will take up new work on Jamun, Tamarind, chiraunji, wood apple, custard apple. Works on crops under network projects will continue as per approved technical programme.
4. Studies on rain fed farming of fruit and vegetable crops should be concentrated at CHES, Godhra while use of minimal irrigation water for optimum productivity of different horticultural crops should be concentrated at Bikaner.
5. The work on rain water harvesting and recycling should be taken up at CHES, Godhra.
6. Technical bulletin on propagation of Ber, Aonla, Prosopis and Ker may be brought out by December 2005.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

Chairman

Dr. D.G. Dhandar
Director, CIAH, Bikaner

Members

Dr. S.N. Pandey
Asstt. Director General (Hort.)
ICAR, KB, New Delhi.

Dr. Abraham Varghese, Principal Scientist,
IIHR, Bangalore
Dr. A.K. Mishra, Principal Scientist
CISH, Lucknow
Dr. B.D. Sharma, Senior Scientist
CIAH, Bikaner
Sh. H.K. Joshi, Scientist SG
CHES, Vejalpur
Sh. M.K. Pachauri, Admn. Officer
CIAH, Bikaner

Invitee Member

Dr. R. Bhargava, Senior Scientist, CIAH, Bikaner
Sh. V.K. Pandey, Assistant Administrative Officer
CIAH, Bikaner
Sh. S.C. Sharma Asstt. Finance & Accounts Officer
CIAH, Bikaner

IMPORTANT RECOMMENDATIONS

1. The Committee expressed satisfaction over the progress on various points of previous meetings
2. Considering the fact that EFC was prepared more than four years back and due to escalation of cost, Committee recommends to ratify the decision for purchase of some of the equipments
3. Repair/Maintenance is a long pending demand of CHES, Godhra and hence ratify the post facto approval for execution.
4. Committee recommended extension for a period of six months for two doctors as AMA of the Station.
5. The Committee emphasized that all out efforts should be made to fully utilize the allocation including CHES Godhra. ❑

10

Conferences, Meetings, Seminars etc.

Dr. Sanjay Singh

- National Symposium on stress management in arid and semi arid ecosystems for productivity enhancement in agriculture on sustainable basis organized by S. D. A. U, S. K. Nagar, Gujarat on April 11–13, 2005,PP 16.
- Naik Memorial National agricultural seminar on value addition to Agro–horti–medicinal produce and its marketing, organized by Dr.P.D.K.V.Akola, V.N.S.P. Pusad and NMPB, New Delhi on October, 17–19, 2005 pp 37.
- Eighth Indian Agricultural Scientists and farmers congress, organized by B.H.U., Varanasi and Bioved Research and communication Centre Allahabad, 21–22, February,2006 pp123.

Dr. S.R. Meena

- National seminar on "Green to evergreen: challenges to extension education" organized by ISEE at IARI, pusa New Delhi during December 15–17, 2005.
- National symposium on" Livelihood security and diversified farming system in arid region" organized by arid zone research associated of India at CAZARI, Jodhpur druing 14–16 January 2006.

Dr. D. Singh

- International Conference on Plasticulture and Precision Farming at New Delhi 17–21 Nov. 2005.
- Meeting at Directorate Of Horticulture, Govt. of Rajasthan for technical discussion on establishment of Model Nursery under Horticulture Technology Mission on 15.12.05
- Meeting on Planting materials at Directorate Of Horticulture, Govt. of Rajasthan on 9.05.05 under Livelihood food security project.

Dr. Arun K. Shukla

- International Symposium on plasticulture and precision farming from 17–20 November 2005 at New Delhi

Dr. R.S. Singh

- Workshop on watershed programme organized by Department of Rural Development, Govt of Rajasthan, at AFRI, Jodhpur on 7.12.2005.
- First Annual workshop of National Network on Germplasm Evaluation and Utilization at NBPGR, New Delhi on 26–27 May, 2005.
- Zonal Research Extension Advisory Committee Meeting for Rabi–2005–06 at ARS, RAU, Bikaner on 24-25.8.2005.
- Foundation laying function of NRC on Pomegranate, Solapur on 25.9.2005 and also attended State level Seminar and Kisan Gosthi on Pomegranate Production in India organized by Pomegranate Growers Association of Maharashtra, held at Hutatma Smriti Mandir, Solapur on 25.9.2005.
- Zonal Research Extension Advisory Committee Meeting for Kharif- 2006 at ARS, RAU, Bikaner on 27.2.2006.
- Meeting of Nagar Raj Bhasa Karyanavan Samiti, Godhra held at CHES, Vejalpur, Godhra on 28.6.2005 and Rajbhasa Committee meeting of CHES centre, Godhra on 29.6.2005.
- National seminar and Presented a paper on Grasses/Forage under Horticultural Plantations

in Arid and Semi arid regions of India in National seminar on Augmenting Forage Resources in arid and semi arid regions: long term strategies held at SIAM, Jaipur during 19-20 November, 2005.

- National Seminar on Conservation, processing and utilization of Monsoon Herbage for Augmenting Animal production held at CSWRI, Arid Region Campus, Bikaner on17–18 December 2005.
- National symposium on Livelihood security and diversified farming systems for arid region held at CAZRI, Jodhpur on 14–16 January, 2006

Dr. B.D. Sharma

- Attended extension advisory meeting, RAU, Bikaner, 8th August 2005

Dr. D.K. Samadia

- Attended the XXIII Group Meeting of All India Coordinated Research project on Vegetable Crops held at BCKV, Kalyani (W.B.) from 16–19 April, 2005.

Dr. O.P. Awasthi

- Attended First International Guava Symposium, organized by Central Institute for Subtropical Horticulture, Lucknow from 5–8 December 2005.

Participation from CHES, Godhra

- V.Lenin, Scientist (Senior Scale) (Ag. Extension). Participated and presented a poster on research paper 'Workload of tribal farmwomen of Gujarat' in the 93rd Indian Science Congress, Hyderabad 3–7 Jan.2006.
- S.Raja, Scientists (Vegetabels crops) Participated in 8th Agricultural scientists and farmers congress held at Banaras Hindu university from 21-22nd February, 2006.
- Participated in National Symposium on stress management in arid and semi arid ecosystems for productivity enhancement in agriculture on sustainable basis organized by S.D.A.U, S.K Nagar, Gujarat on April 11–13, 2005.
- Participated in 12th Vasant Rao Naik Memorial National agricultural seminar on value addition to Agro–horti–medicinal produce and its marketing, organized by Dr.P.D.K.V.Akola, V.N.S.P. Pusad and NMPB, New Delhi on October, 17–19, 2005.
- Participated in National Work shop on Dry land agriculture held on10th and 11th May 2005 at CAZRI in Rajasthan.
- Participated in the 8th Indian Scientist and farmer Congress held at BHU, Varanasi on 21st and 22nd March 2006.

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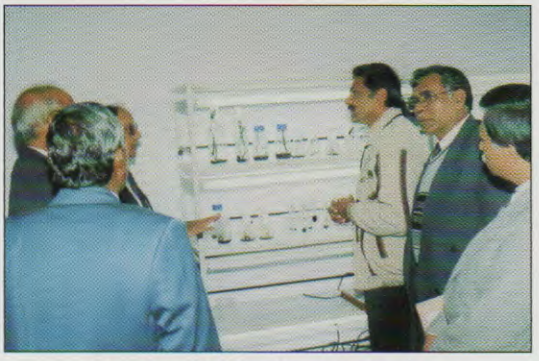
Distinguished Visitors

Shri.R. S. Rawat, Deputy Director I/C, National Language Department, Home Ministry, Mumbai, visited CHES, Ghodra on 24.12.2005.

RAC team visiting the vegetables research block



QRT team visiting tissue culture lab

QRT team reviewing biocontrol works

QRT team visiting PHT lab

Field visit of QRT team

QRT meeting at CHES, Godhra

12

Empowerment of Women

The institute at Bikaner and the regional station at CHES, Godhra have taken all possible efforts to impart training and demonstrations for the farm women particularly who are engaged in prodution of arid and semia arid horticultural crops.The following are some of the illustrations of different activities during the reporting period.

Tribal woman farmers visiting stall of CHES, Godhra

Field demonstration on drip irrigation

Field demonstration by Extension scientist

13
Personnel

S.No. Name	Designation/Discipline
	CIAH, BIKANER
Research Management Position	
Dr. D. G. Dhandar	Director
Scientific	
Dr. B. D. Sharma	Senior Scientist (Soil Science)
Dr. R. Bhargava	Senior Scientist (Plant Physiology)
Dr. P. L. Saroj	Senior Scientist (Horticulture) at present on deputation to SVBPUAT, Meerut.
Dr. R. S. Singh	Senior Scientist (Horticulture)
Dr. O. P. Awasthi	Senior Scientist (Horticulture)
Dr. P. Nallathambi	Senior Scientist (Plant Pathology)
Dr. D. K. Samadia	Senior Scientist (Horticulture)
Dr. Dhurendra Singh	Senior Scientist (Plant Biotechnology)
Dr (Smt). C. Umamaheshwari	Scientist (Plant Pathology)
Dr. Anil Kumar Shukla	Scientist Senior Scale (Hort.) at present on deputation to MPUAT, Udaipur.
Dr. Arun Kumar Shukla	Scientist Senior Scale (Fruit Science)
Sh. A. Nagaraja	Scientist (Fruit Science)
Dr. S. R. Meena	Scientist (Agril.Extension)
Dr. Indu Shekher Singh	Scientist (Soil Sci.,Soil Phy. & SWC)
Sh. R. Nagarajuna Kumar	Scientist (Computer Application) Joined on 26.12.2005
Administration	
Sh. Padam Singh	Administrative Officer retired from ICAR Services w.e.f. 28.02.2006
Sh. M. K. Pachauri	Administrative Officer (Joined on 06.03.2006)
Sh. V. K. Pandey	Assistant Administrative Officer
Sh. S. C. Sharma	Assistant Finance & Acctt.Officer
Technical	
Sh. S. K. Pandey	T-5 (Technical Officer) Farm
Sh. M. K. Jain	T-4 (Senior Computer operator)
Sh. P. P. Pareek	T-4 (Hindi Translator)
Sh. G. R. Baria	T-4 (Field Technician)
Dr.U.V. Singh	T-4 (Field Technician)
Sh.C.L. Meena	T-4 (Field Technician)
Sh. Sanjay Patil	T-4 (Photographer cum Artist)

S.No.	Name	Designation/Discipline
		REGIONAL STATION (CHES, VEJALPUR)
	Scientific	
	Dr. B. G. Bagle	Head
	Dr. S. S. Hiwale	Senior Scientist (Horticulture)
	Dr. Sanjay Singh	Senior Scientist (Horticulture)
	Sh. H. K. Joshi	Scientist Sel.Grade (Plant Pathology)
	Dr. A. K. Singh	Scientist Senior Scale (Fruit Science)
	Sh.V. Lenin	Scientist (Agril.Extension)
	Sh. Raja Shankar	Scientist (Vegetable Science)
	Dr. V.V. Appa Rao	Scientist (Soil Science)
	Sh.D. T. Meshram	Scientist (Soil Water Conservation & Engineering)
	Administration	
	Sh.J. B. Saxena	Assistant Adm.Officer
	Sh.Ayaz Ahmed	Asstt.Finance & Acctt.Officer
	Technical	
	Sh. D. K. Saraswat	T-8 (Technical Officer) Farm
	Sh. Nihal Singh	T-6 (Technical Officer) Farm
	Sh. G. U. Trivedi	T-5 (Librarian)
	Sh.A. V. Dhobi	T-5 (Overseer)
	Sh.M. N. Makwana	T-4 (Hindi Translator)

Promotion/Assessments

Scientist

1. Dr. Anil Kumar Shukla, Scientsit (Hort.) to Scientist Sr.Scale (Hort.) w.e.f. 31.08.2003.
2. Dr.A. K. Singh, Scientist (FS) to Scientist Sr.Scale (FS), w.e.f. 20.11.2003.
3. Dr. Arun Kumar Shukla, Scientist (FS) to Scientist Sr.Scale (FS), w.e.f. 20.11.2003.
4. Sh.V. Lenin, Scientist(Agril.Extension) to Scientist Sr.Scale (Agril.Ext.) w.e.f. 13.07.2003.

Technical

1. Sh.A.V.Dhobi, T-4 (Overseer) to T-5 (Overseer) w.e.f. 05.12.2002
2. Sh.C. L. Meena, T-3 (F.T.) to T-4 (F.T.) w.e.f. 13.07.2003.
3. Sh.B. R. Khatri, T-2 to T-3 (Computer operator), w.e.f. 29.03.2004.
4. Sh.S. M. Kalu, T-I-3 (Driver) to T-3 (Driver), w.e.f. 03.02.2000.
5. Sh.R. D. Rathva, T-I-3 (L.T) to T-3 (L.T), w.e.f. 03.02.2000.
6. Sh.D.P. Patel, T-2 (F.T.) to T-I-3 (F.T.) w.e.f. 01.01.1999.
7. Sh.C. S. Chamar, T-2 (F.T.) to T-I-3 (F.T.) w.e.f. 01.01.1999.
8. Sh.A. J. Solanki, T-2 (F.T.) to T-I-3 (F.T.) w.e.f. 01.07.1999.

Superannuation

Shri Padam Singh, Administrative Officer retires on 28.02.2006.

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Meteorological Data

CIAH, Bikaner

Month	Rainfall (mm)	Temperature		Wind velocity (km/hr)	Relative humidity	
		Max.	Min.		Max.	Min.
April	0	38.5	20.2	10.3	51.3	40.2
May	0	42.1	22.3	13.4	61.2	20.3
June	18.6	41.2	26.8	17.5	42.8	23.4
July	64.8	36.6	25.9	11.3	84.8	64.4
August	2.5	35.6	26.6	10.2	80.6	56.4
September	77.4	36.2	25.3	7.2	80.8	58.6
October	6.0	36.1	18.2	4.1	73.6	40.8
November	0	28.2	9.4	3.8	63.4	30.2
December	0	22.2	5.1	3.7	85.8	48.2
January	0	20.3	4.8	3.3	60.6	55.8
February	0	29.8	8.1	3.1	74.4	36.4
March	0	36.9	17.1	2.8	75.2	38.2

CHES, Godhra