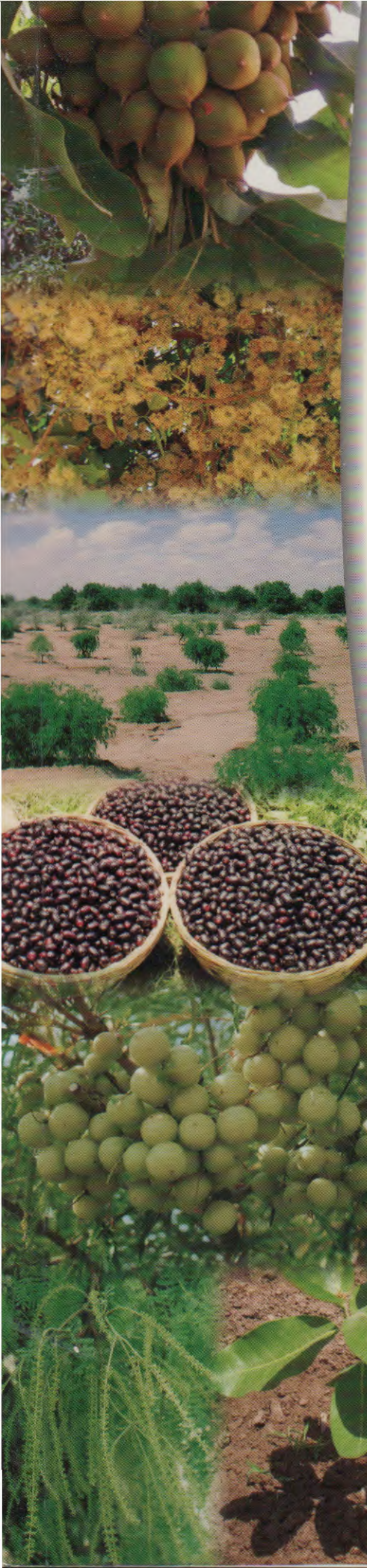


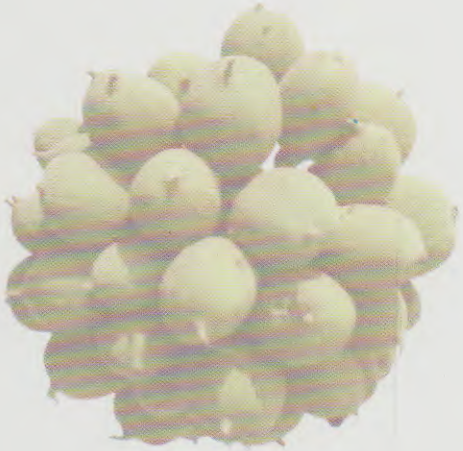
# 2006-07
# Annual Report

भाकृअनुप
ICAR


केन्द्रीय शुष्क बागवानी संस्थान
**Central Institute for Arid Horticulture**
**Bikaner 334 006**

CIAH

# 2006-07
# Annual Report



भाकृअनुप
ICAR


केन्द्रीय शुष्क बागवानी संस्थान

**Central Institute for Arid Horticulture**

Beechwal, Bikaner 334 006

Rajasthan

**Correct Citation**
CIAH-Annual Report 2006–07

**Compiled and edited by**

Dr P. Nallathambi
Dr O. P. Awasthi
Dr R. Bhargava
Dr D. K. Samadia
Dr T. A. More

**Central Institute for Arid Horticulture**
15 Sri Ganganagar Highway
Beechwal, Bikaner 334 006
Rajasthan, India

Telephone: 91-151-2250960
Fax: 91-151-2250145
E-mail: ciah@hub.nic.in
Website: http://www.ciah.ernet.in

Published by Dr T. A. More, Director, Central Institute for Arid Horticulture (ICAR), 15 Sri Ganganagar Highway, Beechwal, Bikaner 334 006 (Rajasthan); Lasertypeset by M/s Xpedite Computer Systems, B-587, 2nd Floor, Pandav Nagar, New Delhi 110 008 and printed at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi 110 028.

# Preface

THE Annual Report of CIAH for the year 2006-07 has been compiled as per the latest guidelines of ICAR. The major research achievements emphasizing on germplasm evaluation and development of new varities, crop management with recent trends and integrated pest and disease management of major arid fruits and vegetables are presented in a concise form.

As known, the arid region in the country occupying about 12 per cent of total area is marked by weakness such as high temperature, low and erratic rainfall, low relative humidity, high potential evapo-transpiration, low soil fertility, etc., However, the region holds strengths such as 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 September, 2000 with a regional station at 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 CHES, Godhra 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 42 research projects are under operation and its regional station in addition to one adhoc scheme. The plant genetic resources, 311 genotypes/strains of ber, 154 genotypes of pomegranate, 26 genotypes of aonla and 48 of date palm and 17 of bael in addition to large number of collections from arid vegetables are being maintained in National Germplasm Repository at CIAH, Bikaner. Few of the genotypes were exploited for the improvement programme and few promising varieties viz., Thar Sevika and Thar Bhubhraj in ber, Goma Aishwariya in aonla, Thar Shobha in Khejri, Thar Manak in mateera and Thar Samridhi in bottle gourd have been released at the institute level.

Apart from this, propagation techniques for the rapid multiplication of arid fruits, growth and development studies on arid vegetable crops, standardization of production technology of aonla, integrated nutrient management with special emphasis on organic farming, 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 are reported. This institute is well equipped with modern equipments and infrastructure facilities.

This Annual Report is an out come 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. The technical supports in terms of computerization by Sh. M. K. Jain, Hindi translation by Sh. P. P. Pareek and photography by Sh. Sanjay Patil are appreciated. I am pleased to present with the hope that it will give useful and scientific information to all the stack holders related to arid horticulture.

May 2007

(T. A. More)
Director

# Contents

# कार्यकारी सारांश

## पादप आनुवंशिक संसाधनों का प्रबन्ध

### फल

बेर के कुल 311 जननप्रकारों को देश के विभिन्न भागों से इकट्ठा करके संस्थान के बीकानेर स्थित राष्ट्रीय संग्राहलय में संरक्षित किया गया। इसी प्रकार उपकेन्द्र, वेजलपुर में कुल 51 जननद्रव्यों का संरक्षित किया गया है। इन जननद्रव्यों को विभिन्न आयामों के अन्तर्गत परखा गया है। बेर के संवर्धन कार्यक्रम में सीआईएएच संकर–1 (थार सेविका) जोकि सेब तथा काठा प्रजातियों के युग्म से बनाया गया है तथा सीआईएएच सलेक्शन–1 (थार भुभराज) जो कि राजस्थान के भुसावर व भरतपुर स्थानों से चयनित किया गया था, को विकसित कर संस्थान स्तर पर जारी किया गया है। थार सेविका प्रजाति अन्य प्रजातियों से अगेती है। 22 प्रतिशत मिठास के साथ इसके फल रसीले होते हैं। थार भुभराज रेगिस्थान के उच्चताप (2.5 डिग्री से 48 डिग्री सेल्सियस) को सहन करने की क्षमता रखता है। इसके फल पीलापन लिए हरे रंग के देखने में अच्छे होते हैं। इन प्रजातियों को अखिल भारतीय शुष्क क्षेत्र फल समन्वित अनुसंधान परियोजना के विभिन्न केन्द्रों के माध्यम से मूल्यांकन किया जा रहा है।

अनार में, संस्थान स्तर पर 154 तथा उपकेन्द्र पर 45 जननद्रव्यों का संरक्षण एवं मूल्यांकन किया जा रहा है। गणेश एवं अनारदाना प्रकार की एच–कतार गुजरात के वर्षा आधारित क्षेत्र में बेहतर परिणाम दे रही है। शुष्क क्षेत्र में अनार में फल फटने की बहुत समस्या है तथा इसका हल खोजने हेतु नए प्रयोग प्रक्षेत्र में लगा दिए गए हैं। खजूर में 48 जननद्रव्यों को संरक्षित किया गया है। इनमें से प्रति पौधा हलावी, सबीह, दयारी, जहीदी, बीकानेर लोकल तथा खदरावी में सबसे अधिक गुच्छे लगे। टीशू कल्चर पौधों में पौध का बनना अधिक दर्ज किया गया।

अवप्रयोगी शुष्क फलों पर भी संग्रहण एवं मूल्यांकन कार्य किए गए जिनमें जामुन, इमली, चिंरोंजी, महुआ, बेल, करोंदा, लसोड़ा, प्रमुख है। शुष्क क्षेत्र की सब्जियों में स्थानीय एवं अधिक प्रचलन की बहुत सी सब्जियों के जननद्रव्यों को संरक्षित किया गया है। इसके अतिरिक्त मतीरा, तरबूज, टिण्डा, काचरी, फूटककड़ी, मतीराककड़ी, लौकी, आदि अन्य को संरक्षण एवं प्रजनन कार्य हेतु रखा गया है।

### सब्जियां

गर्म शुष्क क्षेत्र की परिस्थिति में सब्जी फसलों के संवर्धन की योजना के अन्तर्गत मतीरा एएचडब्लू–19 का सूगरबेबी नामक किस्म से योग करवा कर एक नई किस्म "थार मानक" का विकास किया है। इसके फल बड़े, मजबूत तथा बीज काले होते हैं तथा इसके फल तेज ताप में फटते भी नहीं है। इसी प्रकार लौकी की एक प्रजाति बांसवाड़ा लोकल–1 एवं गुजरात लोकल–1 के युग्म से एएचएलएस राउण्ड–1 (थार समृद्धि) नाम से जारी की गई है। गलतौरई तथा तौरई कीधाराएं विकसित करने का कार्य प्रगति पर है। सेम फली के मूल्यांकन का कार्य जारी है। इसमें एएचएसबी–1 लाईन को श्रेष्ठता के आधार पर चयनित किया गया है। ग्वार फली में राजस्थान के चूरू जिले से एकत्रित जननद्रव्य के साथ एएचजी–13 के विकास का कार्य किया जा रहा है। चयनित किस्मों से श्रेष्ठ गुणवत्ता वाली किस्मों का विकास करने हेतु बड़े पैमाने पर प्रयोग कार्य किया गया है। अर्द्धशुष्क क्षेत्र में कद्दूवर्गीय जननद्रव्यों पर उपज, गुणवत्ता तथा सूखा सहिष्णु किस्मों के विकास व इनको व्यवसायिक स्तर पर बढ़ाने हेतु कार्य किया जा रहा है।

खेजड़ी की 'खेजड़ी सलैक्शन–1 प्रजाति विकसित कर इसको "थार शोभा" नाम से जारी कर इस संस्थान ने महत्वपूर्ण उपलब्धी अर्जित की है। थार शोभा का पांच

साल का ग्राफ्टेड पौधा भी अच्छी उपज देने में सक्षम है। यह प्रजाति शुष्क क्षेत्र के अधिकतम तथा न्यूनतम दोनों प्रकार के तापक्रम को सहन करने की विलक्षन क्षमता लिए हुए है।

खजूर में सूक्ष्म प्रवर्धन का कार्य किया जा रहा है। खजूर की हलावी प्रजाति में इस प्रकार का कार्य आरंभ किया गया है।

## फसल प्रबन्ध

शुष्क क्षेत्र में आंवला आधारित बहुस्तरीय फसल प्रणाली विकसित करने के प्रयोग में प्रथम स्तर की फसल का प्रदर्शन अच्छा रहा हैं। मॉडल प्रणाली में बेर की प्रजाति सेब का मॉडल–1 तथा मॉडल–2 में करौंदा ने अच्छे परिणाम दिए हैं। सरसों–आंवला– मोठ ने उपज के आधार पर बेहतर परिणाम दिए। मोठ को सभी चारों फसल मोडलों में बोया गया था।

अर्द्धशुष्क स्थिति पौधों के वानस्पतिक परिमापकों में विभिन्न पौध रोपण प्रणालियों में उल्लेखनीय अंतर दर्ज किया गया। इनमें उपज आदि में स्पष्ट अंतर प्राप्त किया। पौधे से पौधे की दूरी 10×10 रखने पर नरेन्द्र आंवला–7 में सर्वाधिक उपज दर्ज की गई। समेकित पोषण प्रबन्धन में विभिन्न जैविक व अजैविक खादों/उर्वरकों के संयोगों द्वारा प्रयोग करने पर पाया गया कि केंचुवा तथा अजैविक खाद का 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 के खादों में फल भार व कुल उत्पादन में अन्तर स्पष्ट दिखाई दिया। उपज बढने के साथ खाद की मात्रा के आधार पर ही फलों में मिठास व स्वादिष्ठता की वृद्धि भी दर्ज की गई।

## मृदा व जल संरक्षण

शुष्क क्षेत्रीय पारिस्थितिकी में मृदा में नमी संरक्षण विधियों के प्रभावों को भूमि की उर्वरकता, जल उपलब्धता, नाभकीय क्षेत्र, पत्तियों द्वारा भोजन खींचना, जलप्रयोग क्षमता, उपज व गुणवत्ता आदि का अध्ययन किया गया। मृदा एवं जल संरक्षण हेतु कई प्रकार के प्रयोग व प्रयास किए गए। बेगन में गोबर की खाद व अन्य नमी संरक्षण के उपायों में तुलनात्मक अध्ययन किया गया।

जैविक पलवार में धान की भूसी सबसे अच्छी दर्ज की गई। 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 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।

अर्द्धशुष्क पारिस्थितिकी में सिंचाई के विभिन्न तरीकों के तुलनात्मक अध्ययन में एक दिन छोड़कर दूसरे दिन सिंचाई करने पर बेहतर परिणाम प्राप्त किए गए। काचरी में एकल लाईन के बूंद–बूंद सिंचाई प्रणाली से परम्परागत प्रणाली की अपेक्षा 25 प्रतिशत अधिक उपज दर्ज की गयी। इसी प्रकार का परिणाम फूटककड़ी की फसल में भी दर्ज किया गया।

## पादप कायिकी एवं कटाई उपरांत तकनीकी

खजूर में पौध उत्पान हेतु रासायनिक उपचार किए गए। मिट्टी मिश्रण के लेप से खलास प्रजाति में जड़ तंत्र के विकास को दर्ज किया गया। एक वर्ष में इस प्रकार से 6 पौध तैयार की गई जिनका परीक्षण किया जा रहा है।

आंवला फल (नरेन्द्र आंवला–7) पकने के तीस दिनों बाद भी उनमें कोई प्रतिकूल प्रभाव नहीं देखा गया। केल्सियम क्लोराइड के दो प्रतिशत घोल से उपचारित फलों में फलभार अथवा अन्य किसी प्रकार से फल पर विपरीत प्रभाव नहीं दर्ज किया गया।

## फसल संरक्षण

लगातार वर्षा के कारण बेर में फल का जमाव व विकास दोनों पर प्रतिकूल प्रभाव पड़ा और फलस्वरूप फलमक्खी एवं फलछेदक कीटों का आक्रमण 4 से 10 प्रतिशत तक बढ़ गया। आंवला (एन.ए–7) में यह 10–13 प्रतिशत तक देखा गया। अर्द्धशुष्क क्षेत्र में करेला एवं कद्दू में फल मक्खी का आक्रमण 10–35 प्रतिशत अधिक दर्ज किया गया।

करेला में चूर्णी फफूंद रोग प्रबंध में सीआईएएच–196 जीव नियंत्रक के द्रव्य व चूर्ण का छिड़काव कर पाया गया कि 72 घण्टों के भीतर रोग पर नियंत्रण हो गया। यद्यपि यह छिड़काव छाया में स्थिति अविकसित पत्तियों पर रोगाणुओं को पनपने से नहीं रोक पाया। पीजीपीआर आइसोलेट्स को जैवरसायन विधि के आधार पर गुणों में वर्गीकृत एवं विश्लेषित किया गया।

बेलेटोन के दो एवं सल्फेक्स के तीन छिड़काओं से बेर के चूर्णी फफूंद रोग पर अर्द्धशुष्क क्षेत्रों में नियंत्रण पाया गया। टमाटर के रोगों पर विभिन्न दवाओं एवं उपचारों से यहां पर नियंत्रण पाया गया। चूर्णी फफूंद, सर्कोसफेरा, आदि रोगों के कारण विभिन्न फसलों की उपज प्रभावित हुई।

## कृषि विस्तार गतिविधियां

राजस्थान के बीकानेर जिले के इंदिरा गांधी नहर परियोजना क्षेत्र में किए गऐ सधन सर्वे किया गया। इस क्षेत्र के किसानों ने बागवानी फसलों को मिश्रित रूप में अंतःसस्य के साथ विभिन्न फसलों के साथ उगाना आंरभ किया 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। किसानों द्वारा फलों के विपणन के तरीकों का भी अध्ययन किया गया। बेर, आंवला तथा अनार की खेती आधुनिक तकनीकी से करने में इस क्षेत्र के किसान अब रूचि लेने लगे हैं।

इस अवधि में वैज्ञानिकों ने विभिन्न स्थानों पर केम्प लगाकर किसानों को विकसित तकनीकियों की जानकारी प्रदान की तथा उनके खेतों पर इनको प्रयोग करने की विधि समझायी। किसान मेलों तथा एनजिओ आदि के माध्यम से तकनीकियों का हस्तानांतरण भी किया गया।

इसी प्रकार उपकेन्द्र गोधरा पर कार्यरत कृषि विज्ञान केन्द्र के माध्यम से विभिन्न प्रशिक्षण कार्यक्रम चलाए गए तथा अर्द्धशुष्क क्षेत्र में किसानों द्वारा अपनाई जाने वाली समेकित बागवानी प्रौद्योगिकियों का एक अध्ययन किया गया।

संस्थान में एक पुर्नोपयोगी योजना सहित बाह्य समर्थित तीन परियोजनाएं कार्यरत हैं। आम के 3666, आंवला के 63, चीकू के 290, अनार के 215, सीताफल के 45 एवं कागजी नीबू के 34 पौधों के विक्रय से 1,41,355 लाख रूपयों का राजस्व अर्जित किया गया।

## प्रक्षेत्र विकास एवं राजस्व अर्जन

बाग के कुल क्षेत्र में बढ़ोतरी करने की एक कार्य योजना को मुख्य संस्थान सहित उपकेन्द्र, वेजलपुर पर लागू किया गया। राजस्व अर्जन करने के कार्य में संस्थान ने इस वर्ष उप केन्द्र सहित फार्म उत्पादों की नीलामी तथा पौधे विक्रय से 1,41,355 रूपयों की आय अर्जित की।

# Executive Summary

## Management of Plant Genetic Resources

### Fruits

A total of 311 *Ziziphus* genotypes/strains collected from different parts of the country are maintained in the National Germplasm Repository of CIAH, Bikaner. In CHES, Godhra, 52 germpalsm are being maintained. All these were evaluated with respect to different traits. Improvement in ber, CIAH-H-1 (Thar Sevika) developed by the hybridization from a cross Seb × Katha and CIAH-Sel-1 (Thar Bhubhraj) as selection from local material of Bhusavar area of Bharatpur district of Rajasthan have been developed and released at Institute level. Thar Sevika is early maturing and matures 10-15 days earlier than other cultivars. The fruits are juicy with a TSS content of 22%, ascorbic acid content mg/100g (90.0), total sugar (5.0), protein mg/g (16.00). CIAH-Sel-1 (Thar Bhubhraj) has ability to withstand extremes of temperature variation from 2.5-48° C. Fruits are attractive, yellowish green in colour. The plants of these varieties have been distributed to different Centers of AICRP on Arid Zone Fruits for further evaluation and testing.

In pomegranate, 154 collection at CIAH, Bikaner and 45 germplasm at CHES, Vejalpur are being maintained and evaluated for growth, yield and fruit quality. Ganesh and Anardana type Line H are performing better under rainfed conditions of Gujarat. Fruit cracking was identified as a major problem in this crop under arid regions and to manage this, new experiments have been already initiated with multidisciplinary approaches. In date palm 48 genotypes including exotic germplasm were maintained in field repository and out of these number of bunch per palm and fruits yield was better in Halawy, Sabiah, Dayari , Zahidi, Bikaner local and Khadrawy. It was observed that sucker production was more in tissue culture plants than off shoots plantations.

Research works on underexploited fruits revealed the commercially viable features in some of the crops like jamun, tamarind, chironji, mahua, bael, karonda and lasora. In case of arid vegetables, a large number of landraces, local cultivars, semi-domesticated and wild forms of mateera/watermelon, round melon, kachri, snap melon, muskmelon, kakdi, bottle gourd and Luffa gourds are maintained for the conservation and breeding programme.

### Vegetables

Under the improvement in vegetable crops under hot arid environment, Mateera (Thar Manak) has been developed through selection from a cross combination of Mateera AHW - 19 × Sugar Baby. The fruits containing very big, bold and blackish seeds are free from cracking under extremes of arid conditions. Similarly, in bottle gourd, AHLS Round-1 (Thar Samridhi) was derived from a cross combination of Banswara Local–1 × Gujarat Local-1) and released at institute level. It is yield uniform and high yielding fruits, which can be harvested early than other varieties under arid region. The advance genetic material of sponge gourd and ridge gourd were evaluation resulted AHSG-4 line which is superior in earliest marketable and uniform, better quality and high yielding fruits under high temperature conditions. Evaluation on performance of sword bean, Indian bean resulted advanced lines of AHSB –1 in the former and AHDB 16 in latter case. In addition, AHDB–03 and AHDB–16 were performing well under arid conditions. In cluster bean, performance of AHG–13 has been purified for single stem type from the local germplasm collected from Churu district of Rajasthan. This selection is for thin and medium long pods of high

quality for vegetable purposes.

This Institute has made a landmark in development of a Khejri Selection-1 for the first time and it is released in the name of 'Thar Shobha'. A five year grafted plant can yield about 4.25 kg sangri and 6.27 kg loong in a year. Tender pods are light green in colour, straight, roundish-flat, soft and sweet. The variety tolerates to extremes of high and low temperatures and aridity conditions.

Micropropagation works on date palm has been initiated and shoot bud formation in flower petals of female flowers of date palm cv. Halawy, embryogenic and callus in shoot tip culture of date palm have been observed.

## Crop management

Evaluation of aonla based diversified cropping models in arid eco-system indicated that the ground storey crops performed well in the different cropping model without affecting the growth and development of main and component crops. Among the understorey crops ber cv. Seb in model 1 recorded an average yield of 70 kg/plant and was significantly superior to control. In model 2, Karonda resulted an average fruit yield of 250 g/plant (1.5 q/ha). *Prosopis cineraria* grown in combination with aonla-*suaeda*– moth bean-mustard ($M_3$) as an understorey component recorded an average yield of 0.5 kg/plant (0.75 q/ha). Moth bean (*Phaseolus acontifolius*) was gown as groundstorey crop during kharif season in all the four cropping models. Among the groundstorey crops, gram excelled the other crops recording an average yield of 10 $qha^{-1}$. It was also observed that soils under ber plantations recorded maximum moisture content at field capacity (Model-1).

Under semi-arid conditions, considerable differences in vegetative parameters were observed among the evaluated planting systems. Yield per plot (68 kg) and per ha (75.48 q/ha) were significantly high in double hedgerow system followed by cluster and hedgerow system of planting in aonla. In another experiment on high-density planting in this crop, 10 × 10 m spacing yielded a maximum 130.6 kg per plant. In another theme on integrated nutrient management, effect of biofertilizers, organic manure and fertilizers combinations on growth and yield of aonla, recycling of organic manures and impact on growth, yield and quality of pomegranate cv. Ganesh and organic farming in vegetable crops were studied.

## Soil and water conservation

The effect of soil moisture conservation methods on soil fertility, water availability, hydro thermal regimes, leaf nutrient concentration and uptake, water use efficiency, yield and quality parameters were studied under arid conditions. Increase in organic carbon content was recorded in the treated plots was 2-7 times higher and the maximum water contribution under FYM mulched plots. These soil moisture conservation measures significantly increased the uptake of N, P and K by leaves of brinjal.

Organic mulching in aonla revealed that paddy straw encouraged plant growth and reduced soil moisture evaporation and all mulch material showed reduction in soil pH and ECe values in soil. Organic carbon, N, P and K were recorded maximum with paddy straw mulching.

Under semi-arid conditions, three level of irrigation and two frequencies of drip irrigation indicated that maximum yield per plant (38.50 kg) was recorded with irrigation by alternate day irrigation with 60 per cent wetted area. Under arid conditions, single line drip system (2.0 m × 0.5 m) effected improvement in yield about 25 per cent higher than conventional system in Kachri. In case of snap melon, significantly higher fruit yields of 19.5 per cent was recorded in this method of irrgation.

## Crop physiology and post harvest technology

Chemical treatments were tried for the suckers production in date palm. Earthing of soil mixture to arial suckers in cv. Khalas indicated that rooting in arial suckers. After one year of earthing, six rooted suckers were produced and these are being tested in field for survival and growth.

Aonla fruits (cv. NA-7) can be retained in trees itself without reducing the fruit quality shelf life of

fruits up to 30th day from the date of maturity. Treatment with calcium chloride (1.5%) could avoid physiological loss in weight and spoilage by saprophytes up to 9 days of economic shelf life. In case of ber, under the zero energy cool chambers, fruits treated with calcium chloride (1.5%) recorded the least physiological loss in weight and spoilage loss during storage.

## Crop protection

Because of incessant rains, fruit set and development were adversely affected and therefore, the incidence of fruit fly and fruit borer was 4.0 to 10.0 per cent in ber. In aonla (cv. NA-7), borer complex ranged between 10.0 to 13.0 per cent. In case of bitter gourd and pumpkin, incidence of fruit fly infestation was 10 to 35 per cent under semi-arid conditions.

Field testing of liquid and powder formulations (1%) of Pf-CIAH-196 for the management of bottle gourd powdery mildew revealed that the colonies were suppressed within 72 hours of sprays. However, bacterial cell suspension sprays could not restrict the proliferation of powdery mildew colonies of immature leaves under shades. PGPR isolates were characterized by biochemical methods and the properties of the soils used in PGPR isolation were also analyzed.

Under semi-arid conditions, 2 sprays of Bayleton and 2 sprays of Sulfex effectively managed ber powdery mildew. Damping-off (PEDO) in tomato was completely managed by drenching (Ridomil Mz), incorporation of *Trichoderma viridae* spore suspension @ $3 \times 10^5$ cfu per g in soil and fumigation of nursery bed with 1% formaldehyde solution. Cumulative loss of yield due to powdery mildew, cercospora leaf spot and YVMV were 41.3 per cent in okra. It was also observed that okra powdery mildew was hyper-parasitized by *Ampelomyces quisqualis* (AQ) within 8-10 days when used as spore suspension.

## Agricultural extension

Intensive surveys were conducted in IGNP area of Bikaner district of Rajasthan. The horticulture based cropping system including mixed cropping system, intercropping, sole cropping with different combinations have been identified. Farmers of this regions also adopted some of the improved varieties of ber (Gola, Seo, Umran, Mudia), Aonla (NA-7, NA-6, Chakaiya, Krishna), and the improved varieties of CIAH viz., mateera (AHW-19, AHW-65), Snap melon (AHS-10, AHS-82), Kachri (AHK-119, AHW-200) and they are getting good income from these varieties. Some of them have developed very good orchards of lemon/lime, mosambi, kinnow, etc. It was identified that farmers of the surveyed area are willing to grow these crops.

During this year various extension programmes were organized to create awareness among the farmers/NGOs about improved/modern arid horticultural technologies and some of them particularly growing of arid vegetables, ber and aonla have been disseminated to the farmers by field demonstrations.

Similarly, the KVK functioning at CHES, Godhra has organized different training programmes including cultivation of major and minor fruits, vegetables in the semi-arid region, propagation of fruits, growing diseases free nurseries of the vegetables.

There are 3 externally funded projects including a revolving fund on commercial propagation of fruit plants. About 3666 plants of mango, 63 aonla, 290 sapota, 215 pomegranate, 25 and 20 budded and seedling plants of custard apple and 34 kagzi lime plants were sold for revenue generation under commercial propagation scheme.

## Farm development and revenue generations

Detailed work plan has been formulated for expanding the area under plantation both in main centre at Bikaner and CHES, Godhra. Under revenue generation, a revolving fund scheme entitled commercial propagation of fruit plants is in operation. By selling of planting materials a revenue of Rs.1, 41,355/was generated.

# Introduction 1

The arid ecosystem, which is spread over nearly 12 per cent of the land area in the states of Rajasthan, Gujarat, Haryana, Punjab, Andhra Pradesh, Karnataka and Maharashtra has strengths and weaknesses. This provides ample opportunity to develop this zone into a horticulture bowl of India, provided adequate technologies to harness the strengths are developed. The conversion of this region into horticulture productive area will provide income, nutrition security and help in employment generation in the region with this view, the National Research Cenre for Arid Horticulture was established in 1993 which was later on upgraded to Central Institute for Arid Horticulture in September 2000.

## Mandate

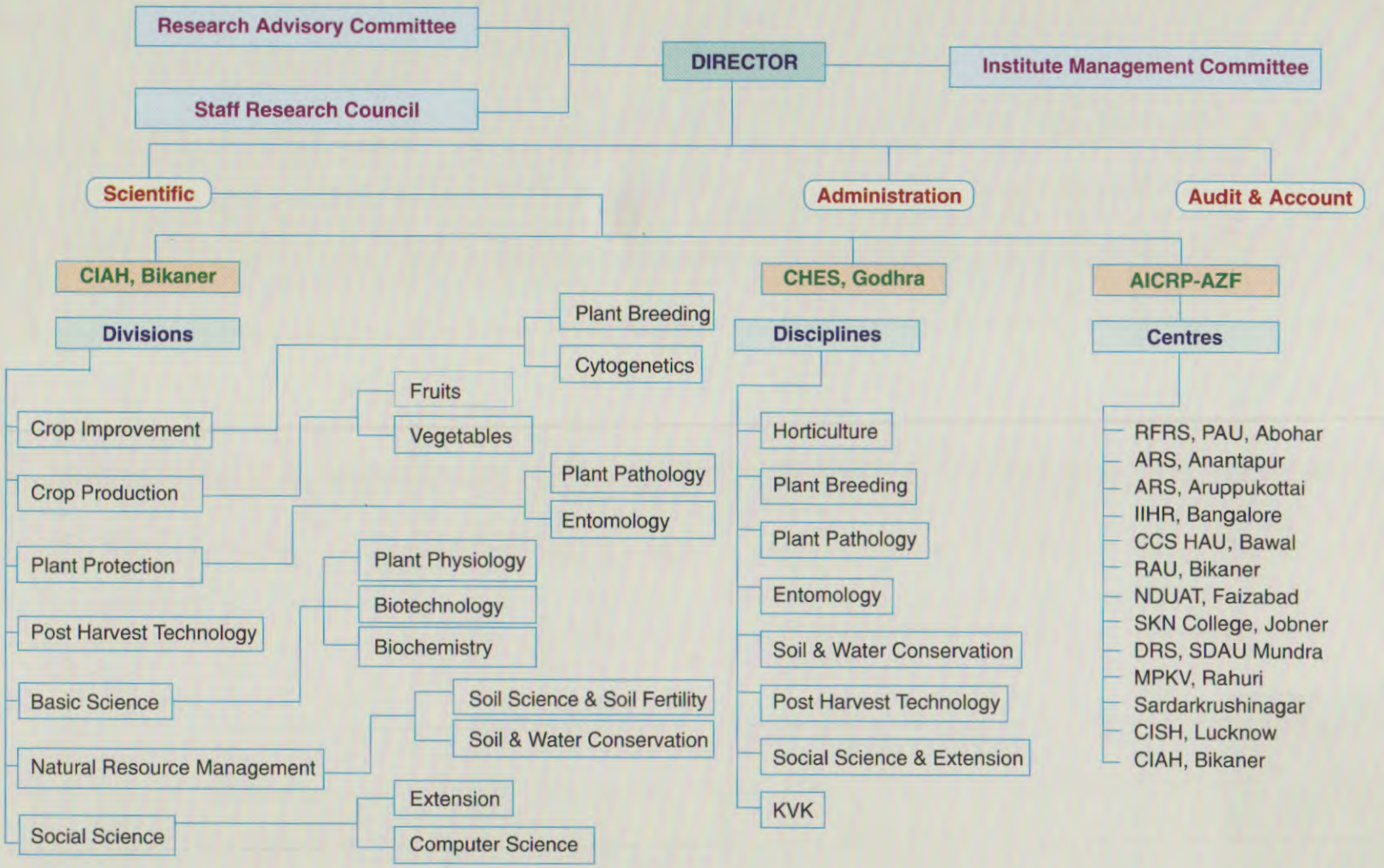
- To undertake basic and strategic research for developing technologies to enhance productivity and utilization of arid and semi-arid horticultural crops.
- To act as National gene bank of arid and semi-arid horticultural crops.
- To develop multistorey horticulture based sustainable cropping system under arid and semi-arid environment.
- To act as National repository of scientific information related to arid and semi-arid horticulture.
- 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.
- To provide consultancy in research and development of arid and semi-arid horticulture.

## Mission/objectives

- 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 agrotechniques 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 eco-physiological 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 the above mandate and objectives, the research and extension woks have been carried out and the significant results from different projects are presented.

# ORGANIZATIONAL SETUP



# Research Achievements 2

## Management of Plant Genetic Resources

### Ber (*Ziziphus mauritiana* Lamk)

**Maintenance, survey and collection of ber germplasm:** There are 311 Ziziphus genotypes/ strains collected from different parts of the country are maintained in the National Germplasm Repository of CIAH, Bikaner. In CHES, Godhra, 52 ber germpalsm are being maintained. The collected germplasm are being evaluated with respect to their morphological and physico-chemical characteristics.

**Morphological characteristics:** Out of 311 genotypes, the plant height was recorded to be maximum in Rashmi (5.87 m), followed by Thornless (5.39 m), Illaichi and Kaithali (5.15 m), while it was recorded to be minimum in Kismis (1.6 m) closely followed by Dandan (1.5 m). Plant spread (N-S, E-W) was recorded to be maximum in Gola Gurgaon (8.0 × 8.50 m) followed by Rashmi (7.7 × 7.4 m) while lower plant spread was recorded in ZG No.2 (2 × 2 m) followed by Narma (3 × 3 m). Flower initiation and fruit set were recorded earliest in Seo (02.08.06) followed by Banarasi Pawand. Katha and Chuhara have also imitated early flowering (25.08.06), while delayed flowering was recorded in ZG 3, Safeda Rohtak, Dandan (14.09.06) and Illaichi (30.09.06), while delayed fruit set was recorded in Kala Gola (30.10.06).

**Yield and quality:** Out of these germplasm, fruit yield was maximum (60 kg/tree) in Sanaur-5, followed by Gola (45 kg) and cultivar Seo (37 kg). Minimum fruit yield was recorded in cv. Bagwadi and Akarota (1.5 kg/tree). Fruit weight was recorded maximum in Chuhara (89.19 g) and it was minimum in Illaichi (14.58 g). TSS° Brix was recorded maximum (21.0%) in Chuhara, while it was minimum in Cultivars Gola and Kaithali (17.0%).

**Frost tolerance:** Incidence of frost injuries was observed during first week of January 2007. Almost all the germplasm were affected by frost. Maximum injury was observed on the foliage of cultivars Gola, Illaichi, Banarasi Pawandi and CAZRI Gola. Cultivars Tikadi, Dandhan, Zogia and Maharvali did not show any symptoms. The incidence of fruit fly although was recorded to be maximum in Gola, Banarasi Pawandi and CAZRI Gola, it was below 10 per cent. Cultivars Seo, Umran, Kaithali and Mundia were free from fruit fly attack.

### Improvement in ber

**CIAH-H-1 (Thar Sevika):** This variety has been developed by the hybridization from a cross Seb × Katha. Plant No. 2 of the $F_1$ population of the cross Seb × Katha was selected on its superior performance and it was further multiplied by patch budding for early assessment of genotype through *in situ* budding during September 1998. Plant height was 4.3 m and spread was 4.8x 5.0 m (N-S, E-W). Flowering in the said hybrid initiated during 1st week of September and extended up to 1st week of November. The peak time of bloom was between 15.09.06 to 30.10.06. The time of fruit set varied between 23.09.06 to 06.11.06 with its peak between 10.10.06 to 30.10.06. This developed hybrid is early in maturity (10-15 days earlier) than other cultivars. Since, fruit mature during the last week of December and are ready for harvesting by the first week of January and extending up to 3rd week of January. It is suitable for staggered harvesting. Average fruit yield/tree was 34 kg. The fruits are juicy with a TSS content of 22 per cent, ascorbic acid content 90 mg/100 g, total sugar and protein 16 mg/g. Incidence of fruit fly and fruit rot during the period under report was recorded to be 2-3 per cent while due to unfavourable climatic conditions, no incidence of

# Management of Plant Genetic Resources

## Major Fruits

- Ber
- Pomegranate
- Aonla
- Date Palm

## Under Exploited Fruits

- Jamun
- Tamarind
- Chronji
- Mahua
- Wood Apple
- Karonda
- Phalsa
- Lasora
- Cactus Pear

## Vegetables

- Kakdi
- Mateera
- Bottle gourd
- Luffa gourd
- Sword bean
- Indian bean
- Cluster bean
- Khejri

powdery mildew was recorded. The fruits have shelf life of 10-12 days under refrigerator and up to 5 days under room temperature (20-23°C). Based on the desirable attributes of the hybrid after six consecutive years evaluation, it was released at the Institute level under the name "Thar Sevika". The plants of the developed hybrid has been distributed to different centers of AICRP on Arid Zone Fruits for further evaluation and testing (Fig. 1).

**Fig. 1. Thar Sevika**

**CIAH-Sel-1 (Thar Bhubhraj):** Systematic survey carried out during the year 1997 in different parts of Rajasthan led to the development of CIAH-Sel-1. It is a local collection from Bhusavar area of Bharatpur district of Rajasthan, CIAH-Sel-1 is an early maturing and semi-erect growth. Plant height was 5.3 m and spread was 4.8x 4.5 m (N-S, E-W). Unlike the hybrid, flowering in the said hybrid initiated during 1st week of September and extended up to 1st week of November. The peak time of bloom was between 15.09.06 to 30.10.06. The time of fruit set varied between 27.09.06 to 06.11.06 with its peak between 10.10.06 to 30.10.06. Average yield was recorded to be 35 kg/tree. The developed selection has ability to withstand extremes of temperature variation from 2.5 to 48°C. Fruits are attractive, yellowish green in colour and juicy having TSS content of 23 per cent, ascorbic acid content 62.0 mg/100g, total sugar 5.0. Incidence of fruit fly during the period under report was recorded to be 2-3 per cent while no incidence of fruit rot and powdery mildew was recorded. The fruits have shelf life of 12 days under refrigerator and up to 5 days under room temperature (20-23°C). The most striking feature of CIAH- Sel-1 is that it escapes chilling injury due to its earliness. Considering the fruit quality attributes, earliness and tolerance to fruit fly, fruit rot and powdery mildew and long term evaluation of CIAH-Sel-1 it was released at Institute level on 24th January 2007 under the name "Thar Bhubharaj" (Fig. 2).

**Fig. 2. Thar Bhubharaj**

### Evaluation of back cross hybrid (CIAH-H-2)

Plant growth characteristics, floral biology, fruit set, yield and fruit fly incidence were recorded in back cross hybrid (CIAH-H-2). Average plant height was recorded to be 3.0 m, while plant spread, N-S and E-W was 4.53 and 4.82 respectively. Flowering was initiated on 16.08.06 and extended up to last week of September. Fruit set initiated on 07.09.06, while the fruits attained maturity on 22.01.07. Incidence of fruit fly was recorded to be less than 6 per cent.

## Pomegranate (*Punica granatum* L.)

### Maintenance and evaluation

A total of 154 genotypes were maintained in CIAH, Bikaner and 45 were maintained at CHES, Godhra. These were evaluated for growth, yield and fruit quality. Cultivars Ganesh and Anardana type Line H are performing better under rainfed condition of Gujarat. The plant height varied from 1.5 to 3.4 m and plant spread from 1.30 to 2.76 m in genotypes after eight years of planting at CIAH. About 50 per

cent genotypes are deciduous in nature. Fruiting in late hast bahar (October) was better than Mrig bahar (July-August) but the development of aril colour was poor. During the year 2007, frost injuries were less. On an average 6 to 22 fruits with an average weight ranging from 110 to 250 g per plant and TSS of 10.5 to 14.0 per cent were recorded. However, better fruit size and weight was observed in cvs. Ganesh and Jalore Seedless.

### Fruit cracking

The screening of germplasm showed that all the genotypes were susceptible to cracking. Simple water spray on fruits was not effective. However, another experiment with application of borax (0.25%), calcium carbonate (1.0%) and Aesfoetida (hing) (1.0%) for the management of fruit cracking is in progress.

### Evaluation of *Anardana* type

Out of 17 *Anardana* type collected from Himachal Pradesh, 10 types initated flowering and fruiting after three years of planting. Average plant height 1-2 m and spread 1.0 to 2.3 m were observed. The number and weight of fruits varied from 7 to 18 and 35- 91g respectively. However, TSS of fruit was 10 to 13° brix. The arils were dried and recovery percentage was 43 per cent.

## Aonla (*Emblica officinalis* Gaertn)

### Collection of bud woods

An exploration was undertaken in Eastern UP and Rajasthan during August- September 2006 to collect bud wood of elite types. Bud wood of seven genotypes i.e. three from Vindhyan Hills, one from Allahabad and three from Pratapgarh areas were collected. Similarly, bud wood of 9 genotypes were collected out of that five were from Chomu (Jaipur) and four from Ajmer areas. The collected materials were subjected to *in-situ* budding in field repository of aonla through patch method.

### Frost injuries

During January 2006 there was severe frost/ chilling temperature (2.0 to -2.0°C) and spell of frost. Most of the collected accessions/genotypes were affected moderate to severe. However, low intensity of damage was observed in deshi type and some other hardy genotypes. The accessions/genotypes collected from Himachal Pradesh showed rapid recovery of frost injury as compared to commercial cultivars like NA 6, Kanchan, and Krishna. The injuring intensity also varied according to age of trees, the young trees were damaged severely and recovered from below the scion–rootstock union where as trees of 6-7 year old recovered from scion part. A physiological transformation of adult phase to vegetative phase/juvenile phase was also remarkably noted in all accessions/genotypes/ cultivars. This resulted in to suppression in fruitfulness among the all affected trees. The affected trees were treated with fungicides to check the secondary infection

## Date palm (*Phoenix dactylifera* L.)

### Maintenance and evaluation

Fifty-eight date palm varieties/genotypes including exotic germplasm were maintained in field repository. The suckers of Agloni, Sakloti, Ruziz and Amiri were evaluated. The growth of the seedlings of *Phoenix sylvestris* was poor during initial stage of establishment. Seedlings of seven introductions from Iraq were evaluated and better survival of plant was observed in all the varieties, except Chip Chap. A seedling of was also evaluated for survival and growth. The growth of seedling plant of *Phoenix dactylifera* (an introduction from Iran EC 517310) was also poor at initial stage.

Plant height was varied from 2.00 to 4.70 m after eight years of planting. Maximum plant spread (N-S, E-W) was observed in cvs. Muscat (4.90 × 4.80 m) followed by Sadami (4.50 × 4. 40 m) and Halawy (4.30 × 4.15 m). The maximum average trunk diameter (1. 50 m) was recorded in cv. Sadami followed by Halawy (1.45m) during the year. There was no effect of frost observed on date palm plants.

Spathe emergence initiated from last week of January in Halawy, Zahidi, Muscat and Tayer and

completed by the end of February. Out of 58 germplasm, spathe emergence/opening and fruiting was observed in cvs. Halawy, Zahidi, Khadrawy, Braim, Chip Chap, Sewi, Dayari, Shamran, Medini, Sedami, Muscat, Khuneizi, Hayani, Sabiah, Medjool, BKN Local, Nagal, Hamara, Umshok, Hetami and Tayer during the year. The regular flowering and fruiting were recorded in cvs. Halawy, Dayari, Khuneizi, Medjool, Shamran, Khadrawy and Zahidi.

The average number of bunch per palm and fruits yield was also better in Halawy, Sabiah, Dayari, Zahidi, Bikaner Local and Khadrawy during the year of evaluation. The maximum number of bunch (7) was observed in Halawy followed by cultivar Dayari. However, an average 3-4 bunches/palm were produced in rest of the varieties. Maximum number of berry (18 –22/strand) was in Bikaner Local and Zahidi. Average bunch weight (3.5 to 9. 50 Kg) was also recorded in cvs. Halawy, Bikaner Local, Dayari and Zahidi. The large size berry was recorded in Medjool (4.50 × 3.05 cm), Dayari (4.10 × 3.00 m) and Halawy (3.44 × 2.14 cm). The early doka stage was recorded in cvs. Halawy i.e. 26.6.06 followed by Khuneizi, Muscat and Tayer. The maximum dropping of fruits in Sedami, Tayer and Muscat was observed. The late harvesting of doka fruits were done in cvs. Sewi, Medjool and Dayari (08.08.2006). However, the pind stage was not attained in any genotypes during the year.

The mustard was sown as intercrop in interspaces of date palm plantation during November month to improve soils and for proper utilization of land and additional income. The intercrop was harvested in March. It was found that mustard crop can be grown with limited irrigations without affecting to the plants.

### Evaluation of tissue culture plants

Tissue culture plants of cultivars A. V. Thomas, Khasab, Khalas, Khuneizi, Nubsully, Yakoobi, Fard and Nagal were evaluated for growth and fruiting. Growth characters in all the plants were better with respect to palm height, number of leaves/plant and trunk diameter. It was also noticed that sucker production was more in tissue culture plants than that of off shoots plantations. However, spathe emergence was very early to offshoots plantations. During the year, flowering and fruiting was observed in cvs. A. V. Thomas,, Khuneizi, Yakoobi and Nagal. Average bunch weight was 0.5 to 2.0 kg. and number of bunches/plant varied from 3 to 8 in fruiting palms. The fruit maturity (doka stage) was observed in first week of July.

## Underexploited fruits

### Jamun

Promising genotypes of jamun have been established in the field. The average plant height ranged from 1.40 to 4.20 m, plant spread i.e. N-S-1.90 m to 3.60 m and E-W from 1.40 m - 3.60 m and stem girth from 15.00 to 52.00 cm. Studies on reproductive biology revealed that peak period of panicle emergence, flowering and fruit set were

Fig. 3. Patch budding

Fig. 4. Soft wood grafting

recorded in the month of February and March respectively in all genotypes. Panicle length ranged from 12.00 to 18.10 cm in different genotypes. Peak period of anthesis was recorded between 8 AM and 1 PM in all genotypes. Peak period of dehiscence was recorded between 9 AM and 2 PM in all the genotypes. Pollen viability ranged from 89 to 98 per cent (Figs 3-5b).

Deep purple colour on fruit surface was observed in all the genotypes during ripening. Percentage of total soluble solids was found to be 14.00, 15.00,

Fig. 5a Flowering in jamun

Fig. 5b Jamun fruits

13.50, 13.40, 14.10 and 14.50 per cent in GJ-1, GJ-2, GJ-3, GJ-4, GJ-5 and GJ-6 respectively during ripening, however titratable acidity was registered 0.39, 0.38, 0.34, 0.36, 0.38, 0.30 per cent in GJ-1, GJ-2, GJ-3, GJ-4, GJ-5 and GJ-6 respectively at the same stage. On the basis of physico-chemical attributes, fruits of GJ-1 and GJ-2 may be harvested by the 1st week of May, GJ-3 by 3rd week of May GJ-4, GJ-5 and GJ-6 by first week of June under semi-arid ecosystem of western India. Maximum fruit weight, pulp weight and TSS content were recorded in GJ-2.

Survey was made in the states of Gujarat, Karnataka, Bihar, Jharkhand, Uttar Pradesh and Haryana and bud sticks of different genotypes were collected and plants were vegetatively multiplied Twenty promising genotypes were studied for their flowering and fruiting. Peak-ripening time was recorded from first week of May to last week of June in different genotypes. Length of panicle ranged from 11.00 to 22.00 cm and number of fruits per panicle from 9.00 to 25.00 in different genotypes. Individual fruit weight ranged from 10.00 to 23.00 g and pulp percentage from 72 to 86. TSS per cent varied from 10.00 to 12.50 and also vitamin C content varied from 32.00 to 50.00 mg/100 g. Elite genotypes are being multiplied to establish in the field.

### Tamarind (*Tamarindus indica*)

Promising genotypes of tamarind have been established in the field. The average plant height ranged between 1.70 and 3.80 m, plant spread - N-S- 2.50 and 4.75 m, and E-W-2.50 m and 4.54 m and stem girth 27.00 and 48.20 cm. Tamarind genotypes like DTS-1, NTI-15, NTI-62, NTI-32 and NTI-75 were collected from UAS, Dharwad, Karnataka. Reproductive biology of existing germplasm indicated that the flowering was noted in PKM-1 (June) followed by Pratisthan and T-263. Peak period

Figs 6. Heavy bearing in promising Tamarind 13

of anthesis was recorded between 7 and 9 AM in all the genotypes. Anther dehiscence commenced at 8 AM to 12 noon and peak period was between 9 and 11 A.M. Flower developed in 17-26 days and pollen viability ranged from 82.50-93.10 per cent. Tamarind-13 recorded maximum panicle length and fruit set per panicle, fruit weight, pulp weight and TSS content. Highest pod weight and length (28.00g and 17.00 cm respectively) were recorded in Collection No. 40. However, the maximum percentage, TSS (72.00%) and total sugar (63.50%) were observed in Collection No. 38. However, maximum acidity (14.80%) was found in Collection

No. 41. On the basis of overall performance Collection Nos. 38, 45 and 46 were found to be promising. Twenty promising genotypes of tamarind were selected on the basis yield and fruit quality attributes at adjoining areas of Jagdalpur. Pod weight ranged between 16.00 and 31.50 g in different genotypes. Maximum TSS (70%) was recorded in Bastar Tamarind- 1 followed by Bastar Tamarind – 3 and Bastar Tamarind - 4 (Fig. 6).

### Chironji (*Bhchanania lanzam*)

Thirty promising genotypes of chironji are established in the field. The average plant height ranged between 0.93 m and 2.70 m, plant spread N-S 0.64 and 1.45 m and E-W 0.70 and 1.40 m and stem girth 13.00 and 28.00 cm. Peak period of flowering was recorded in the month of February in majority of the genotypes. Ripening time varied from third week of April to second week of May. TSS and vitamin C content of the fruit ranged from 18.0 - 22.5 per cent and 42.0 – 60.0 mg/100 g respectively. Kernel weight and kernel protein ranged between 0.09 and 0.14 g and 23.00 and 28.00 per cent respectively in different genotypes. These genotypes would be exploited as potential parents to develop high yielding stable genotypes (Figs 7-10).

**Figs 7-8. Chironji soft wood grafting**

**Fig. 9. Chironji CPT-7**

**Fig. 10. Chironji CPT-1**

### Mahua (*Madhuca latifolia*)

The average plant height in this crop ranged between 0.90 and 2.27 m, plant spread N-S 0.60 and 1.25 m and E-W 0.50 and 1.30 m and stem girth 8.00 and 22.00 cm. Plants have started flowering and fruiting under field conditions. Twenty new genotypes (MH 51- MH 71) were evaluated. Early

**Fig. 11. Soft wood grafted plants of Mahua**

**Fig. 12. MH-14**

**Fig. 13. MH-63**

flowering was observed in the 1st week of March in MH-60, while it was recorded late (2nd week of April) in MH-70. Ripening span in different genotypes was observed from 2nd week of May to first week of June. Dry flower yield varied from 32.00 to 50.50 kg/plant being highest in MH-71. Highest total soluble solids, total sugar and vitamin C content was recorded in flowers of MH-71, however, juice content was found to be highest in MH-63. Maximum fruit weight, seed weight, kernel oil and protein

content were found in MH-71. These genotypes would be exploited as potential parents to develop high yielding stable genotypes having good horticultural traits (Figs 11-13).

### Bael (*Aegle marmelos*)

At CIAH, Bikaner 17 bael germplasm were maintained in the field repository while 15 are maintained and evaluated at CHES, Godhra, Gujarat. The survival (80%) was better but vegetative growth was poor during early stage of growth under Bikaner conditions. During the year 2007, no genotypes were found free from frost affect. However, under semi-arid conditions, CISH Bael-2, NB-5 and Pant Aparna performed better. Inter-crops were grown under rainfed conditions and cluster bean was found suitable.

All the genotypes in CHES, Godhra exhibited significant difference for most of the growth characters. Studies on floral biology revealed that the flower bud emergence started from 30th April and continued up to 23rd June, while anthesis initiated from 22nd May and completed on 24th June. Bud length and width varied from 10.00 to 13.00 mm and 7.00 to 9.50 mm while flower length and width ranged between 12.00 and 19.00 mm and 25.00 and 35.00 mm respectively. Number of petals in different genotypes varied from 4 to 6 but majority of flowers showed four petals only. Stamen length varied from 6.75 mm (NB-7) to 9.00 mm (CISHB-2) and carpel length varied from 6.00 mm (Pant Aparna) to 9.00 mm (CISHB-2). Ovary length was recorded maximum in Pant Aparna (8.00 mm) and stigma length was recorded highest (3.50 mm) in CISH Bael-2, Pant Aparna and NB-7. Pollen viability was more than 95 per cent in almost all the genotypes.

### Wood apple (*Feronia limonia*)

Three new germplasm lines were collected from Manglage and Puniad villages in Baroda district. The trees are tall with 12-15 m heights in the panchayat land. Maximum fruit size was found to be 480 g. The shape of the fruit was round with 7 per cent TSS and a pulp to stone ratio of 1.60. The collection made from Puniad was cluster bearing in habit with 3-4 fruits in a bunch. The fruit weight ranged from 75 to 48 g, round in shape with a pulp skin ratio of 1.02. Comparative performance of *in situ* budded and nursery budded plants of wood apple germplasm during the year indicated that there were non-significant differences in respect of most of the growth parameters, except plant height. However, maximum plant height, stock scion diameter and plant spread was recorded in *in situ* grafted plants compared to nursery grafted plants.

### Karonda (*Carisa carandus*)

Seedlings of karonda collection from Godhra was raised during the year. Seven genotypes of karonda were evaluated but due to frost/low temperature, all genotypes were affected.

### Phalsa (*Grewia subinaequalis*)

During the year flowering and fruit set were noted in all genotypes. It was observed that irrigation is necessary at the time of fruit growth to achieve better yield. Due to less soil moisture conditions, fruit drop was also noted in all genotypes.

### Lasora (*Cordia myxa*)

Out of 65 collections, all collections were affected by frost/low temperature during the month of January by severe frost. However, new growth starts after manuring and irrigation employed to the plants and flowering and fruit set were observed in germplasm during March 2007.

### Cactus pear (*Opuntia ficus indica* Mill.)

The cladode of one thorn less type (*Opuntia* sp.) *was* collected from Nagpur and multiplied in the nursery. In clones 1269, 1270, 1271, 1280, 1281 and 1458 plant growth was better under multiplication. However, plants growth in other genotypes was not encouraging.

For cultivation of vegetable type (1308), irrigation is required to produce cladodes i.e. nopalitos for green vegetable and salad. Under germplasm evaluation, the better plant growth, flowering and fruiting was observed in clone 1270 and 1271 under arid conditions. The performances of other

genotypes are to be ascertained. The seedling of genotypes (IC 437338) is ready in the nursery for further planting and evaluation.

### Evaluation of exotic species

Exotic fruit species (Carob, Chinese jujube, Argan, Marula nut) were maintained in the repository. Better plant growth was also recorded in Marula nut (*Sclerocarryo caffra*). Effect of frost was minimum in Chinese jujube while Marula plant was highly affected by frost. Stem cuttings were tried for multiplication of Marula nut and it was observed that it can be propagated through stem cuttings with treatment of 1000 ppm IBA in arid region.

Marula nut (*Sclerocarya birrea* subsp. caffra Family- Anacardiaceae), a native fruit plant of South Africa and parts of eastern Botswana, was introduced. The fruits are juicy and seeds are very hard. The seeds were sown in the nursery after cutting the upper tip of the nut by saw for easy to germinate. Saplings were planted in the mother block of nursery and first time flowering and fruiting was observed during the month of October, 2006 under hot arid environment. Fast tree growth was observed but plants were sucessptible to frost during winter season. The fruits are yellow in colour, sweet in taste but pulp content was less. The average fruit weight 24.8 g and 3.6 × 3.4 cm size, T.S.S.11.7° brix and 6.92 g weight of stone was observed.

## Arid vegetables

### Cucurbits

In CIAH, Bikaner, a large number of landraces, local cultivars, semi-domesticated and wild forms of mateera/watermelon (*Citrullus lanatus*), roundmelon (*Praecitrullus fistulosus*), kachri (*Cucumis melo*), snap melon (*Cucumis melo* var. *momordica*), muskmelon (*Cucumis melo*), *kakdi* (*Cucumis melo* var. *utilissimus*), bottle gourd (*Lagenaria siceraria*) and *Luffa* gourds were collected, evaluated and maintained for the conservation and utilization in breeding programme.

One accession of mateera possessing red colour seeds was collected from Sardarshar (Churu) during 2006. The conserved landraces and genetic stocks of kakdi (non-dessertic forms of *Cucumis melo*) was maintained and multiplied for conservation. Bottlegourd collection AHLS 24 was evaluated under high temperature conditions during summer and rainy season of 2006. The current vegetable germplasm holding at CIAH, Bikaner is presented in Table 1.

### Kakdi (*Cucumis melo* var. *utilissimus*)

Nineteen lines of kakdi were evaluated for growth characters and biotic stresses and wider variability was observed (Fig. 14)

**Fig. 14. Variability in kakdi lines**

**Table 1. Working germplasm holding in vegetable crops at CIAH**

| Crop | Nos. | Crop | Nos. | Crop | Nos. |
|---|---|---|---|---|---|
| Mateera/watermelon | 65 | Bottle gourd | 20 | Chilli | 45 |
| Round melon | 10 | Ridge gourd | 20 | Brinjal | 30 |
| Muskmelon | 60 | Sponge gourd | 15 | Cluster bean | 5 |
| Snap melon | 65 | Bitter gourd | 4 | Indian bean | 30 |
| Kachri | 68 | Pumpkin | 4 | Sword bean | 1 |
| Kakdi | 18 | Ivy gourd | 1 | Other vegetables | 35 |

## Mateera (*Citrullus lanatus*)

**Large scale testing of mateera:** Mateera F6/a and Mateera AHW 19 were tested and the pooled data of important characters are presented (Fig. 15).

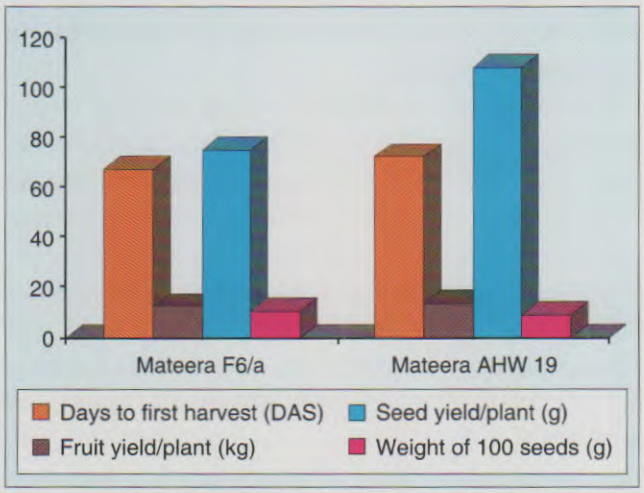



**Fig. 15. Performance of Tharm Manak**

**Mateera (Thar Manak):** Developed through selection from a cross combination of Mateera AHW - 19 × Sugar Baby. The first marketable harvesting starts in 70-80 days from sowing. The fruits are 2.65 to 4.21 kg in weight. Average number of marketable fruits per plant ranged from 2.59 to 4.22. Average fruit yield potential is 10 to 14 kg/plant. The fruits are free from cracking under extremes of arid conditions. The flesh is red, solid (firm), and granular and has good sugar content (9.5-11.2% TSS). The seeds are very big, bold and blackish in colour (Fig. 16).

**Fig. 16. Thar Manak (Mateera)**

## Bottle gourd (*Lagenaria scieraria*)

AHLS Round-1 (Thar Samridhi): The bottle gourd derived form a cross combination of Banswara Local–1 × Gujarat Local-1) was uniform and high yielder, very early harvest. 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, 12-14 cm in length and 28-30 cm in girth) can be harvested for the hugest quality yields. 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 hectare is 240 –300 q.

## Luffa gourd (*Luffa* spp.)

The advance genetic material of sponge gourd and ridge gourd and these lines were evaluated for agro-morphological characters and fruiting behaviour under the arid conditions. The purified genetic material of AHSG-4 was found to be superior for the earliest marketable and uniform harvesting, and produces better quality fruit and high yielding under high temperature conditions. The advanced material of ridge gourd AHRG- 8 was also tested for earliness and fruit yield potential.

## Sword bean (*Canavalia gladiata*)

**Varietal trial of sword bean:** To assess the yield potential of tender pods and seed yield in sword bean variety AHSB-1, an experiment was conducted during 2006-07 at CIAH, Bikaner. A study on growth

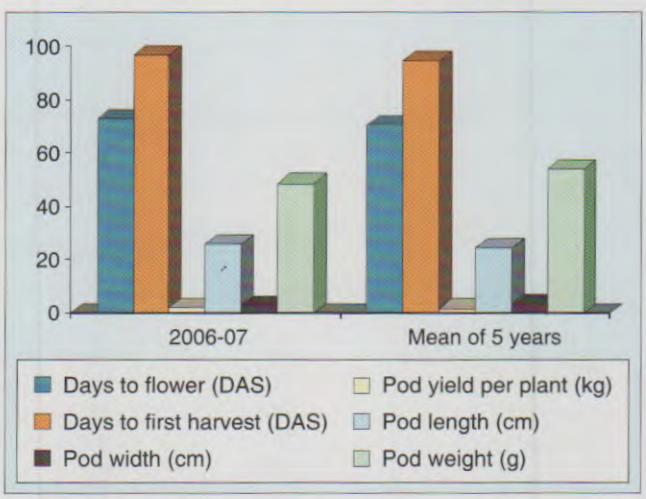



**Fig. 17. Performance of sword bean variety AHSB -1**

and development of pods was also done to standardize the stages of harvesting. Light shining 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 12-18 days after setting. The number of marketable tender pods ranged form 22.4 to 30.5 with a marketable yield potential of about 1.732 kg/plants. For seed production point of view, about 20 pods can be harvested resulting to seed yield potential of about 400 g/plant. The weight of 100 seeds is 190.58 gram. The performance of this variety and mean data of last 5 years are presented (Fig. 17).

### Indian bean (*Lablab purpureus*)

Two selected advanced lines were tested for flowering and fruiting behaviour under arid conditions. The variety AHDB-16 exhibited superiority for earliness (Second week of October) under high temperature conditions. It is high yielding, stable and found to be the most potential for commercial cultivation. For first marketable harvesting, it took 94.12 days in comparison to AHDB-3 (103.75 days). Flowering and first harevest were 10 days earielr (71.23 and 94.12 DAS) in AHDB-16. Pod yield was 1.882 kg/plant during this particular year. Similar trend was onderved in the performance of both the varieties over the 5 years also.

**AHDB -3:** It is a selection from the land races collected form tribal area of Gujarat. Develop through single plant selection for the highest quality early yields under the arid agro-climatic conditions of Rajasthan. Tender pods are 13.85 cm in length and 1.05 cm in width. Average weight of tender pod is 8.52 g. At marketable stages weight of pod pulp and send kernel is 7.03 g and 1.51 g, respectively. Pods ate soft and shining green in colour. The string is about 1.0 cm long. Average yield potential is 1.768 kg/plant. Plants medium in growth habit and about 3.0 m height. Flowers are purple in colour.

**AHDB-16:** It is a selection from a population collected from tribal area of Rajasthan. It is developed through single plant selection for the earliest harvest as early as in mid October and higher early yield under the arid conditions. Tender pods are 10.23 cm in length and 1.58 cm in width. Average pod weight at tender stage is 5.63 g. The weight of pod pulp and seed kernel is 3.76 and 1.85 g, respectively. Medium sized pods are whitish green in colour and sickle shape. Pods are smooth, soft and shining. The string is 0.35-045 cm in length. Average number of seeds/pods is 5.2. Kidney shaped seeds is yellowish white in colour. Average pod yield potential is 1.760 kg/plant. Plants are medium in growth habit and 2.75-3.25 in height. Flowers are white in colour.

### Cluster bean (*Cyamopsis tetragonoloba*)

**Performance of AHG -13:** It was developed through single plant selection for high quality vegetable pods. This genotype is purified for single stem type from the local germplasm collected from Churu district of Rajasthan (Fig. 18). This selection is also for the cultivation under arid agro-climatic conditions (<250 mm rainfall). It exhibited better response towards the favourable situations for higher yields. On the basis of experimental trials conducted over the seasons and years under varying situations (rainfed/limited irrigation adopting management of production sites) at CIAH, Bikaner, the analyzed data depicted the potentiality of this genotype for the cultivation under the arid agro-climatic conditions.

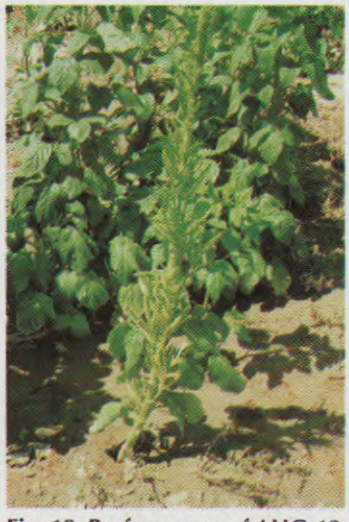


**Fig. 18. Performance of AHG-13**

The plant can attain an average height of 67.96-105.04 cm. The genotype is very early for first picking and took about 55 days from sowing. The number of pods/cluster and number of clusters/plant ranged form 8.09 to 13.43 and 8.47 to 13.82, respectively.

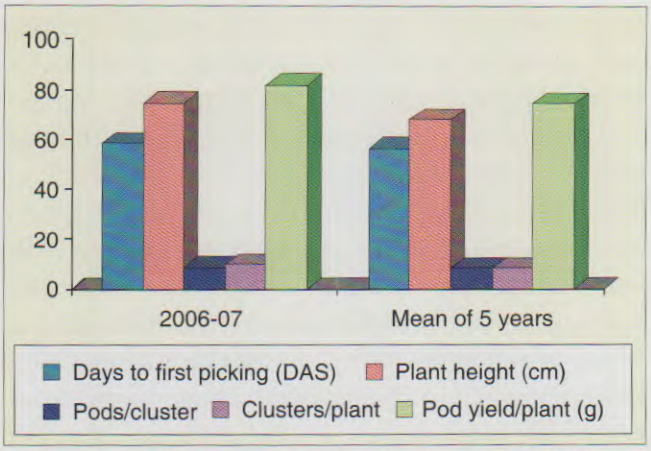



**Fig. 19. Performance of cluster bean variety AHG-13 under rainfed conditions**

Bearing starts from 2-3 node position from grounds level. The light green colour tender pods at marketable stages are 6.5-8.5 cm in length and 0.38-0.45 cm in width. The pod has 0.32 -0.51 cm long string. Average pod weight at marketable stage is 0.917 g and at fully grown green stage 0.87 g. The number of seeds/pod are 8-10. Under rainfed situation the yield potential per plant is ranged from 58.78 to 81.75 g as compared to from a field with life saving irrigations where it was recorded 116.75-210.5 g. Tender pod yield potential is 4.463-10.461 kg/4 $m^2$ plot area under varying situation of crop production.

The number of branches in the initial population was 1-3 and as a result of continuous selection for single stem type, now the purified material is in the ratio of 80:20 in which 80 per cent plants are of single stem type where as 20 per cent plants with one additional but productive branch after eight years of purification. Average internodal length in plant is 6.4 cm. The thickness of stem in the middle portion of the plant is about 1.32 cm. The number of bearing node goes as high as up to 22. Leaves are dark green and glossy. Leaf stalk is 5.5 cm in length. The length and width of upper and middle leaflets is 10.6 × 7.8 and 8.2 × 5.6 cm, respectively This selection is suitable for sowing as a spring-summer and rainy season crop (Figs 19-20).

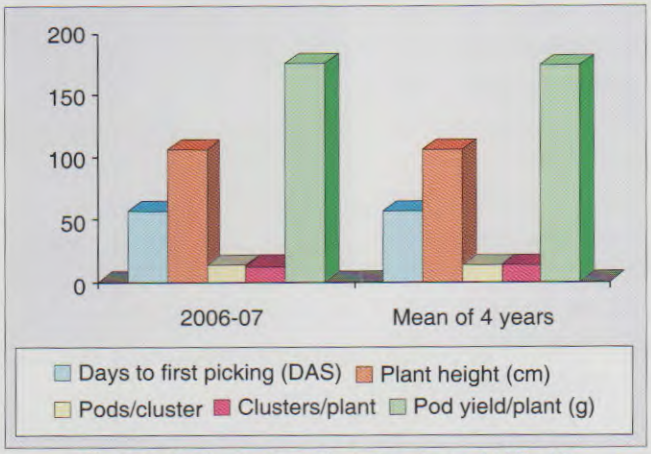



**Fig. 20. Performance of cluster bean AHG -13 under limited irrigated conditions**

## Khejri (*Prosopis cineraria*)

**Evaluation of khejri for *sangri* production**: Nine elite types top worked in khejri germplasm plot for *ex situ* conservation were evaluated. The genotype Khejri Selection –1 was high yielder for tender pods

**Fig. 21. Flowing of Thar Shobha**

**Fig. 22. Fruit setting of Thar Shobha**

and loong per plant with better quality. Recently this selection has been recommended for release at the Institute level as an improved variety for the commercialization of khejri as a horticultural crop and named as Thar Shobha.

**Khejri Selection 1 (Thar Shobha):** Since there is no standard variety in *khejri* for uniform and high quality sangri production under the traditional system of crop cultivation. Thar Shobha is the first improved genotype to develop plantations for better quality, uniform and higher sangri production on commercial scale. A five year grafted plant yields about 4.25 kg sangri and 6.27 kg loong in a year. Tender pod length ranged from 18.25 to 21.15 cm and weight 2.15 to 2.75 g. Tender pods of the variety are light green in colour, straight, roundish-flat, soft and sweet. The variety tolerates the extreme high and low temperatures, and aridity conditions (Figs 21-22).

## Biotechnology and tissue culture

### Micro propagation

In cactus pear (*Opuntia ficus indica* Mill) a micropropagation technique was tested. The cactus pear for a thornless, vegetable type elite genotype, which was collected under germplasm collection programmes was developed successfully through single bud explant. Physiologically mature buds on cladodes were collected and single bud segment was used for culture initiation in polybags. Maximum multiple shoots (8 explant) formation was achieved on MS medium supplemented with vermiculite, 3% sucrose, 4 g Agar and 2 mg BA+ 0.1 mg NAA. Micro-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.

Date palm, shoot bud formation in flower petals of female flowers of date palm cv. Halawi, embryogenic and callus in shoot tip culture of date palm have been observed. In case of ker, profuse axillary branching in ker, rooting in micro- shoot and hardening up to pot stages was noticed.

Preliminary studies were conducted on vegetative propagation of aonla, ber alovera have shown encouraging results in term of rate of multiplication, extension of propagation period, faster growth and development of rootstock under hi-tech glass house.

## Crop Management

### Planting models and Agro-techniques

### Evaluation of aonla based diversified cropping models in arid eco-system

The experiment comprises of four different cropping models viz., Aonla-Khejri-Sewan ($M_1$), Aonla-Pomegranate-Mateera-Gram ($M_2$), Aonla-Lime-Clusterbean-Fenugreek ($M_3$) and Aonla-Ker-Kachri-Cumin ($M_4$). The frost affected plants of aonla which exhibited cent per cent mortality during January 2006, were budded *in-situ* on two year old root stock. Cent per cent survival of the budded plants was recorded up to March 2007. Among the perennial components lime and pomegranate showed a very poor survival. However, cent per cent survival was recorded in *Prosopis* recording an average plant height of 1.2 m and stem girth 6.00 cm.

The ground storey crops performed well in the different cropping model without affecting the growth and development of main and component crops. Two cuts of *L. sindicus* was taken. Gram grown as a *rabi* season crop in $M_2$ recorded an average yield of 8.0 $qha^{-1}$. Cumin grown in $M_4$ did not perform well during the year under report.

### Planting systems

Under semi-arid conditions, an experiment on high density with five planting system. Considerable differences in vegetative parameters were observed among the evaluated planting systems. Plant growth was maximum (4.97 m) in double hedge row planting systems having maximum number of plants (222/ha) followed by cluster, and hedgerow planting system during 5$^{th}$ year of orchard (Fig. 23). However, maximum values for root stock girth, scion girth, and plant spread were recorded in square system of planting, but the differences among the various

# Crop Management

## Cropping System

- Aonla based cropping models
- Planting system in aonla
- High density planting

## Integrated Nutrient Management

- Nutrient management in pomegranate
- Leaf mineral composition
- Physiological activity
- Soil moisture content
- Soil fertility
- Yield and quality
- Irrigation and fertigation in kinnow
- Irrigation and fertigation in ber
- Irrigation and fertigation in pomegranate

## Organic Farming

- Vermicompost in Indian Aloe
- Biofertilizers in aonla
- Organic recycling in pomegranate
- Organic manuring in sapota
- Organic farming in vegetables

## Soil Water Conservation

- Soil fertility
- Soil water contribution
- Nutrients uptake
- Water use efficiency
- Yield and quality
- Physio-chemical properties of soil
- Organic mulching
- Drip irrigation in anola
- Single drip system in vegetables

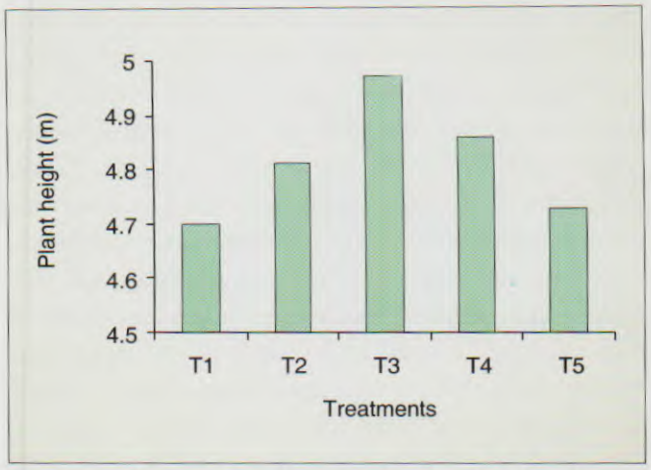



**Fig. 23. Planting systems on the plant height (m)**

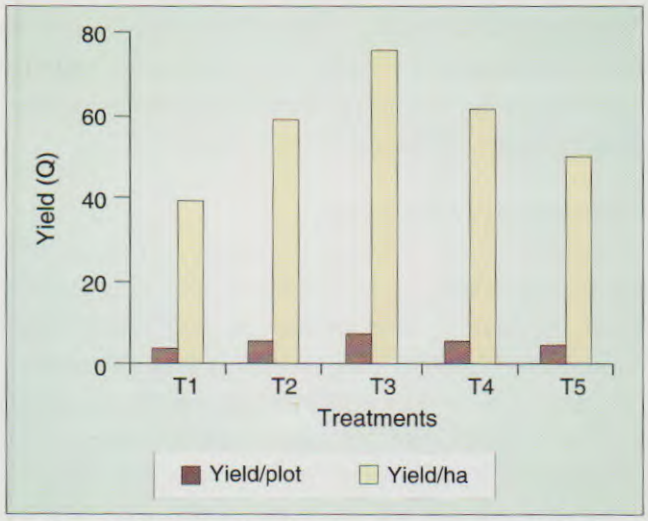



**Fig. 24. High density planting system on the yield of aonla cv. NA-7**

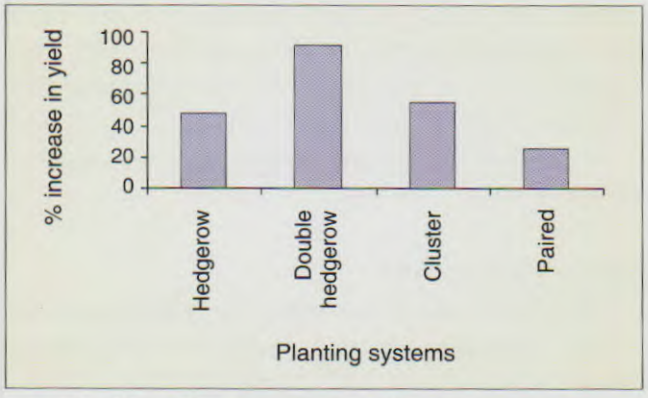



**Fig. 25. Percentage increase in yield over square system**

planting systems were non significant.

Results of study on the yield and attributing characters revealed that different planting system exhibited significant differences for the yield/plot and/ha. Yield per plot (680.00 kg) and per ha (75.48 q/ha) were significantly highest in double hedgerow system followed by cluster and hedgerow system of planting and it was recorded lowest in square system of planting (355.50 kg/plot and 39.50 q/ha). Fruit yield per plant (39.50 kg) was recorded highest in square system of planting, but the differences among the treatments were non significant during fifth year of orchard life under purely rainfed condition (Figs 24, 25). Percentage increase in yield over square system was recorded maximum in double hedgerow system (91.08) followed by cluster (55.26) and hedgerow (47.79) system of planting.

Various planting systems had pronounced influence on the quality attributes of aonla, but the differences among the various planting systems were non significant. Fruit weight (48.90 g), fruit length (4.17 cm), fruit width (4.38 cm) and fruit pulp (46.05g) were recorded maximum in the fruits of square system. The quality in terms of TSS (8.15°Brix), total sugar (5.00%) and vitamin C (498.00 mg/100 g) were recorded highest in double hedgerow system, among the different planting systems studied.

## High-density planting

In the seventh year of planting, various growth parameters were recorded. Maximum plant height, stock, scion diameter and plant spread was recorded in 10 × 10 m spacing. Data on flowering and fruiting indicated that the differences were non-significant in respect of total number of branchlet/shoot, branchlet with female flowers and branchlet with no flowers showed non- significant differences, except number of fruit set/shoot. However, all the above parameters were maximum in 10 × 10 m spacing. Maximum yield per plant (130.6 kg) was recorded in 10 × 10 m spacing while maximum yield per ha was recorded in 5 × 5 m spacing (400 plants/ha), giving a highest net return of Rs 1,77,800. The results indicated that, up to 7$^{th}$ year of age,

there is no adverse effect of close spacing on growth, yield and productivity of the Aonla cv. NA-7.

Sampling of aonla determinate and indeterminate shoots collected on different dates to work out nutrient composition in bearing, non-bearing shoots and at different stages of flowering and fruiting was carried out. The results indicated that indeterminate shoot have higher NPK content at the various crop growth stages compared to determinate shoots. In determinate shoots the nutrient composition showed increasing trend as the time passed in leaf, whereas in case of shoot and fruit it showed a decreasing trend, except potash.

## Integrated Nutrient Management

### Integrated plant nutrient management in pomegranate

The recommended doses of NPK (750g N, 250g P and 250g K) per plant per year were applied through 10 treatments along with control ($N_0$, $P_0$, $K_0$) in 10 years old orchard. The following are the treatments viz., $T_1$: sheep manure (SM) @ 30 kg/plant; $T_2$: cattle manure (CM) 35 kg/plant; $T_3$: Vermicompost @ 25 kg/plant; $T_4$: inorganic fertilizers (IF) through urea, $T_5$: CM: SM in 50:50 ratio; $T_6$: CM: VC in 50:50 ratio; $T_7$: CM:IF in 50:50 ratio; $T_8$: SM: VC in 50:50 ratio $T_9$: SM:IF in 50:50 ratio; $T_{10}$ VC:IF in 50:50 ratio and xi) control ($T_{11}$) in the month of June,

### Growth attributers

The plant height was measured during August to February. Over all data revealed that maximum plant height (2.95 m) was recorded in VC:IF in 50:50 ratio. The plant height in control treatment was only 1.85 m. Thus, best treatment i.e. vermicompost and inorganic fertilizer has recorded 60.0 per cent increase in plant height over control. In general also data revealed that organic sources of nutrients increased the plant height in comparison to inorganic fertilizer alone.

Tree volume was also maximum (12.50 $m^3$) in this treatment. The relative change in tree volume was also evaluated and data revealed that 85 per cent increase was recorded in VC:IF in 50:50 ratio over control. Observation on fruit setting infdicated a clear-cut difference was observed in fruit setting in different treatments. Data revealed that fruit set was 80 to 85 per cent in $T_{10}$, $T_3$, $T_1$, $T_6$ and $T_8$ which were statistically at par while in $T_2$, $T_4$, $T_5$, $T_7$, $T_9$ and $T_{11}$ (control). The fruit cracking in pomegranate was predominant under arid condition and therefore, extent of cracking and pattern of cracking was also observed in different treatments. It was also noticed that cracking mostly starts after 35-50 days after setting. Apparently, it was also observed that cracked fruit have hard and distorted black skin in comparison to non-cracked fruits skin was red and yellow in colour. Fruit weight was in the ranging 125 to 275 g. Maximum fruit weight (275 g) was recorded in $T_{10}$. In control treatment the fruit development was very poor and matured fruit skin was very hard and aril size was also small while in vermicompost with inorganic fertilizer treated plants have big size of fruit, attractive colour of arils.

### Leaf mineral composition

Nitrogen content was in the range of 1.55 to 2.50 per cent and maximum N content was recorded in $T_3$, $T_1$, $T_{10}$ and $T_8$ and minimum in $T_{11}$ treatment. Maximum P content was estimated in $T_3$, $T_6$ and $T_8$ treatments. K content was estimated in the range of 1.50 to 2.25 per cent and maximum K content was recorded in $T_3$ treatment and minimum in control treatment. Among the micronutrients, zinc was in the range of 40 to 60 ppm and maximum content was measured in $T_3$ and $T_8$ treatment and minimum in $T_2$, $T_4$, $T_7$ and control ($T_{11}$) treatments. The Copper content was estimated in the range of 5 to 7 ppm and statistically at par in all treatments. The iron contents were in the range of 55 to 110 ppm. The maximum iron content was observed in $T_{10}$, $T_3$ and $T_7$ treatment while minimum was in control treatment.

### Physiological activity

The physiological parameters like photosynthetic activity, transpiration rate, water use efficiency; stomata conductance and stomata resistance were measured during vegetative and fruiting stages of

pomegrante. The photosynthetic activity ($P_N$) was in the range of 0.32 to 0.75 mg $CO_2$ $m^{-2}$ $s^{-1}$. The maximum $P_N$ activity was recorded in $T_8$ and $T_3$ (0.7500 mg $CO_2$ $m^{-2}s^{-1}$), $T_6$ (0.5 mg $CO_2$ $m^{-2}s^{-1}$). The minimum activity (0. 3200 mg $CO_2$ $m^{-2}$ $s^{-1}$) was recorded in $T_4$ and $T_{11}$ treatments. The transpiration rate was recorded in the range of 1.60 to 1.9 mg $H_2O$ $m^{-2}$ $s^{-1}$. The mean maximum transpiration rate (1.900 mg $H_2O$ $m^{-2}s^{-1}$) was recorded in $T_{11}$ treatment followed in $T_4$ (1.850 mg$H_2O$ $m^{-2}s^{-1}$), $T_5$ and $T_7$ treatments and minimum water transpired (1.5 mg $H_2O$ $m^{-2}$ $s^{-1}$) was in treatment $T_{10}$ followed in$T_8$, $T_2$ $T_3$ and $T_6$ treatments. The maximum water use efficiency (53.33%) was estimated in $T_8$ treatment followed in $T_{10}$, $T_3$, $T_6$ and $T_5$ treatments. The minimum water use efficiency (23.53%) was recorded in $T_{11}$ control treatment. The stomata resistance and stomata conductance was in the inversely proportionate to each other and among the treatments, they were differed significantly.

## Soil moisture content

Data of soil moisture revealed that maximum soil moisture (10-11%) up to the vertical depth of 20 cm was recorded in $T_3$, $T_1$, $T_2$ $T_6$ and $T_8$ treatments and minimum soil moisture (5.5-6.5%) at the same depths was observed in $T_4$ and control. At 40 cm vertical soil depth, the maximum soil moisture (7.5 to 8.0%) was recorded in $T_3$, $T_8$ and $T_{10}$ treatments and minimum moisture was recorded in $T_4$ and $T_{11}$ treatments. At 100 cm soil depth, soil moisture was recorded to the tune of 14 to 16 per cent in all treatments and soil moisture contents were statistically at par in all treatments. The depletion revealed that the maximum moisture depletes from 20, 30 and 40 cm soil layers in $T_1$, $T_2$. $T_3$, $T_6$, $T_8$ and $T_{10}$ while in $T_4$ and $T_{11}$ the depletion was from 10-20 cm depths.The depletion in moisture was more and fast in control and inorganically fertilized treatments while in organically treated cases, the depletion was slow and gradual. In organic manures treatment.

## Soil fertility

The status of different physico-chemical characteristics of the soil indicated the changes in soil fertility in respect of soil pH, organic carbon, electrical conductivity, available contents of N, P, and K contents. The organic carbon content was only 0.09 per cent initially and reached to 0.30 per cent after eight years. The maximum organic carbon (0.35%) was estimated in $T_3$, $T_6$ and $T_8$ and $T_{10}$ treatments and maximum available nitrogen (210 kg/ha) build up was in $T_{10}$. The available P content was only 12.5 before deployment of treatments and reached to the maximum (26.0 kg $ha^{-1}$) in $T_{10}$ treatment while in control treatment the status of available P has gone down in comparison of initial level. The available potassium content also increased in all treatments, except control one. The K content has increased from 184.6 kg $ha^{-1}$ to 260.0 kg $ha^{-1}$ in $T_{10}$ treatment followed in $T_3$ and $T_8$ treatments

## Yield and quality

On each plant 80-90 fruits were retained for yield purpose. Maximum fruit yield per plant (16.5 kg) was recorded in $T_{10}$ treatment and it was statistically at par with yield in $T_3$, $T_6$ and $T_8$ treatments. The minimum fruit yield was 10 kg in control treatment. The data revealed that fruit yield was found in the range of 25.0 to 42.00 q $ha^{-1}$. The maximum and significantly higher fruit yield (42.00 q $ha^{-1}$) was recorded in $T_{10}$ treatment. The increase in fruit yield in different treatments over control was also estimated and found that maximum (105.50%) increase in fruit yield was recorded in $T_{10}$ treatment.

In control treatment, marketable fruits were about 25 per cent while in $T_{10}$ treatment, the marketable fruits were 65 per cent followed in $T_3$ (62%) and statistically at par in $T_6$ and $T_8$ treatments.The fruit quality of pomegranate indicated that the total soluble solids in different treatments were in the range of 15 to 17° brix. The maximum TSS content (17.5° brix) was estimated in $T_3$, $T_6$, $T_8$ and $T_{10}$ treatments. Fruit juice acidity was in the range of 0.14 to 0.22 per cent. The ratios of these two parameters i.e. TSS and juice acidity were also estimated to evaluate the fruit quality and data shows that this was in the range of 65.00 to 125.00 and the maximum value (125.00) was observed in $T_8$

treatments while it was minimum in $T_{11}$ treatment. Lower values of TSS/Acidity reflect the poor quality of fruits while higher values show the additive factor of fruit quality.

## Irrigation methods and fertigation schedules in arid fruit crops

The study was undertaken on kinnow, ber and pomegranate fruit crops at research farm of CIAH, Bikaner. In each crop four irrigation methods viz., drip ($I_1$), micro sprinkler ($I_2$), pipe ($I_3$) and open channel ($I_4$) at three irrigation levels viz., 1.00 CPE ($L_1$), 0.75 CPE ($L_2$) and 0.50 CPE ($L_3$) and four fertigation namely125 ($F_1$), 100 ($F_2$), 75 ($F_3$) and 50% ($F_4$) of recommended nitrogen) schedules along with the control treatment (open channel with 100% recommended dose of N fertilizer) were tried to evaluate the efficacy of different irrigation methods and fertigation schedules. The crop wise achievements made in the project are envisaged here.

### Kinnow

The Kinnow fruit crop was seven year old and water requirement was worked on the basis of open pan evaporation. The maximum plant height 3.25 m was recorded in $I_2L_2$ treatment Overall data revealed that drip irrigation at 0.75 CPE level and micro- sprinkler at 1.00 CPE level are giving maximum plant growth. The leaf nutrient status (N, P, K and Zn) was estimated in different irrigation systems and observed that maximum N content (2.20%) was estimated in $I_1L_1$ treatment and it was statistically at par with $I_1L_2$ and $I_2L_2$ treatments. Same pattern was also recorded in case of phosphorus and potassium content. Zinc content was not significantly differing among the treatments except control where zinc content (25 ppm) was significantly lower.

**Fig. 26. Kinnow under micro-irrgation**

The fruit development was recorded in different treatment and data revealed that in drip and micro-sprinkler systems with 1.00 and 0.75 CPE irrigation levels, the fruit development (change in fruit weight) was rapid while in other treatments. The maximum fruit yield (95 q $ha^{-1}$) was recorded in $I_2L_1$ and which was statistically at par with $I_1L_1$ and $I_2L_2$ (90 q $ha^{-1}$) and in remaining treatments the fruit yield was significantly lower. Accordingly water use efficiency was also computed and observed that maximum water use efficiency (2.64 q/ha-cm) was recorded in $I_2L_2$.

Different nitrogen levels i.e. 125, 100, 75 and 50 per cent of recommended dose were applied through drip, and micro sprinkler and bubbler systems of irrigation and 100% recommended dose of N with open channel method of irrigation be taken as control.

The data revealed that the 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). The lowering the level of nitrogen dose by 25 per cent than recommended dose also did not significantly reduced the fruit yield. The quality parameters i.e. juice recovery, number of seeds, TSS and juice acidity of matured fruits were also evaluated. Maximum fruit juice (56.5%) of total fruit weight was recorded in 1.00 CPE through drip, which was statically at par with 1.00CPE through micro sprinkler and 0.75CPE through drip (Fig. 26).

### Ber

The fertigation schedule was given in 16 splits and irrigation requirements were computed on the basis of open pan evaporation and applied through

respective irrigation system. The maximum plant height (3.50 m) was recorded in $I_1L_1$ irrigation level, which was statistically at par with $I_2L_1$ and $I_2L_2$ irrigation levels and minimum plant height (2.50 m) was observed in $I_4L_1$. The fertirrigation levels also influenced the plant height and 75 per cent recommended dose of N through drip and micro sprinkler, plant height was statistically at par. In similar way, canopy volume was also in the same pattern. The development, quality and yield of fruit were also evaluated. It has been observed that the fast gain in fruit weight was recorded in $I_1L_1$ and $I_2L_1$ and $I_2L_2$ treatment during November to January months. The colour turning was recorded in the month of last week of January. Maximum yield (58.50 q ha-1) was recorded in $I_2L_1$ and which was statistically at par with $I_1L_1$ (54.0 q ha-1) and $I_2L_2$ (53.5 q ha-1) treatments. The minimum fruit yield (22.5 q ha-1) was recorded in control treatment ($I_4L_1$). It has been observed that reducing the amount of irrigation water up to 25 per cent in drip system did not reduce the fruit yield while in micro sprinkler, the reduction in yield was observed while in pipe and open channel systems fruit yield reduced even at 1.00 CPE level.

The quality parameters i.e. TSS, pulp stone ration and juice acidity of matured fruits were also evaluated. The data presented in the table revealed that maximum TSS (19.5 degree brix) was measured in $I_1L_1$, $I_1L_2$, $I_2L_1$ and $I_2L_2$ treatments in pipe and open channel system at all irrigation levels, the TSS was only 17.5° brix.

Application of excess amount of N fertilizer (125% RD of N) did no increase the fruit yield, plant height and canopy volume of the trees in ber crop. On the other hand in drip fertigation on application of 75 per cent recommended dose of N effectively increased the fruit yield by 125 and 100 per cent RD of nitrogen fertilizer of drip and micro sprinkler fertigation. Further it was also observed that application of different levels of N through pipe and open channel systems did not increased the fruit yield and plant height. In fruit quality parameters in N fertigation through drip and micro sprinkler increased the pulp content over open channel fertigation system.

## Pomegranate

The data pertaining to plant height, canopy volume, fruit cracking, leaf nutrient content, quality and fruit yield was recorded. Data pertaining to plant height revealed maximum plant height (2.10 m) was recorded in $I_2L_1$ and minimum (1.30 m) in control ($I_4L_1$) treatment. The maximum canopy volume (16.50 $m^3$) was also recorded in $I_1L_1$, $I_2L_1$ and $I_2L_2$ treatments and minimum (11.25 $m^3$) in control treatment. The fruit cracking was recorded to the tune of 30-35 per cent in all treatments and neither irrigation system nor irrigation level changed the cracking behavior of the crop. Maximum fruit yield (48.5 q $ha^{-1}$) was recorded in $I_2L_1$ followed in $I_1L_1$ (45.0 q $ha^{-1}$), $I_2L_2$ (43.0 q $ha^{-1}$) and minimum fruit yield was recorded in control (21.50 q $ha^{-1}$).

The fertigation also increased the fruit yield, plant growth and data revealed that maximum fruit yield (43.5 q $ha^{-1}$) was obtained with 125 per cent RD of nitrogen fertilizer while it was statistically at par with 100 and 75 per cent RDN through drip irrigation system. Maximum plant height and canopy volume was also recorded in drip and micro sprinkler fertigation at 125, 100 and 75 of RDN. In pipe and open channel system fertigation, both parameters were statistically lower than earlier systems. Nitrogen fertigation also did not affect the fruit cracking and irrespective of any treatment the cracking was to the tune of 30-35 per cent (Fig. 27).

**Fig. 27. Pomegranate under drip irrigation**

### Moisture extraction pattern

The soil moisture contents at different depths (vertical) and horizontal distance from the main stem after irrigation was monitored through Time Domain Reflectrometry (TDR) in Kinnow and pomegranate. Soil moisture depleted (15.5 to 9.0%) at depths from 30 to 60 cm, whereas, the reduction in moisture level was low at 10 to 20 cm (15.5 to 12.8%) and at 60 to 100 cm (19.7 to 18.5%) depths under drip and micro irrigation systems. Similar pattern was also observed with pipe and open channel systems and it was maximum at 10 to 30 cm depths (15.5 to 10.0%). Thus, moisture depletion pattern revealed that plant extract the maximum moisture from 20 to 60 cm soil strata where feeder roots of the kinnow and pomegranate plant exists. In deeper layers (60-100 cm) it has been observed the changes in soil moisture content is very low and soil remains in field capacity level while in middle layers (20-60 cm), the depletion in soil moisture was rapid.

## Organic and biodynamic farming

### Vermicompost

The vermicompost was prepared using the local available farm waste like neem, ardu, khejri and banana (from roadside waste) leaves and cattle manure. It ha been observed that graminaceous material take long time (72 days) while in protinaceous material and soften raw material (banana leaves) take only 60 days in the month of March to June. The optimum moisture content ranged from 28 to 35 per cent of dry weight basis.

### Performance of Indian aloe

The different packages of organic and biodynamic preparation were tried in Indian aloe. The combination of vermicompost, spray of BD-501 and inorganic N gave the maximum number of pad per plant, number of suckers and pad thickness while completely inorganic fertilizer and spray of BD-501 gave the minimum number of pads, suckers and pad thickness

## Biofertilizers

### Aonla

A field trial was conducted to study the effect of biofertilizers i.e.*Azotobactor, Azospirillum*, PSB and VAM in combination with Farm Yard Manure on soil properties, growth, yield and quality attributes of aonla NA-7. Considerable improvement in soil properties in terms of bulk density, hydraulic conductivity, pH and ECe were observed by application of different biofertilizers and organic manure. Bulk density (1.34 g/cc) was high in soil treated with FYM+*Azotobactor* +VAM. Hydraulic conductivity showed reversed trend and as result there were considerable improvement in the soils in which biofertilizers and manure were applied. Maximum yield (32.25kg) was recorded in this treatment. The differences among the various biofertilizer and manure combinations were non significant for yield and yield attributing characters.

### Organic manure and fertilizers

The results of all combinations of organic sources of nutrients improved the soil properties than inorganic fertilizers. Significant improvement was observed in soil properties owing to application of different cakes along with FYM plus CPP. Vegetative growth was recorded significantly highest in the plants treated with st. dose of N P K plus FYM. An improvement in yield and yield attributing characters were observed by the application of various organic sources of nutrients. Yield/plant (33.15kg) was recorded from the trees which wee treated with FYM +St. dose of NPK followed by FYM + half dos of NPK and FYM + cakes + CPP.

## Pomegranate

### Organic recycling on growth, yield and quality of pomegranate cv. Ganesh

Application of leaf litter (Subabool, Neem, Sun hemp and Dhaincha @ 5kg/plant) had non-significant effect on growth characters like plant height and spread, however stem diameter was

significantly influenced. The rotten samples of leaf litter analyzed for NPK content indicated that Subabool leaf litter had maximum and sun hemp had the least NPK content.

Leaf relative water content (RWC) on 3rd day after irrigation indicated significant differences among treated and control plants Composition of leaf in respect of NPK content was significantly influenced by application of leaf litter. Maximum N was recorded in Subabool application and minimum in control. Almost similar trend was observed in respect of P and K content. The results indicated that application of leaf litter increases the nutritional composition of leaf.

Data on soil moisture content at different intervals and its composition in respect of PH, Electrical conductivity and organic carbon content were significantly influenced. Soil moisture was highest in sun hemp and Subabool even before application of irrigation compared to control after application of irrigation, moisture retentation was highest where leaf litter was applied. There was reduction in soil PH values; electrical conductivity compared to control, organic carbon content was however, increased indicating improvement in soil health.

## Sapota

### Effect of organic manure

The results of the studies revealed that, application of different fertilizers treatment had no significant effect on growth parameter of sapota cv. kallipatti. Maximum no of fruits/shoot were retained (37 no/shoot) and yield/plant (94.55 kg/plant) in application of castor cake. Data on soil moisture retention indicated that maximum soil moisture (14.51%) on oven dry wt. 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 increase in yield over control.

## Semi arid vegetables

### Organic farming

An experiment was conducted in vegetables with different forms of organic matter like FYM, Vermi compost, poultry manure and sheep manure with biofertilizer combinations like *azatobacter* and *azospirillum* and PSB taking Bottle gourd and Sponge gourd as test crops with four replications in rainy season of 2006. Bottle gourd applied with vermi compost resulted significantly high yield (88q/ha) followed by the same receiving poultry, sheep manure and FYM respectively. In sponge gourd also the maximum yield was observed in vermi compost treatment (41.87q/ha). Between two sources of bio fertilizers *Azatobacter* proved better compared to *Azospirillum in both* bottle gourd and sponge gourd.

## Soil and Water Conservation

Different soil moisture conservation measures on changes in fertility status of soil, soil water contribution, hydrothermal regimes, leaf nutrient concentration, nutrient uptake, water use efficiency, yield and quality of brinjal have been investigated under arid conditions.

### Fertility status of soil

Soil water conservation measures were observed to be effective in improving the physical condition of soil, however, the differences were non-insignificant. About 2-7 times increase in organic carbon content was recorded in the treated plots over control. A substantial decrease in $CaCO_3$ content in the surface soils of the treated plots was recorded. The slight increase in available phosphorus content was noticed in the treated plots. The remarkable changes in soil K status were recorded in the treated plots. The treated plots recorded less soil K as compared to control.

### Soil water contribution on fruit yield

The maximum water contribution was recorded under FYM mulched plots (20.80 mm) followed by plots mulched with cluster bean (*Cymopsis tetragonoloba*) residues (16.59 mm). The efficiency

of FYM incorporation (15.54 mm) treatment towards soil water contribution was at par with the cluster bean straw mulch (16.59 mm). At 15 and 30 cm soil depth, the FYM mulch treatment was observed to have conserved maximum soil moisture (8.5-50.5%) followed by cluster bean straw mulch (18.5-48.7%) per 0.15 m soil depth as compared to control during the crop growth period. While at 15 cm depth, FYM and cluster bean straw mulches were best with regard to moderating the soil thermal regime.

### Leaf nutrients and their uptake

The maximum concentration of N (3.80%), P (0.76%) and K (4.24%) in brinjal leaf was recorded in the plots mulched with FYM followed by plots mulched with cluster bean (3.50, 0.76 and 3.10% respectively). These soil moisture conservation measures significantly increased the uptake of N, P and K by leaves of brinjal. The highest uptake of N (256), P (51) and K (286) kg $ha^{-1}$ was noted under FYM mulch treatment.

### Water use efficiency

The brinjal crop grown in FYM mulched plots experienced maximum water use efficiency (138 kg/ha mm) followed by plots treated with FYM incorporation (129 kg/ha mm). Among the crop/grass mulches, brinjal grown under cluster bean residues mulch had shown maximum water use efficiency.

### Growth, yield and quality

FYM mulch, cluster bean residues mulch, FYM incorporation and *Aerva* (*Aerva pseudotomentosa*) residues mulch was 58, 49, 43 and 43 per cent respectively higher than the control. FYM mulch treatment also produced maximum fruit yield (260 q/ha), which was followed by cluster bean straw mulch (250 q/ha) as compared to control (90 q/ha). FYM mulch produced fruit with higher TSS, protein, vitamin A, b-carotene and other morphological features of the fruit over the other treatments. However, acidity and ascorbic acid were maximum in control and cluster bean straw mulch respectively.

### Changes in physico-chemical properties of soil in ber

The impact of leaf litter decomposition and changes in soil properties of 10 years old plantation of *Ziziphus mauritiana* was investigated. Soils beneath the canopy calcareous in reaction (pH 8.0-8.1). Surface soil near the basin of the tree recorded less $C_aCO_3$ content (1.5%) as compared to soil of interspaces (3.0%) and control (5.0%). Electrical conductivity and organic carbon content varied from 0.19 to 0.24 $dsm^{-1}$ and 0.09 to 0.39% respectively. Tremendous increase in organic carbon content (13%) of the soil was recorded below the canopy. Available N (130-188 $kgha^{-1}$) and K (274 to 412 $kgha^{-1}$) content beneath the tree canopy were considerably higher than that of bare field. No significant increase in available P content was recorded near the basins of the tree.

The exchangeable cations ($Ca^{++}$, $Mg^{++}$, $K^{+}$ and $Na^{+}$) and calcium content near the basins of tree were two fold higher (3.3 to 8.6 meq/100 g). Potassium was 5-6 fold (1.3 to 2.5 meq/100 g) increased as compared to control. A remarkable decrease in exchangeable magnesium and sodium content were recorded.

### Organic mulching in aonla

Under semi-arid conditions, organic (paddy straw, maize straw, and grasses, subabool lopping and rice husk) and synthetic (black polythene) mulches encouraged the plant growth and reduced the soil moisture evaporation than control. Soil moisture content was highest in black polyethylene mulch closely followed by paddy straw, and it was lowest under control (under no mulched condition). Paddy straw showed better response followed by maize straw and subabool loppings. The bulk density showed reversed trend and as a result, maximum bulk density was observed in no mulch condition (1.40 g/cc) followed by rice husk (1.37 g/cc) and it was recorded lowest with paddy straw mulch (1.27 g/cc). Hydraulic conductivity was recorded highest in paddy straw (0.43 cm/h) followed by maize straw (0.39 cm/hr) while minimum (0.31 cm/hr) was found

with control (no mulching). All mulching material showed reduction in soil pH and ECe values when compared with control. Organic carbon, N, P and K were recorded maximum with paddy straw mulch and it was recorded lowest in black polythene mulch even less than control.

Among the various mulches studied, maximum plant height (4.95 m), root stock girth (37.78 cm) and scion girth (30.00 cm) was recorded with black polyethylene while it was recorded minimum in control. Plant height (4.87 m), rootstock girth (37.46cm) and scion girth (29.45cm) were recorded maximum with paddy straw closely followed by maize straw, subabool loppings and grasses, among the organic mulches evaluated. Nitrogen content in plant tissues was recorded highest in the plant treated with paddy straw mulch (2.79%). Similar trend was also observed with respect to P and K content in aonla shoots. Calcium, magnesium and sulphur were highest i.e. 1.43, 0.75 and 0.27 per cent, respectively, in paddy straw mulched plants, which was closely followed by subabool lopping and maize straw, but the differences among the treatments were non-significant.

### Double ring system of irrigation in aonla

A double ring method of irrigation was adopted for water management in the full bearing trees of aonla. The size of outer ring of the system was maintained 2.0-2.5 feet wide depending on canopy structure and the remaining inside area was kept free from water application and irrigation water applied to the outer ring area where maximum roots confined and take maximum advantages of the applied water. Under this method of irrigation 50-60 per cent water could be saved and the maximum fruit size and weight was observed as compared to conventional ring method where excessive water is applied through single ring method which highly favourable for weeds growth.

### Drip irrigation in aonla

Under semi-arid conditions, this experiment was conducted with seven treatments comprising of three intensities (20, 40 and 60% wetted area) and two frequencies of drip irrigation (alternate day and 4 days interval) and control. The maximum annual increase in the height of plant (0.84 m) was recorded from the plants of alternate day irrigation with 60 per cent wetted area. The stem girth (10.05 cm) and plant spread (E-W-0.65 m and N-S-0.60 m) were also maximum under the same treatment. Yield per plant was influenced significantly by different treatments. Yield of 38.50 kg per plant was recorded when irrigated at alternate 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 also the highest percentage of N. P. K. Ca and Mg in the aonla shoots.

### Single drip system in arid vegetables

In kachri (*Cucumis melo*), under irrigation management practices, single line drip system (2.0 m × 0.50 m) was found to be most potential over all other treatments. The improvement in yield was about 25% higher over channel system of irrigation. Where as, mulching with dry hays and weeds in the vine spread areas of crop gave better results than control. In general, the range for first marketable harvesting was from 68.-74 days under various treatment combinations. The number of fruits/plant and seeds/fruit ranged from 16.8-24.5 and 310-355, respectively. The seed yield per plant is about 85 g. The weight of 100 seeds is 1.033 g.

### Snap melon (*Cucumis melo* var. *momordica*)

Under recommended open furrow (channels) system of crop cultivation the snap melon variety AHS-10 recorded an average yield potential of 228 q/ha. Significantly higher fruit yields of 19.5 per cent under single line drip system and 12.5 per cent with mini-sprinkler have been recorded over channel system. Similarly, dry hay/weed mulch improved fruit yield by 22.4 per cent and foliar application of $GA_3$ by 19.4 per cent as compared to control in snap melon. Variety AHS-10 recorded seed yield of about 22 g/fruit with average 865 seeds/fruit. The weight of 100 seed is 2.549 g.

# Crop Physiology and Post-harvest Technology

## Crop Physiology

- Water stress on growth and development
- Phytochemical efficiency
- Light interception and photosynthesis
- Date palm suckers production

## Post-harvest Technology

- Storage on aonla
- Storage on ber

## Crop physiology and post harvest technology

### Crop Physiology

#### Impact of water stress on seedling growth and development

In order to study the effect of water stress on seed germination and seedling growth a pot experiment was conducted using mateera and watermelon. For assessing the germination behavior in above crops, the seeds were germinated in petridishes containing PEG solution of different water potential. The germination percentage declined with the imposition of water stress. When the seeds were irrigated with PEG solution of –0.2 MPa the percentage germination dropped to 10-13 per cent. Similarly, the germination was delayed and reduced when the seeds were irrigated with PEG solution having water potential of 1.0 MPa. On the contrary, the seeds of mateera germinated upto 80 per cent when irrigated with pure water. However, under water stress the per cent germination declined marginally.

An experiment was conducted in pots to study the effect of water stress on growth and development of seedling. Fifteen seeds of mateera or watermelon were sown in plastic pots and irrigated daily upto 5$^{th}$ day after sowing. Thereafter, the irrigation was stopped in one set and the other set was irrigated regularly. The observations were recorded on 2, 5 and 7 days after imposition of stress. In mateera, length of shoot at 7 day after sowing was 17.12 cm in control whereas as the same was 14.53 cm under stress. Similar trend was also observed in other parameters. However, in watermelon, the magnitude of reduction in plant morphological parameters were more as compared to mateera. This is illustrated by the fact that the length of shoot at 7 days after sowing was 20.22 cm in control which dropped to 16.32 cm under water stress. The results revealed that the mateera can tolerate the water stress even at the seedling stage as compared to watermelon.

#### Photochemical efficiency of mateera and watermelon

The impact of water stress on morphological and photosynthetic parameters have revealed that the rate of photosynthesis declined in watermelon with imposition of water stress. In order to further evaluate the effect of water stress on photochemical efficiency, an experiment was laid out in the field and water stress was imposed by with holding of irrigation at 30 days after sowing. The photochemical efficiency in terms of Fv/Fm was estimated using Plant Stress Monitor. It was observed that at 15$^{th}$ day after with holding of irrigation, the photochemical efficiency in mateera remains fairly constant (0.67 in control and 0.63 in stress). However, in case of watermelon, it was observed that photochemical efficiency reduced by 30 per cent showing thereby that imposition of water stress in watermelon hampers even the photochemical pathway and thus reduced the rate of photosynthesis.

#### Variation in light interception and photosynthesis rate in ber

The ber plants have either upright or dropping type of canopy structure. Therefore, in order to assess the light intercepted by leaves at different level of canopy, an experiment was conducted using cv. Gola of ber that has a drooping type of canopy. The data was recorded with the help of CI –340 Photosynthesis system. The observations were recorded on the outer most whorl of leaves, the leaves in the middle and the leaves near the tree trunk. It was observed that outermost leaves are fully exposed to sunlight, hence receives full solar radiations reaching the ground. The rate of photosynthesis is also maximum in these leaves. The leaves which are in the middle of canopy gets only 50 per cent of the solar radiations falling on the tress and has low rate of photosynthesis (7.56 µmol $m^{-2}$ $s^{-1}$). Similarly, the leaves in the inner most layer received only 10 per cent of the light incident on the tree and has the least rate of photosynthesis (2.10 µmol $m^{-2}$ $s^{-1}$). The results demonstrated that the canopy of cv. Gola is highly

efficient in trapping the solar radiation incident on it. The leaves in different whorls have different rates of photosynthesis which reflects their contribution to the carbon budget of the plants. The majority of the carbon is fixed in outermost leaves followed by middle leaves. The leaves in the inner most layer has very low rate of photosynthesis as they receive very little light. Therefore it remains to ascertain the role of these leaves in the canopy of ber cv. Gola.

### Variation in photochemical efficiency in kinnow

The earlier experiments conducted to study the effect of water stress on growth, development and physiological functions of kinnow revealed that the photosynthetic rate of kinnow declined steady with the duration of water stress period. Therefore, the present experiment was conducted in order to assess the impact of water stress on photochemical efficiency of kinnow. The plants were selected, fully irrigated and then the irrigation was stopped up to 20 days. The data on photochemical efficiency of plants was recorded at regular interval of five days. The data thus generated revealed that the photochemical efficiency of leaves of kinnow plants declined as the soil water level decreased. Thus, it can be concluded that this process has a role to play in reduction of photosynthesis in kinnow with imposition of water stress.

### Date palm suckers production

Effect of chemicals on suckers production in date palm was tested by application of Alar (B-9) 7500 and 5000 ppm with control in cv. Halawy. Three plants for each treatment were taken for spray. Morphological effects i.e. curling of leaves, burning of tips, etc. was observed after one week of spray. In another study, earthing of soil mixture to arial suckers was also done in date palm cv. Khalas and rooting was observed in arial suckers after one year of earthing treatment. Six rooted suckers were detached from mother palm and planted in field for survival and growth.

## Post Harvest Technology

### Tree storage on shelf life and quality (Aonla)

It was observed that fruits of cv. NA-7 can be retained on trees itself without reducing the fruit quality shelf life of fruits up to 30$^{th}$ day from the date of maturity. This practice may be adopted by the aonla growers to fetch more economic return by expanding harvesting span.

### Effect of post- harvest treatments

The experimental results revealed that fruits treated with calcium chloride (1.5%) influenced least physiological loss in weight and spoilage loss and exhibited 9 days of economic shelf life in addition to low respiratory activity on the last day of storage (day 13). It was followed by 2.0 per cent calcium chloride as compared to maximum PLW and spoilage loss in control. Moreover, fruits treated with calcium chloride 1.5 per cent and kept in zero energy cool chamber recorded the least physiological loss in weight and spoilage loss during storage under ambient conditions.

### Ber

The efficacy of different post harvest treatments showed that fruits treated with calcium chloride 1.5 per cent was effective in least physiological loss in weight and spoilage loss and exhibited 5 days of storage life, it was closely followed by 2.0 per cent calcium chloride, while untreated control had 3 days economic life under ambient conditions. Under the zero energy cool chamber and post harvest treatments, calcium chloride at 1.5 per cent recorded the least physiological loss in weight and spoilage loss during storage under ambient conditions while it was highest in untreated control under ambient conditions.

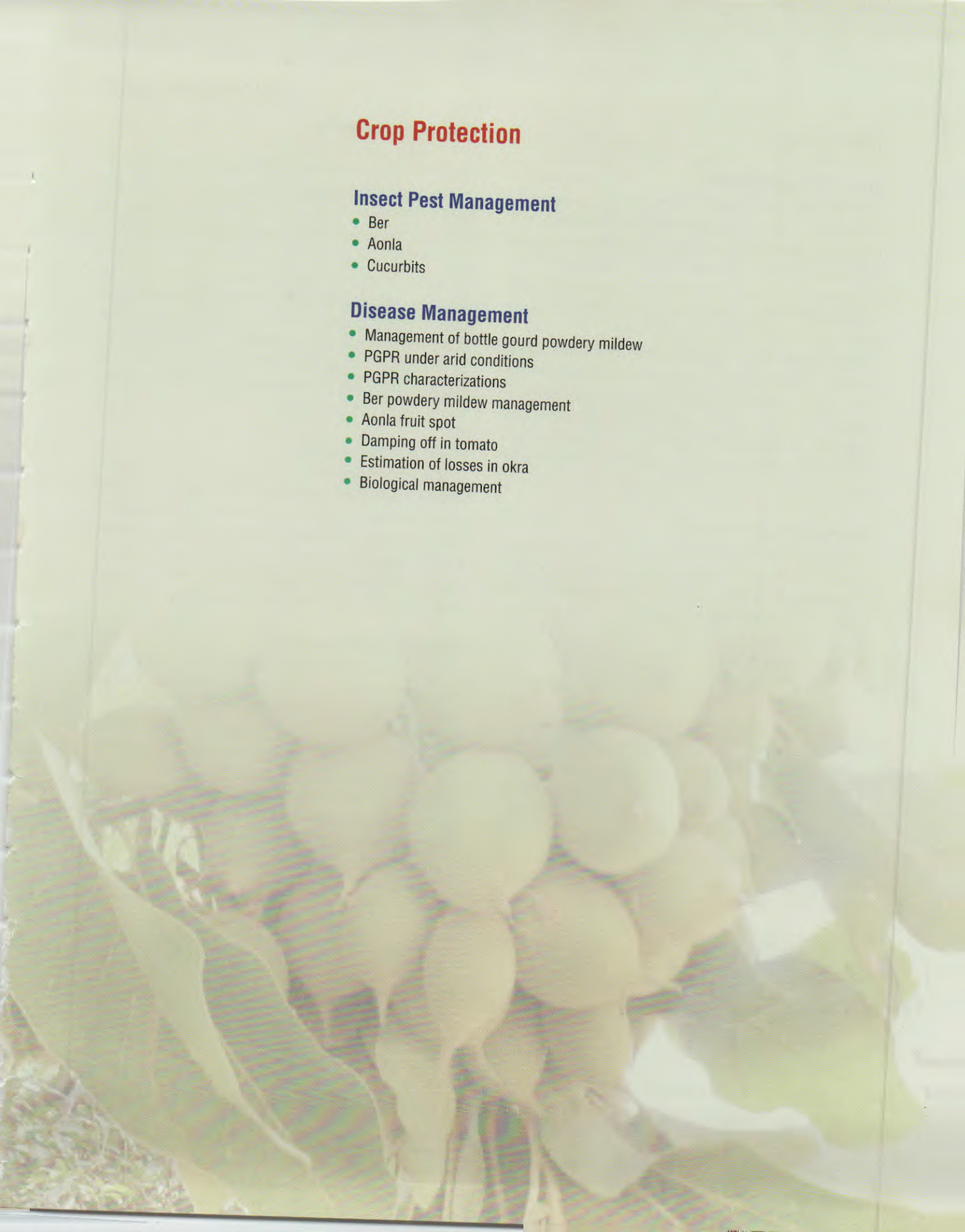
# Crop Protection

## Insect Pest Management

- Ber
- Aonla
- Cucurbits

## Disease Management

- Management of bottle gourd powdery mildew
- PGPR under arid conditions
- PGPR characterizations
- Ber powdery mildew management
- Aonla fruit spot
- Damping off in tomato
- Estimation of losses in okra
- Biological management



## Crop Protection

### Insect Pest Management

**Ber:** Experiments on avoidable losses in ber cvs. Gola and Umran due to fruit fly and fruit borer and powdery mildew were carried out. However, due to incessant rains fruit set and development was adversely affected. Observations on fallen fruits revealed the incidence of fruit fly and fruit borer to the tune of 4.0 to 10.0 per cent only.

**Aonla:** Experiments on avoidable losses in aonla cv. NA-7 due to borer complex was carried out. Treatments were imposed. But no significant differences were observed on the incidence of borer complex in treatment and control. The average infestation arranged between 10.0 to 13.0 per cent only.

### Bitter gourd and pumpkin

Results of field experiments on overall incidence of fruit fly revealed that the infestation ranged between 10.0 to 35.0 per cent both on number and weight basis. However pooled data of 14 harvests of bitter gourd revealed the incidence to the extent of 20.0 per cent.

Fig. 28. Unsprayed

Fig. 29. Cells suspension

Fig. 30. Restriction of colonies

Fig. 31. Powder formulation

## Disease Management

### Bacteria against powdery mildew of bottle gourd

The liquid and powder formulations (1%) of Pf-CIAH-196 were tested for the management of powdery mildew in bottle gourd. Intensive colonies were suppressed within 72 hours of sprays. However, after one week, further spread was not restricted in immature leaves which were under the shades. Powder formulation was better in restriction of further spread of the pathogen in treated leaves as compared to bacterial cell suspension perhaps due to presence of talc and cellulose added as carrier in the former (Fig. 28-31).

### PGPR in arid conditions

Soil and plant samples from ber, arid vegetables (watermelon, kachari, snap melon and kakadi) and date palm were collected. Total bacterial population in these samples was isolated using different culture media. Ninety one isolates of pure cultures different strains (*Bacillus* spp. and *P. fluorescens*) are being maintained in their respective medium.

### PGPR characterization

Out of these isolate, 30 isolates have been characterized by biochemical methods. Twenty isolates (Mat. R, ML, MR-BG, Hemp, Aj-1, Aj-3, Aj-6, Aj-6-KB, Aj-5a-R, KS-BG, MS-BG, R-Aj-5b, KB-Aj, Ber-S,) were grouped into Fluoresecent Pseudomonads based on the morphology of colonies, Gram staining, KOK test, production of fluorescing pigments and levan formation, Arginine dihydrolase, gelatin liquefaction. Ten isolates (Snap-R, KS-BG, Phog-Endo, Kac-R, Snap-S, 6a, 6b, Phog-

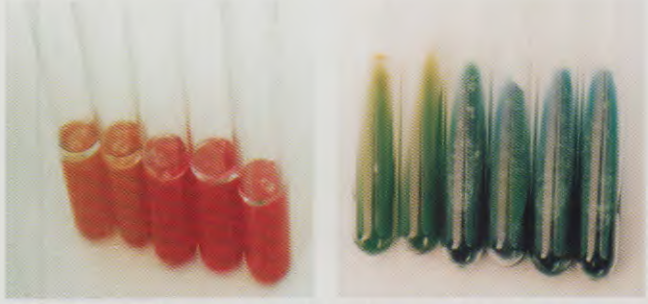


Fig. 32. Reactions of bacterial isolates on biochemical tests

soil, K-RS, Mat-AG-Endo) are grouped under *Bacillus* spp. based on the biochemical tests viz., starch hydrolysis, citrate utilization and catalase test (Fig. 32).

### Properties of the soils used in PGPR isolation

To study the impact of PGPR on soil fertility and structural changes, general physical and chemical properties were studied at initial stage. Texture of the soil was loamy sand throughout the profile. The bulk density varied from 1.40 to 1.42 Mg $m^{-3}$ and showed an increasing trend with depth. Water retention capacity at field capacity and wilting point ranged from 3.80 to 4.15% (w/w) and from 1.52 to 1.61% (w/w) respectively.

Soils were alkaline in reaction with pH varying from 8.2 to 8.4. Electrical conductivity ranged between 0.16 and 0.22 dS $m^{-1}$. The soils were calcareous throughout but lacking a regular trend of free $CaCO_3$ distribution. The organic carbon content remained low, ranging between 0.03 and 0.09%. Exchangeable calcium and magnesium remained dominant on the exchange complex of the soil. Exchangeable bases were in the order of $Ca^{2+} > Mg^{2+} > Na^{1+} > K^{1+}$. According to the standard soil test values of primary nutrients, the soils were rated low in available nitrogen and phosphorus content while medium in potassium.

### Ber powdery mildew management

Under semi-arid regions, different strategies were applied to manage powdery mildew (*Oidium zizyphi*) of ber cv. Gola (Fig. 33). The results revealed that the fungicide 2 spray of Bayleton most effectively reduced the disease severity (per cent disease index, of 4.56 as compared to control (25.07) whereas, 3 sprays of Sulfex, a cheaper fungicides also provided good control. Comparatively, even three sprays of MKP (7.18) and SA (9.18) also resulted disease control but neem oil (20.1) and organic preparation (21.21) did not show adequate efficacy against the disease. Alternate sprays of Bayleton with MKP (6.51), Sulfex with MKP (8.61), and Sulfex with SA (11.33) also showed better results and thereby reduced the number of spray of fungicides.

**Fig. 33. Ber powdery mildew**

### Aonla fruit spots

Fruit spots on aonla characterized by round, grey centres and with 1-3 mm diameter size, encircled by a prominent pinkish margin, were observed during September-November months. It could be managed by one spray of Blitox (copper oxychloride, 50 w.p. 0.3%), Mancozeb (Dithane M-45, 0.2%), and foliar spray of MKP(1%).

### Damping-off (PEDO) in tomato

Integrated approaches including seed treatment with fungicides (Ridomil Mz), fungicidal soil drenching (Ridomil Mz), incorporation of *Trichoderma viridae* spore suspension @ 3 × 105 cfu per g in soil, fumigation of nursery bed with 1% Formaldehyde solution, soil-solarization by covering a double layered thin (100 gauge) LDPE (polyelthylene) sheet for 2 weeks during April-May months and then repeating the same (covering with LDPE) for 1 week after removing in the polyethylene sheet and moistening the soil, completely managed PEDO in the tomato and chilli nurseries. The mortality of seedlings in the untreated nurseries ranged from 43.2 to 51.5 per cent.

### Estimation of losses in okra

About 28.2 per cent yield loss due to YVMV was estimated using paired plot technique. Cumulative loss of yield due to powdery mildew, *Cerospora* leaf spot and YVMV was estimated to 41.3 per cent.


**Fig. 34. Colonization by *A. quisqualis* on powdery mildew of okra**

Variety Parbhani Kranti was found to be free of YVMV.

### Biological management

Under semi-arid conditions, the local isolate of *T. viride* was effective in reducing mortality of seedlings of tomato and chilli due to post emergence damping off disease caused by *Pythium* spp. Okra powdery mildew was hyper- parasitized powdery mildew colonies on leaves with in 8-10 days by *Ampelomyces quisqualis* (AQ) when used as spore suspension (Fig. 34). Ber powdery mildew (*Oidium zizyphi*) was associated with *Cladosporium oxysporum* and *Alternaria* sp. Cercospora leaf spot of bottle was reduced (PDI=9.63) by incorporating *Azotobacter* in the soil as compared to control (23.88).

## Agricultural Extension

The survey conducted in IGNP area of Bikaner district resulted the following information.

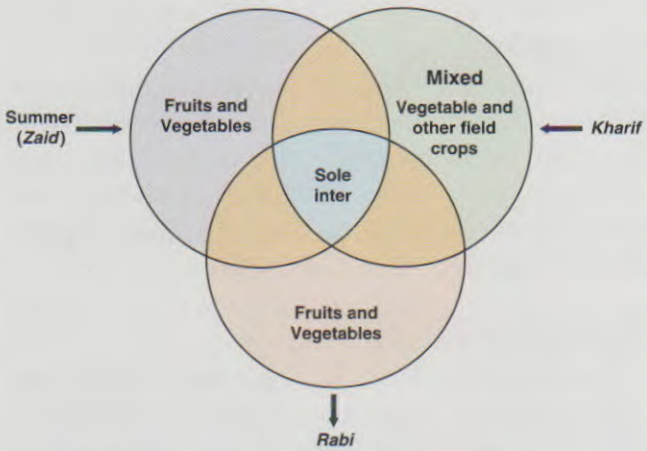



**Fig. 35. Van diagram of hort-based cropping system**

### Horti-based cropping system

### Mixed cropping

The mixed cropping system is the most prominent and conventional cropping system (pear millet, seasamum, mateera, snap melon, kachri, cluster bean, round melon, moth bean, cowpea, groundnut and bottle gourd, with different combinations) is practiced by majority of the farmers of IGNP area during the kharif season. In addition, 8-32 perennial khejri (*Prosopis cineraria*) plants/ha were also observed (Fig. 35).

### Intercropping

Farmers grow arid vegetables, groundnut, etc. in ber, aonla/pomegrante orchards as intercrops in different seasons of the year. During rabi season (irrigated conditions), cumin/pea/green fodder/ mustard/cauliflower/cabbage/spinach/fenugreek/ wheat/gram/chilli/brinjal, etc. are also grown as intercrops in orchards. During summer (zaid) season also some of the farmers grow arid vegetable crops as intercrop in their orchards. Sole cropping

More than one-third population of the farmers grow brinjal, cauliflower, cabbage, spinach, chilli, fenugreek (leaves), coriander (green), carrot, radish, tomato, etc. on small scale as sole crops during rabi season. During kharif season about 30 per cent population of the farmers grow mateera, snap melon, kachri, etc. as sole at large scale and some of the farmers grow brinjal, tomato, bottle gourd, ridge gourd, round melon, Indian aloe, etc. also on small scale. It was also observed that a few farmers grow ber, aonla, pomegrante, lasora, lime/lemon, kinno, mosmbi, etc. on their fields as sole crops. Farmers having irrigation facilities grow mateera, snap melon, kachri, ridge gourd, round melon, bottle gourds, tar Kakadi, brinjal, tomato, cluster-bean (veg. etable), chilli, etc. during summer (zaid) season also as sole crops.

### Adoption

Most of the farmers of IGNP area grow deshi/ local varieties of horticultural crops. However, some of the farmers are growing improved ber vars. Gola,

Seo, Umran, Mudia), Aonla (NA-7, NA-6, Chakaiya, Krishna), Mateera (AHW-19, AHW-65), Snap melon (AHS-10, AHS-82), Kachri (AHK-119, AHW-200) and other vegetable crops.

### Income and profit analysis

The farmers reported that they are getting good income from improved varieties of mateera, snap melon, kachari, ber, aonla, lasora, lime/lemon, kinno, mosambi, etc. The yield (in quintals), net income (in thousand Rs.) per hectare of 5-6 years old major arid fruit crops is depicted in Fig. 36.

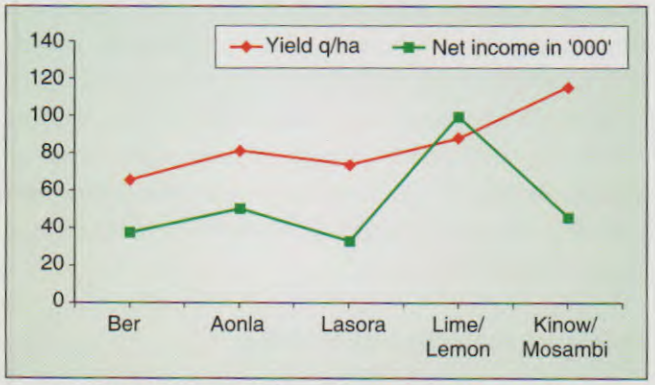



**Fig. 36. The yield and net income per hectare from arid fruit crops**

This was felt that the desires/expectations of the farmers with respect to adoption of improved technologies, technical knowledge/information, training, inputs, marketing, and other requirement for the production of horticultural crops were also assessed.

### Sources for technical information/guidance and inputs

The farmers use several kind of sources including fellow farmers, relatives, friends, news papers, radio, TV, local markets, input dealers/agencies,/ shopkeepers etc. and a few of them have direct contact with SAUs like RAU-Bikaner, ICAR Institutes likes CIAH-Bikaner, CAZRI-Jodhpur, state Govt. department of horticulture/agriculture, etc. The information about marketing pattern of horticultural produces like grading, packing, transportation, selling price and bargaining system, consumers preferences, etc. were also evaluated and collected.

The suggestions of the farmers were invited to promote the horticultural development, particularly in arid eco-system. Some of the motivational factors which encourage the farmers to adopt and grow horticultural crops were like:

- High income per unit area from arid fruit and vegetable crops.
- High demand in local areas/market
- Availability of high yielding varieties of arid fruit and vegetable
- Motivation and encouragement of farmers by Governmental and non-Governemental records and extension organization.
- Government schemes and substitutes for the adoption and production of horticultural crops.
- Availabilities of suitable improved arid horticultural technologies, seeds and planting materials.
- Increasing awareness and interest of arid farmers about arid horticultural crop production, etc.

### An assessment of arid horticultural status

It was observed that 4-16 per cent farmers use modern agro-techniques of arid vegetable production and rest of the them use traditional methods. However, 86-93 per cent vegetables growers use modern micro-irrgation (sprikler/drip) system and chemical fertilizers in vegetable production. In case of fruis (ber and aonla) cent per cent farmers sue squre system of plantation and 77-86 per cent of fruit growers use agro-chemicals in fruit production.

More than one-fourth population of the farmers grown brinjal, tomato, okra, bottle gourd, ridge gourd, round melon, chilli, Indian aloe, cluster bean (veg.) etc. on small scale during kharif season. More than 30 per cent population of the farmers grow brinjal, cauliflower/cabbage, spincah, carrot, radish, tomato, fenugreek (leaves), chilli, pea, etc. on small scale and >30 per cent farmers grow cumin (seeds) and fenugreek (seeds) at large scale during rabi season under irrigated conditions. Most of the farmers grow local/deshi varieties of the above horticultural crops. However, some of the farmers

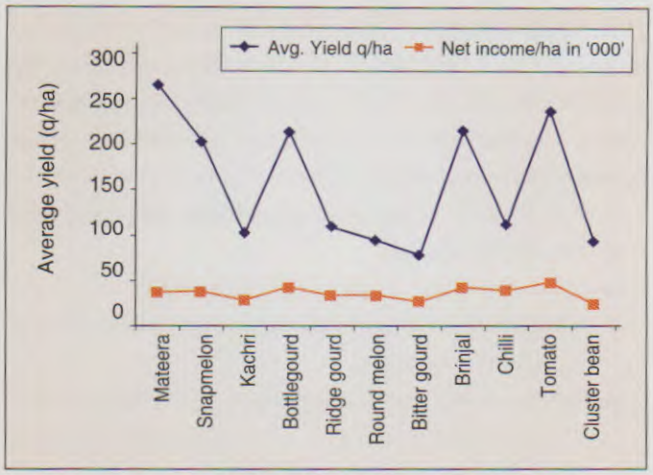



**Fig. 37. Average yield and net income per hectare from *kharif* vegetables**

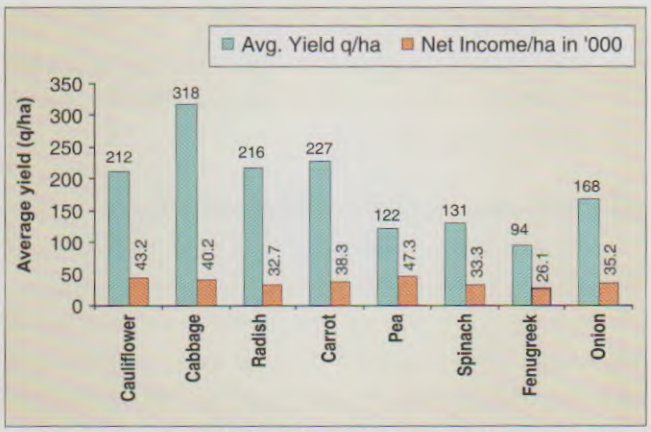



**Fig. 38. Average yield and net income per hectare from *rabi* vegetables**

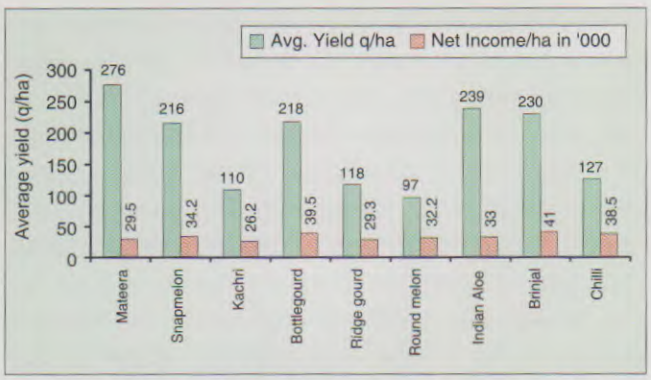



**Fig. 39. Aveage yield and net income per hectare from summer (*zaid*) vegetables**

grow improved varieties of ber (Gola, Seo, Umran, Mudia), aonla (NA-7, NA-6, Krishna, Chakaiya), mateera (AHW-19, AHW-65) snap melon (AHS-10, AHS-82), kachari (AHK-200, AHK-119). The improved varieties of mateera, snap melon and kachri give good yield as reported by them. The farmers are getting good profit by growing arid fruits and vegetable crops in different season of the year. The farmers of the surveyed area/Tehsils, are very eager to grow lime/lemon, mosmbi, kinnow, mandrin, guava, etc. and some of them have developed very good orchards of lemon/lime, mosmbi, kinnow, etc. on their fields. They purchase the plating materials from different sources of the state and other places of the country and trying to develop commercial orchards of the above fruit crops on their fields. There is very high need of proper technical guidance and suitable improved varieties/planting materials of the above fruit and vegetable crops.

## ITKs used in horticultural crops

Indigenous technological knowledge (ITKs) used by the farmers related to plant protection measures, termite control, vegetable seed storage, improving soil fertility, preparation of value-added products, soil and water conservation practices, improving quality/growth and production of arid horticultural crops were also collected and documented. The major ITKs which are under use by farmers are,

- Management of insect pests in vegetables crops by spraying ash plus kerosene oil mixture.
- Application of neem seed kernal powder on crops and in soil also followed for pests management.
- Burning of mustarnd/seasemum oil in vegetable field to avoid incidences of viruses.
- Smoging and dusting of as and arid fruit and vegetable crops to potect from frost injuries.
- Storage of vegetables seeds in pods with dry neem leaves and coating using mustard oil.
- Storage of fruits and vegetables under wet sandy soil at cool place.
- Irrigation in fruit crops using up lifted earthen pots etc.,

## Value addition

Thirteen to twenty seven per cent farmers prepare some value added products from the fruit of mateera, khejri, snap melon, kachri, aonla, ber, fenugreek, etc. for personal consumption and to sell them in local markets to earn money.

Income and profit analysis. During the survey the data/information related to arid vegetable production were collected. An average yield (in quintals), net income (in thousand Rs.) per hectare from arid vegetables as reported by farmers of Bikaner district during *kharif*, *rabi* and summer (Zaid) season of the year is depicted in (Figs 37–39).

**Marketing pattern:** During the survey the marketing pattern of horticultural produces including grading, packing, transportation, selling, selling price, bargaining, consumer preferences, farmers problem in selling/marketing, etc. were also evaluated.

**Constraints:** The farmers of Bikaner district/IGNP area reported several constraints, but the major constraints in adopting/growing horticultural crops as reported by the farmers were poor resources, poor and erratic rainfall, scarcity of water, poor supply of electricity, very deep and salty ground water, frequent draught, lack of location specific suitable technologies, lack of technological knowledge amongst the farmers, very extreme temperature, non availability of desired quantity and quality of seeds and planting materials, lack of reliable sources of inputs at local level with reasonable cost, faith in traditional cropping system and cultural practices, lack of loan/credit and subsidy facilities purchase to horticultural inputs, lack of farmers training, lack of technological demonstrations, poor extension system, low risk bearing capacity etc. are the important bottlenecks/ constraints, which are responsible for hindering the progress and development of horticulture in Bikaner district of Rajasthan.

## Computer Applications

Web-Site developed as per DARE format for the Institute and hosted at the Institute Server. The web-site provides detailed information about Institute. This can be browsed at the http://www.ciah.ernet.in. This web-site provides overview of Institute related information, describes origin and objectives of on going projects, technologies developed and transferred. The web-site is designed using Microsoft Front page and sub menus are designed using Java Script and Active Server Pages. Hindi version of home page is also designed by downloading Hindi fonts from CDAC web-site.

# Education, Training and Transfer of Technologies

# 3

Various extension programmes were organized to create awareness and interest among the farmers/NGOs about improved/modern arid horticultural technologies and disseminated the same to farmers fields. The following are the major extension programmes under taken by CIAH Bikaner (Fig. 40-43).

**Fig. 40. Field demonstration on planting of saplings**

**Fig. 41. Organization of farmers and scientist interactions**

**Fig. 42. Extension scientist interacting with farmers**

**Fig. 43. Extension scientist explaining institute's activities to the farmers**

Krishi Vigyan Kendra, Panchmahals, is functioning under the aies auspices of Central Institute for Arid Horticulture, Bikaner. It has impartd the following training programmes to the farmers, lay out demonstration, produces seeds, organizes field days and conducts visits of the farmers. Following are the salient programmes of the K.V.K., Panchmahals (Fig. 44-53).

**Fig. 44. Dr. H. K. Joshi, I/c KVK, Vejalpur is explaining the cultivation technology of ber to the farmers visiting along with the Regional Manager, Bank of Baroda, Godhra**


**Fig. 45. Celebration of Aonla Day at CHES, Vejalpur.**

**Fig. 46. Students of Navsari Agricultural University, Navsari visiting the aonla orchard of the CHES,Vejalpur under RAWE programme.**


**Fig. 47. Scientists of the CHES, Vejalpur delivering lecture on the occasion of training programme at CHES, Vejalpur**

Fig. 48. Dr. B. G. Bagle, Head, CHES, Vejalpur, explaining the activity of CHES, Vejalpur to the field workers of Panchmahals District


Fig. 49. Fisrt SAC meeting of KVK held at CHES, Vejalpur


Fig. 50. Interstate visit of the farmers from Nagore District (Rajasthan) sponsored by Govt. of Rajasthan and National Horticultural Mission visiting CHES, Vejalpur

Fig. 51. Dr. H. K. Joshi, explaining the technology at village Vaghjipur of Shehra Taluka during a training programme organized by Zill Gram Vikas Agency, Godhra

Fig. 52. Farmers from Nagore getting acquainted with the marketing modes of aonla


Fig. 53. Dr. S. Singh, Sr.Scientist (Fruits), CHES, Vejalpur chairing the aonla day celebration function.

## On- and off-campus training imparted to the farmers

| Discipline | No. of Courses | No. of participants | No of SC/ST participants |
|---|---|---|---|
| Horticulture | 2 | 53 | 53 |
| Plant Protection | 2 | 45 | 45 |
| Agricultural Extension | 3 | 83 | 75 |
| Agro-forestry | 2 | 30 | — |
| Total | | 211 | 173 |

## Topics of the training

- Cultivation of major fruits in the semi-arid region.
- Cultivation of minor fruits in the semi-arid region.
- Propagation of fruits in the semi-arid region.
- Cultivation of vegetables in the semi-arid region.
- Growing diseases fee nurseries of the vegetables.
- Simple plant protection measures in major horticultural crops.
- Agro-forestry with the help of horticulture.

# Empowerment of Women 4

Several farm women were educated about modern arid horticultural technologies through group approach and individual contact. They had visited the Institute and awareness and interest were created amongst them in respect of improved production practices of arid horticulture, post harvest technologies, etc. through method demonstration and speech. They were taught about the techniques which may be helpful in reducing the drudgery in crop production and post harvest management. They were acquainted with modern tools and techniques of value addition of arid fruits and vegetables. They were encouraged to participate in decision making for batter crop production under arid and semi-arid regions and household management (Fig. 54-57).

**Fig. 54. Participation of woman farmers in field demonstration at CIAH, Bikaner**

**Fig. 55. Women trainees and other farmers on the occasion training programme arranged by Mahatma Gandhi Pratisthan and KrishiVigyan Kendra**

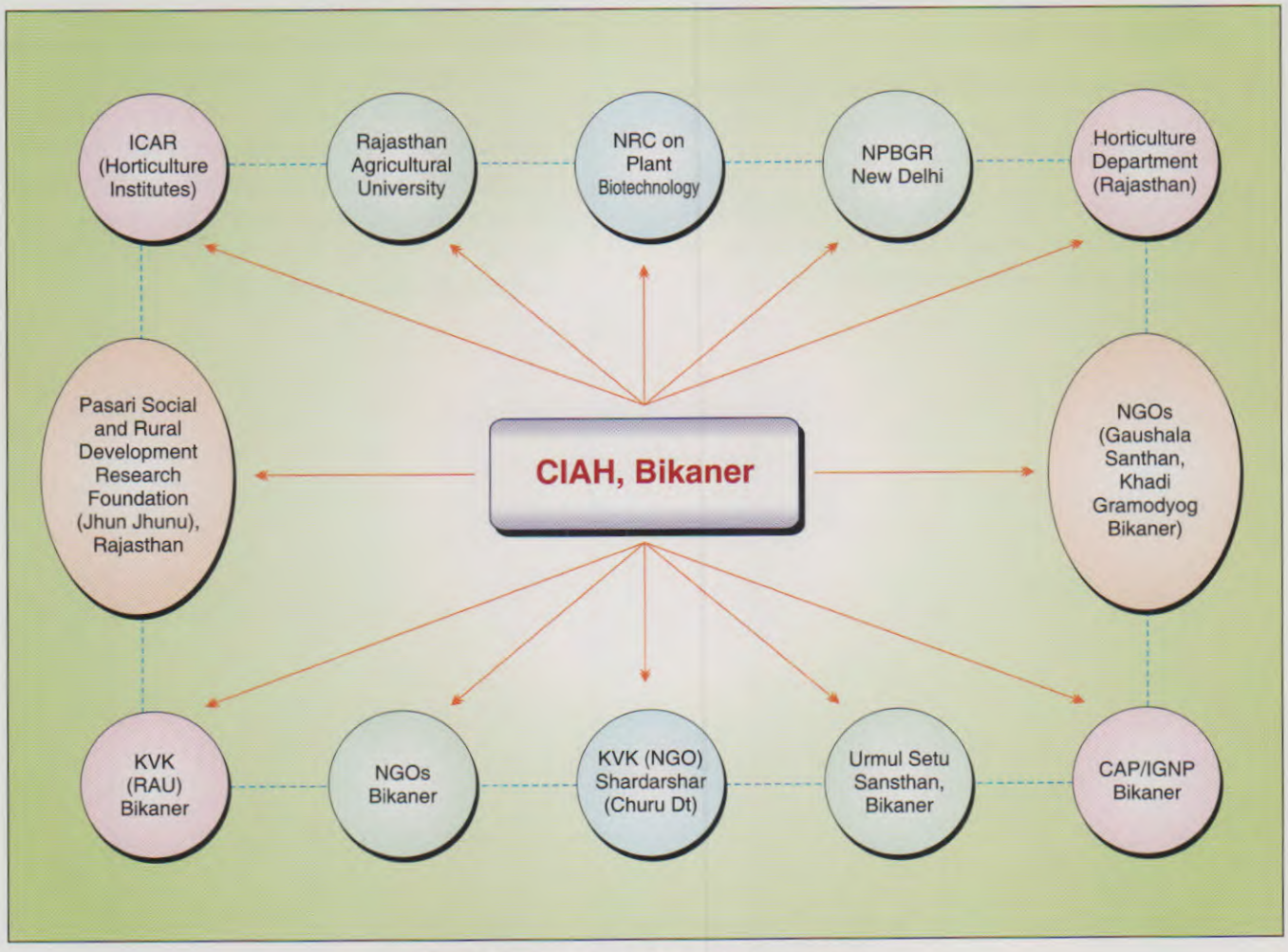
**Fig. 56. Kum. F. J. Mirza, Khedut Talim Kendra, Dahod and 35 female farmers visiting the CHES farm to get acquainted with the technology of horticulture developed at farm**

**Fig. 57. Women participants of a self help group (SHG) of Godhra taluka visiting the CHES, Vejalpur for obtaining**

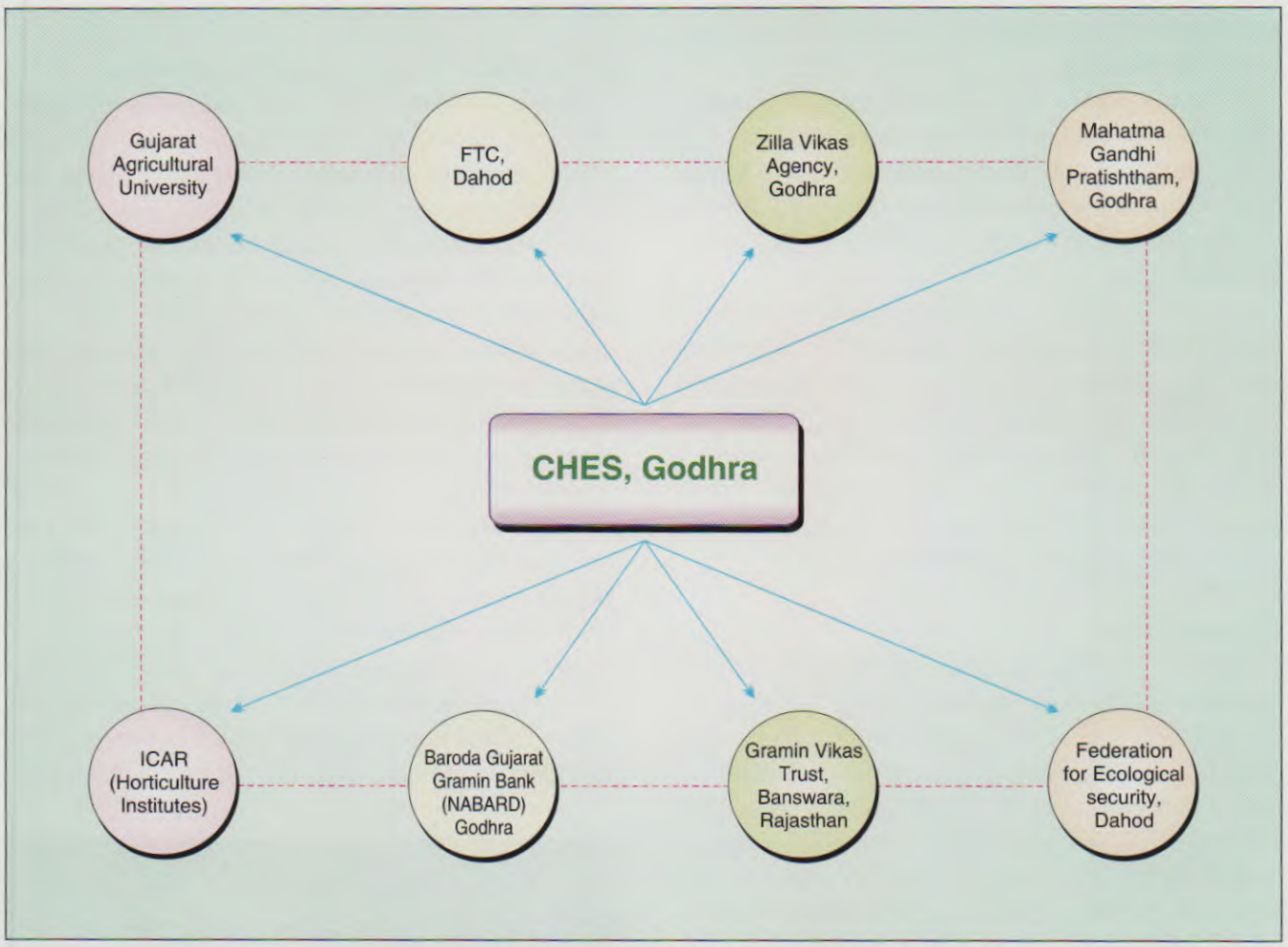
# Awards and Recognitions 5

- Dr. B. G. Bagle, Hiwale S.S. Dr. S. Singh, nominated as member of scientific advisory committee of KVK, CHES, Vejalpur by the Director,CIAH,Bikaner.
- Dr. Hiwale, S. S., nominated as Rapporteur in AICRP Arid fruits Session on " Plant propagation".
- Dr. Hiwale, S. S., nominated by president Indian Society for Arid Horticulture to the as member to the executive body of the society.
- Dr. Hiwale, S.S., nominated as Major Guide for Post-Graduate studies by Vice Chancellor, Anand Agricultural University recognized. Allotted three students to conduct research leading to M.Sc. (Agri) degree.
- Dr. A. K. Shukla was awarded with best poster presentation in Technical Session II in National Seminar on production, utilization and export of underutilized fruits in Plenary Session by Dr. D. K. Bagchi, Vice Chancellar, BCKV, Kalyani on 24 November 2006.

# Linkages and Collaborations 6




**Central Institute for Arid Horticulture, Bikaner**




**Central Horticultural Experimental Station (CIAH), Godhra**

# Externally Funded Projects 7

## Aonla based multistorey cropping system (AP-Cess Fund Scheme)

### Establishment, growth and survival of main and component crops

In this scheme, four different cropping model viz., Aonla-Ber-Brinjal-Moth bean-Fenugreek ($M_1$), Aonla-Bael-Karonda-Mothbean-Gram ($M_2$), Aonla-Khejri-Saji-Mothbean-Mustard ($M_3$) and Aonla-Drumstick-Senna-Mothbean-Cumin ($M_4$) were experimented.

Aonla was severely affected and severe mortality was recorded during later stages of crop growth. Root stocks however, survived and *in situ* budding was carried out during September 2006. Cent per cent survival of the budded plants were recorded up to March 2007. The other perennial crops although were affected recouped with the rise in temperature and no mortality was recorded.

### Growth studies

Plant height of aonla varied between 0.80 cm in control and 120.00 cm in model-3 (M3). Among the second tier crops, maximum plant height was recorded in drumstick, 4.8 m grown in model 4 (M4) followed by ber, 2.75m in model 1 (M1), bael and *Prosopis cinereraria* 1.25 m in models-2 and 3 respectively. Plant height was recorded to be minimum in *Suaeda fruticosa*, which was due to pruning done for extraction of salt.

Stem girth was maximum in drumstick 60.00 cm (M4), followed by ber 30.0 cm (M1), bael, 8.25 (M2) and *Prosopis cineraria* (M3). In aonla stem girth varied from 6.00 cm in control to 8.50 cm in model-3. Stem girth of karonda ($M_2$) was recorded to be 7.50 cm while in *Saji* ($M_3$). Plant spread (NS-EW) was recorded to be maximum in ber, followed by drumstick, suaeda, *Prosopis* and karonda while minimum plant spread was recorded in bael and aonla.

### Production of main and under storeycrops

Aonla grown as an over storey component although entered into reproductive phase, no yield could be recorded during the year under report due to severe damage caused by frost-chilling injury. Among the understorey crops ber cv. Seb in model-1 recorded an average yield of 70 kg/plant and was significantly superior to control. Bael grown as component crops in model-2 are still in their juvenile phase, Karonda in the same model resulted an average fruit yield of 250 g/plant (1.5 q/ha). *Prosopis cineraria* grown in combination with aonla - suaeda - mustard ($M_4$) as an understorey component recorded an average yield of 0.5 kg/plant (0.75 q/ha). In comparison to previous years yield, yield of *Suaeda fruticosa* declined by 25 per cent, thus recording an average bush yield of 0.60 q $ha^{-1}$ in model 3 as compared to 0.37 $qha^{-1}$ in contro (Fig. 58). Drumstick pods (PKM-1) flowered and fruited twice in a year Feb-March and September to October. and gave an average yield of 18.0 kg/plant/season.

**Fig. 58. *Suaeda fruticosa* salt**

### Production of ground-storey seasonal crops

Moth bean (*Phaseolus acontifolius*) was gown as ground storey crop during kharif season in all the four cropping models. Reduction (3.5 bqha$^{-1}$ (M2) to 2.50 qha$^{-1}$ in (control) in seed yield of moth bean was recorded. Fenugreek, gram, mustard and cumin were grown as groundstorey *rabi* crops in models 1, 2, 3 and 4 respectively while brinjal and Senna (*Cassia angustifolia*) were grown between two aonla trees in models-1 and 4 respectively. Fruit yield of brinjal was recorded to be 43 per cent more than control. Among the groundstorey crops, gram excelled the other crops recording an average yield of 10 qha$^{-1}$ as compared to control 7.5. Mustard recorded an average grain yield of 7.8 q ha$^{-1}$. The performance of cumin during the year under report was very poor. Growth and development of over storey component was not affected by the groundstorey components and vice-versa, however, yield reduction in groundstorey crops was recorded in some of the treatment combinations.

### Allelopathic effect

The allelopathic influence of *Carissa congesta* was studied on germination and early growth of moth bean (*Phaseolus acontifolius*) and cluster bean (*Cymopsis tetragonolobus* sp.). About 60 per cent seed germination of moth bean ws recorded 15 days after sowing, while in cluster bean significantly lower germination percentage was recorded. Similar effect of *Ziziphus mauritana* aqueous solution was recorded.

### Physiological attributes in aonla based multistorey cropping system

The difference in rate of stomatal conductance was recorded in aonla, ber, bael, karonda, *Prosopis* and drumstick using a portable porometer. Stomatal conductance was observed to be higher during rainy season and winter months (August-February). The rate of stomatal conductance was maximum in ber during the first fortnight of April (350 mmol/m^2/s), while it was minimum in bael. During the winter month (November), it was recorded to be maximum in *ber* (930 mmol/m^2/s) followed by aonla (510 mmol/m^2/s) while it was recorded to be minimum in *Prosopis cineraria* (114 mmol/m^2/s). As regards the leaf temperature, it was observed that leaf temperature has direct correlation with day temperature. Not much variation in leaf temperature was recorded in the different fruit species.

### Physical properties of soil

The bulk density of soil varied from 1.32 to 1.52 Mgm$^{-3}$. However, the maximum bulk density (1.48-1.51 Mgm$^{-3}$) at various depth was recorded under bael plantation (Model-2) and minimum (1.37-1.44 Mgm$^{-3}$) under ber plantation (Model 1). Soils under ber plantations recorded maximum moisture content at field capacity (Model-1) and varied between 3.65 to 4.29 per cent.

### Chemical properties of soil

Organic carbon content of soil varied from 0.03 to 0.27 per cent (0.3 to 2.7 g kg$^{-1}$). Soils beneath drumstick plantations recorded highest (1.6 to 2.7 g kg$^{-1}$) organic carbon content, while it was recorded to be minimum under *Prosopis cineraria* (0.4 to 0.5g kg$^{-1}$). Soils are calcareous in reaction with pH varying from 8.1 to 8.3 and EC ranging between 0.06 and 0.24 dsm$^{-1}$.

The available nitrogen content at various depths i.e. up to 45 cm varied between 78.0 and 148 kgha$^{-1}$. However, the highest available nitrogen was observed on the surface horizons under *Suaeda fruticosa* plantations followed by drumstick plantations. Available phosphorus under different plantations varied between 3.0 to 5.2 kgha$^{-1}$. The highest available P content was recorded beneath *Prosopis cineraria* plantation. Available potassium content varied from 152-423 kgha$^{-1}$. Surface layer under *Suaeda fruticosa* plantation contained highest available K content followed by drumstick plantation.

Exchangeable calcium and magnesium dominated the exchange complex of soils under all perennial plantations, except *Suaeda fruticosa*. The highest exchangeable calcium and magnesium at all the depths was recorded under ber plantation whereas exchangeable K and Na was recorded under *Suaeda fruticosa* plantation.

### Network project on underutilized fruits

Soft wood grafting and wedge grafting were performed at monthly interval to standardize vegetative propagation of Mahua, Chironji and Rayan on the available rootstocks. Soft wood grafting is showing better success and survival in comparison to wedge grafting in Mahua, Rayan and Chironji under semi-arid environment of western India. Mahua and Rayan recorded appreciable success (>60%) in the months of March-July. Patch budding was found successful in Karonda.

## Reproductive biology

### Rayan

Reproductive biology was studied in 15 promising genotypes. The peak period of flowering and fruit set was recorded in the month of November – December and December - January respectively in majority of the genotypes. Variable percentage of anthesis/dehiscence was registered in different genotypes. Peak period of anthesis was recorded between 8 and 11 AM in all the genotypes. None of the genotypes showed anthesis before 3 AM and after 12 noon. Anther dehiscence commenced after opening of flowers i.e. at 5 AM and continued till 2 PM. Peak period of dehiscence was recorded between 10 AM and 1 PM in all genotypes. Number of petals and sepals were six. Pedicel length, pedicel thickness, flower length and flower breadth varied from 0.65-1.31 mm, 1.12-1.15 mm, 5.30-5.50 mm and 7.10-7.50 mm respectively in different genotypes.

### Fruit quality

Survey was carried out in the district Panchmahals and adjoining areas to identify the elite genotypes among its population. Thirty genotypes were selected and evaluated for their fruiting and fruit quality attributes. The average fruit weight and pulp weight ranged from 1.30 to 7.12 g and 0.39 to 5.70 g respectively in different genotypes. Total soluble solids ranged from 20.80 to 27.00 per cent. These genotypes would be exploited as potential parents to develop high yielding stable genotypes having horticultural traits.

### Karonda

Peak period of flowering was recorded during the month of February-March in different genotypes. Variable percentage of anthesis was registered in different genotypes. Peak period of anthesis was recorded from 3 to 6 PM in all the genotypes. Anthers dehisced between 4 and 7 PM on the same day. The flower length, flower diameter and pedicel length varied from 20 to 27 mm, 18 to 23 mm, 5 to 8 mm respectively in different genotypes. There were 5 each sepals and petals. Petal length, sepal length and ovary length ranged from 23 to 28 mm, 3 to 4.8 mm and 2 to 3 mm respectively in different genotypes. Pollen viability and pollen germination varied between 90.0 and 98.5 per cent and 35.5 and 60.1 per cent, respectively. These genotypes would be further exploited as potential parents to develop high yielding stable genotypes having positive horticultural traits under semi-arid tropics of western India.

### Fruit quality attributes

During survey in the district Panchmahals, 30 genotypes were evaluated for their fruiting and fruit quality attributes. There was a wide variation among the genotypes. The average fruit weight and pulp weight ranged from 2.00 to 6.00 g and 1.40 to 4.64 g respectively in different genotypes. Total soluble solids ranged from 9.00 to 11.00 per cent. These genotypes would be exploited as potential parents to develop high yielding stable genotypes having horticultural traits. Apart from Gujarat, survey was also made in other parts of the country. Eight genotypes were collected from Bihar, Uttar Pradesh and Haryana. Plants have been established in the field.

### Revolving Fund Nursery Scheme "Commercial propagation of fruit plants

In all 3666 plants of mango, 63 plants of Aonla, 290 plants of sapota, 215 plants of pomegranate, 25 and 20 budded and seedling plants of custard apple, and 34plants of kagzilime were sold during the year realizing the revenue of Rs.1,41,355.

# Publications

# 8

## Published in referred journals


Apparao V. V., Singh Sanjay, Sharma, B. D., Meshram, D. T. (2006). DRIS norms for sapota Manilkara achras (Mill) Fosberg ] in western plains of India. *Indian Journal of Horticulture,* 63:145-147.

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): 192-194.

Bhargava, R., Sharma, B. D. and Dhandar, D. G. (2006). Variation in physiological parameters of some ber (*Zizyphus mauritaiana* var. *roitundifolia*) cultivars. *Indian Journal of Arid Horticulture* 1(1): 28-31.

Bhargava, Rakesh, Sharma, B. D. and Dhandar, D. G. (2006). Variation in physiological parameters of some ber (*Ziziphus mauritiana* var. *rotundifolia*) cultivars. *Indian Journal of Arid Horticulture*, 1 (1): 28-30.

Dhandar, D. G., Nallathambi, P and Umamaheshwari, C. (2006). Bacterial leaf and fruit spot: A major constraint in pomegranate orchards. *Indian Journal of Arid Horticulture*, 1 (1): 83-84.

Dhandar, D. G. and Bhargava, R. (2006). Arid horticulture: An over view. *Indian Journal of Arid Horticulture,* 1(1): 1-7.

Meena, S. R., Singh, I. S., Shukla, A. K., Singh, D. and Dhandar, D. G. (2006). An evaluation of ber based farming system in hot arid eco-system of western Rajasthan. *Indian Journal of Arid Horticulture,* 1 (1): 71-73.

Meena, S. R. and Jhamtani, A (2005). Changing cropping pattern subsequent to farm mechanization. *Indian Journal of Extensiion Education*, 41 (182): 31-36.

Meena, S. R., Dhandar, G. D. and Awasthi, O. P (2006). Constraints in adoption of ber production technologies. *Indian Journal of Extension Education*, 42 (1&2): 92-95.

Meshram D. T. and B. G. Bagle (2006). Dry and wet spell for agriculture planningat anchmahals District of central Gujarat. *Journal of Maharashtra Agricultural University,* 31(3):333-336.

Meshram D. T., Bagle B. G. and AppaRao V. V. (2006). Estimation of surface runoff using SCS Model from micro watershed in semi-arid region. *Journal Agrimeterology,* 8(1):77-80.

Nagaraja, A., Nallathambi, P and Umamaheshwari, C. (2006). Dehydration methods and their impact on microbial contamination in Kachari (*Cucumis callosus*). *Indian Journal of Arid Horticulture*, 1 (1): 76- 77.

Nagarjuna Kumar, R. and Sailaja. B (2006). Role of information and communication technologies for improving input efficiency of horticulture crop production, *Indian Journal Arid Horticulture*, 1(1):63-68

Nallathambi, P., Umamaheshwari, C., Awasthi, O. P. and Nagaraja, A. (2006). Review on ber diseases and their management. *Indian Journal of Arid Horticulture*, 1 (1): 47-56.

Samadia, D. K. (2006). Evaluation of pomegranate germplasm under arid conditions.*Indian Journal of Arid Horticulture*, 1 (1): 15-19.

Samadia, D. K. and O. P. Pareek (2006). Fruit quality improvement in pomegranate under hot arid environment. *Indian Journal of Horticulture,* 63 (2): 126-132.

Shukla, A. K, Singh. D, Meena S. R and Dhandar D. G. (2006). Survey and collection of aonla germplasm from Eastern Uttar Pradesh. *Indian Journal of Arid Horticulture*, 1(1)69-70.

Shukla, A. K., Samadia, D. K., Shukla, A. K. and Dhandar, D. G. (2005). Genetic resource of aonla (*Emblica officinalis*). *Indian Journal of Plant Genetic Resources*, 18 (2): 188-193.

Singh, D., Shukla A. K, Bhargava, R., Awasthi, O.P. and Meena S.R. (2006). Direct Organogenesis in single bud explant of lasoda (*Cordia myxa*Roxb.) *Indian Journal of Arid Horticulture*, 1(1): 31-34.

Singh, I. S., Awasthi, O. P. and Meena, S. R. (2006). Influence of mulch on soil hydrothermal regimes, leaf and soil nutrient concentrations, growth and fruit yield of brinjal (*Solanum melongena* L.) grown under arid ecosystem. *Agropedology*, 16 (2).

Singh, S., Singh, A. K. and Joshi, H. K. (2005). Prolonging storability of Indian goose berry (*Emblica*

*officinalis*) under semi-arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences,* 75(10): 647-650.

Singh, Sanjay and Singh, A. K. (2006). Standardization of method and time of propagation in jamun (*Syzygium cuminii*) under semi arid environment of western India. *Indian Journal of Agricultural Sciences*, 76:142-45.

Singh, Sanjay, Singh, A. K. and Joshi, H. K. (2006). Standardization of maturity indices in Indian Gooseberry (*Emblica officinalis* Gaertn) under semi arid conditions of Gujarat. *Indian Journal of Agricultural Sciences*,76(10): 591-95.

Singh, Sanjay, Singh, A. K., and Apparao, V. V. (2006). Performance of tamarind (*Tamarindus indica* L.) under semi arid conditions of Gujarat.*The Horticulture Journal*,19(1), 20-23.

Singh, Sanjay,Singh, A. K and V V Apparao (2006). Genetic diversity in *Chironji* (*Buchanania lanzan* Spreng) under semi arid ecosystem of Gujarat. *Indian Journal of Agricultural Sciences*, 76: 695-698.

## Published in proceedings

Bagle, B. G. (2006). Management of fruit fly, fruit borer and powdery mildew in ber cv. Umran. In: National Symposium on Improving Input Use Efficiency in Horticulture, Bangalore, 9-11th August,2006.

Bagle, B. G. (2007). Integrated Pest Management in Aonla Inivted lecture delivered in National Seminar on Recent advances in production protection and PHM in arid fruits held at Mandasor, 17-18 March,2007.

Bagle, B. G., Joshi H. K., Hiwale S. S. and Apparao V. V. (2006). Management of borer and fruit spot in Aonla cv. NA-7. paper presented in National Symposium of improving in putuse efficiency in horticulture held at Bangalore from 9-11th August,2006.

Bhargava, R. Singh, R. S. and Dhandar D. G. (2006) Carbon and water use efficiency in date palm cultivars under arid eco-system. Abstract *In.* National Symposium on Improving Input use efficiency in Horticulture held at IIHR, Bangalore, p. 98-99.

Bhargava, R., Sharma, B. D., Dhandar, D. G. (2006). Carbon and water use efficiency in ber (*Ziziphus mauritiana* var. *rotundifolia*) cultivars under arid ecosytem. National Symposium: Improving Input Use Efficiency in Horticulture, held at IIHR, Bangalore, Aug. 9-11, 2006, p 98.

Bhargava, R., Singh R. S., Dhandar, D. G. (2006). Carbon and water use efficiency in date palm cultivars under arid ecosytem. National Symposium: Improving Input Use Efficiency in Horticulture, held at IIHR, Bangalore, Aug. 9-11, 2006, pp 98.

Chaudhary. M, Singh, D and Shukla, A. K. (2006) Opportunities of product diversification in underutilized fruits of arid regions. In book of abstract of National symposium on underutilized horticultural crops at IIHR,Banglore 8-9.06.06 pp.90

Dhandar, D. G., R.S. Singh., Bhargava, R., and O. P. Awasthi. (2006). Diversification using underutilized species for Sustainable Production in arid regions. Paper presented in National Seminar on under utilized Horticultural crops at IIHR, Bangalore, 8-9 June, 2006,p12

Hiwale, S. S., Apparao, V. V., Dhandhar, D. G. and Bagle, B. G. "Effect of Nutritional experiments through organic fertilizers in Sapota cv. Kallipatti" paper presented in National Symposium of improving in putuse efficiency in horticulture held at Bangalore 9-11th August,2006.

Joshi, H. K., Bagle, B. G. and More, T. A. (2007). Integrated pest management in ber and aonla. Proceedings of National Seminar on Recent advances in production, protection and post harvest management of Grape, mandarin and arid fruits

Meena, S. R., Singh, I. S., Singh, R. S and More, T. A. (2007). Problems and prospects of seed spices production in arid ecosystem. Book of abstracts of papers of National seminar organized by NRCSS, Tabiji, Ajmer (Rajasthan) February,2-3, 2007. pp. 84.

Meena, S. R., Singh, I. S., Singh, R. S and More, T. A. (2007). Production, development, quality and export of seed spices-issues and strategies" organized by NRCSS Tabiji, Ajmer (Rajasthan) during February,2-3, 2007.

Meshram D. T., Appa Rao V. V., Singh A. K., Bagle B. G. and Dhandar D. G. (2006) - Impact of watershed development programme on rural employment at Khadai and Bhadroli Khurd microshed waterphed of Panchmahals District of Central Gujarat in National Conference on Role of Soil and Water Conservation in rural employment 19-21 September,2006

Pareek, O. P., Bhargava, R. and Sharma, B. D. (2006). Enhancing water use efficiency in horticultural crops. National Symposium: Improving Input Use Efficiency in Horticulture, held at IIHR, Bangalore, Aug. 9-11, 2006, pp 14.

Rathi Y. S., Singh G. P. Singh D. and Shukla A. K. (2007). Relevance of Communication Technology in farming system extension in Proc. of National Seminar on Information and Communication

Technology, 27-29 December. 2006.

Samadia, D. K. and T. A. More (2007). Performance of minor seed spice crops under arid conditions of western Rajasthan. National seminar on " Production, development, quality and export of seed spices: Issuesand strategies. NRC on Seed Spices, Ajmer. Abstract of Papers, February, 2-3, 2007. pp. 9.

Sharma, B. D. (2006). Nutrient Management in Arid Fruits under Micro-Irrigation System. In Winter School on Sustainable farming system in arid and semi-arid region of India, Organised by CAZRI, RRS, Bikaner.

Sharma, B. D. Bhargava, R. and More, T. A. (2007). Response of kinnow mandarin to micro-irrigation under arid ecosystem of western Rajasthan. In: Proceedings of National Seminar on Recent Advances in Production, Protection and Post harvest Management of Grape, Mandarin and Arid Fruits at KNK COH (JNKVV), Mandsaur, March 17-18, 2007. P: 59-61.

Sharma, B. D., Dhandar, D. G. and Bhargava, R. (2006). Nitrogen use efficiency in Ber (*Ziziphus mauritiana* var. rotundifolia) under drip irrigation. In: National Symposium on Input Use Efficiency in Horticulture, August 9- 11, 2006, Bangalore, Society for Promotion of Horticulture. P: 100-101.

Sharma, B. D., Dhandar, D. G. and Bhargava, R. (2006). Water use efficiency in Pomegranate under Micro irrigation systems. In: National Symposium on Input Use Efficiency in Horticulture, August 9- 11, 2006, Bangalore, pp. 100.

Shukla A. K, Singh, D., Meena S. R., Singh, I. S., Bhargava, R, and Dhandar, D. G. (2006). Enhancement of water use efficiency in aonla through double ring system of irrigation under hot arid agro ecosystem. In National Symposium on Input use Efficiency in Horticulture 9-11 August 2006 at IIHR Bangalore. pp. 99.

Shukla Arun Kumar and Singh B. P. (2006). Effect of plant specing and level of N on flowering, fruit characters and yield of papaya. In National Symposium on Input use Efficiency in Horticulture 9-11 August 2006 at IIHR Bangalore. Pp160.

Shukla, A. K., Singh D., Meena S. R., Singh I. S., Bhargava R and Dhandar, D. G. (2006). Enhancement of water use efficiency in aonla through double ring system of irrigation under hot arid agro-ecosystem.. National Symposium: Improving Input Use Efficiency in Horticulture, held at IIHR, Bangalore, August 9-11, 2006, pp 99.

Singh, D. and Shukla A. K. (2007). Coriander seed production as influenced by honey bee pollination. National Seminar on Production, development, quality and export of seed spices-Issues and strategies. NRCSS, Ajmer 2-3 February 2007.

Singh, D., Shukla A. K., Singh S. P. Meena S. R. and Dhandar D. G. (2006) Improvement in natural plantation of underutilized fruits through in situ budding In book of abstract of National Seminar on production, utilization and export of underutilized fruits BCKV, Kalyani 22-24 November, 2006 pp. 52.

Singh Dhurendra, Shukla A. K. and Rathi Y. S (2006) Plug technology of nursery raising for improving saline water use efficiency. In National Symposium on Input use Efficiency in Horticulture 9-11 August 2006 at IIHR Bangalore. pp. 67.

Singh Sanjay, Joshi, H. K, Singh, A. K., Bagle, B. G. and Dhandar, D. G (2006). Reproductive biology of Mahua (*Bassia latifolia*). National symposium on underutilized horticultural crops, 8-9th June, 2006 at IIHR, Bangalore, pp 60.

Singh Sanjay, Singh, A. K., Apparao, V. V. Bagle, B. G. and Dhandar, D. G (2006). Physio- biochemical changes during fruit development in chironji (*Buchanania lanzan* Spreng). National symposium on under utilized horticultural crops, 8-9th June, 2006 at IIHR, Bangalore, pp 78.

Singh, A. K., Singh Sanjay, Apparao, V. V., Meshram, D. T. Bagle, B.G. and Dhandar, D. G. (2006). Efficacy of planting systems on productivity and economics of aonla Cv.NA-7 under rain fed conditions. Proceedings on National Symposium on Production, Utilization and Export of Underutilized Fruits with Commercial Potentialities, 22-24 November 2006,B.C.KV. Kalyani. P.P-63.

Singh, A. K., Singh Sanjay, Apparao, V. V., and Meshram, D. T. Bagle, B. G. and Dhandar, D. G. (2006). Studies on floral biology of bael (*Aegle marmelos* Correa) under semi-arid ecosystem. National Symposium on Production, Utilization and export of underutilized Fruits with Commercial Potentialities, 22-24 November 2006, B.C.KV. pp. 31.

Singh, A. K., Singh Sanjay, Bagle, B. G. and Dhandar, D.G. (2006). Growth behaviuor of bael genotypes under semi-arid tropics of western India. National Symposium on Underutilized Horticultural Crops on 8th and 9th June at IIHR, Bangalore, pp. 41.

Singh, A. K., Singh, S., Apparao V. V., Bagle, B. G., and More T. A., 2007. Recent advances in propagation techniques in arid fruits. Proceedings of National

Seminar on Recent advances in production, protection and post harvest management of Grape, mandarin and arid fruits. Organized by JNKVV, KNK College of Horticulture, Mandsaur, M.P. 458001 on March.17-18,2007

Singh, D, Shukla A. K, Bhargava, R, Awasthi O. P. and Dhandar D. G. (2006) Micropropagation technique of vegetable type cactus pear (*Opuntia ficus Indica*) In National Symposium on underutilized horticultural crops, 8-9 June IIHR Bangalore. pp. 64.

Singh, D, Shukla A. K, Bhargava, R, Awasthi O. P. and Dhandar D. G. (2006) Micropropagation technique of vegetable type cactus pear (*Opuntia ficus Indica*) In National Symposium on underutilized horticultural crops 8-9 June 2006 at IIHR Bangalore. pp. 64.

Singh, D., Singh, U. V., Shukla, A. K., Bhargava, R., Meena, S. R. and Dhandar, D. G. (2006) Enhancement of vegetative propagation efficiency of aonla under polyhouse in hot arid agro ecosystem In National Symposium on Input use Efficiency in Horticulture 9-11, August, 2006 IIHR Bangalore. pp. 61.

Singh, D., Shukla, A. K., Bhargava, R. Meena, S. R. and Dhandar, D. G. (2006) Landraces-A potential genetic resource for abiotic stresses for gene mining in developing arid horticultural crops In National Seminar on Gene Constructs 17-18 may, 2006 at IIHR, Bangalore pp. 71.

Singh, D., Shukla, A. K., Singh, R. S., and More, T. A. (2007). Capacity building of rural youth through in situ budding technique. In 8th Agril. Science Congress, TNAU, Coimbtore. 15-17 Feb. 2007 pp. 242.

Singh, I. S., Awasthi, O. P. and Dhandar, D. G. (2006). Water conservation, fruit yield and mulching in brinjal. Abstract of paper published in National Symposium on "Improving Input Use Efficiency in Horticulture" held during 9-11 August 2006 at Bangalore. pp. 97-98.

Singh, I. S., Dhandar, D. G., Awasthi, O. P. and Meena, S. R. (2006). Soil water conservation measures in brinjal (*Solanum melongena* L.). Abstract of paper published in conference on "Natural Resource Management for sustainable Development in Western India (NRMSD-2006)" hled during 11-13 October, 2006 at Pune. pp. 54-55.

Singh, R. S., Bhargava, R. and Dhandar, D. G. (2006). Date palm (*Phoenix dactylifera* L.) Cultivation. Book chapter In. Underutilized Horticultural crops. Vol. II (edited by Peter *et al*, 2007), New India Publishing Agency, New Delhi.

Singh, R. S., Sharma, B. D. and More, T. A. (2007). Water management in Pomegranate, In National Seminar on Recent advances in production, protection and post harvest manament of Grape, Mnadarin and arid fruits held at KNK College of Horticulture, Mandsaur,(MP) during 17-18 March, 2007.

Singh, S., Singh, A. K., Joshi, H. K., Bagle, B. G. and More, T. A. (2007). Reproductive biology of Rayan (*Manilkara hexandra*) under semi-arid tropics of Western India. Proceedings of National Seminar on Recent advances in production, protection and post harvest management of Grape, mandarin and arid fruits. Organized by JNKVV, KNK College of Horticulture, Mandsaur, M.P. on March, p. 105.

Singh, S., Singh, A. K., Joshi, H. K., Bagle, B. G. and More, T. A., 2007. Impact of tree storage on fruit quality of aonla under semi arid ecosystem of Western India. Proceedings of National Seminar on Recent advances in production, protection and post harvest management of Grape, mandarin and arid fruts. Organized by JNKVV, KNK College of Horticulture, Mandsaur, M. P., March, P. 107.

Singh, Sanjay., Singh, A. K., Joshi, H. K., Bagle, B. G. and Dhandar, D. G (2006). Genetic diversity in *Rayan* (*Monilkara hexandra*) under semi arid tropics of western India. National symposium on production, utilization and export of under utilized fruits with commercial potentialities at BCKV, Kalyani Nadia West Bengal during November 22-24, 2006, pp. 10.

Singh, Sanjay., Singh, A. K., Joshi, H. K., Bagle, B. G. and Dhandar, D. G. (2006). Developmental pattern and standardization of maturity indices in *jamun* (*Syzygium cuminii* Skeels) under semi arid ecosystem of western India. National symposium on production, utilization and export of under utilized fruits with commercial potentialities at BCKV, Kalyani Nadia West Bengal during November 22-24,2006, pp. 14.

Singh, Sanjay., Singh, A. K., Joshi, H. K., Bagle., B.G. and T. A., More, (2007). Impact of tree storage on fruit quality of aonla under semi arid ecosystem of western India. National Seminar on Recent Advances in Production, Protection and post harvest Management of Grape, Mandarin and Arid Fruits at KNK college of Horticulture, Mandsaur, MP during 17-18th March, 2007. pp 106.

Singh, R. S., Sharma, B. D. and More, T. A. (2007). Irrigation management in pomegranate. In: Proceedings of National Seminar on Recent Advances in Production, Protection and Post

Harvest Management of Grape, Mandarin and Arid Fruits at KNK COH (JNKVV), Mandsaur, March 17-18. 2007. P:

Singh, A. K., Hiwale, S. S., Singh., Bagle, B. G., and More, T. A., 2007. Promising varieties of aonla. Proceedings of National Seminar on Recent advances in production, protection and post harvest management of Grape, mandarin and arid fruits. Organized by JNKVV, KNK College of Horticulture, Mandsaur, M.P. on March, 17-18, 2007.

## Books and chapters

Awasthi, O. P. (2005). Tamarind (*Tamarindus indica* L.). In: Prospects and Dimensions for Utilization of Arid Foods Book (Madhu Goyal and Shanti K. Sharma, Eds), Yash Publishing House, Bikaner.

Awasthi, O. P. (2006). Pilu (*Salvadora oleoides*) In Book on Advances in Arid Horticulture (Production technology of Arid and semiarid fruits) (Saroj, P.L. and Awasthi, O.P.; Eds.), International Book Distributing Co. Lucknow. pp. 395-404.

Awasthi, O. P. (2006). Fruit based cropping system in arid and semi arid region. Compendium of winter school on sustainable Farming Systems for Arid and Semi arid Eco-Systems, Organised by CAZRI, Regional Research Station, Bikaner from 4-24 Nov. 2006.

Awasthi, O. P., Singh, D. and Shukla, Anil. K. (2006). Karonda (*Carissa congesta*) In: Advances in Arid Horticulture Vo2. (Production technology of Arid and semiarid fruits) (Saroj, P.L. and Awasthi, O.P.; Eds.), International Book Distributing Co. Lucknow. pp. 243-256.

Awasthi, O. P. and Saroj, P. L. (2006) Manilla Tamarind (*Pithecellobium dulce*). In Book on Advances in Arid Horticulture Vol. 2 (Production technology of Arid and semiarid fruits) (Saroj, P.L. and Awasthi, O.P.; Eds.), International Book Distributing Co. Lucknow. pp. 319-332.

Pareek O. P. and Shukla A. K. (2006) Prospect of value addition in Arid region. Prospects and Dimensions for Utilization of Arid Foods (Eds Goyal etal) Yash Publishers (Academic Book center) Bikaner pp309-315.

Samadia, D. K. (2006). Cucurbitaceous crop culture for arid and semi arid regions. Chapter in compendium of winter school on "Sustainable farming systems for arid and seni arid eco-systems. 04-24 November 2006. RRS, CAZRI, Bikaner. 124-126 pp.

Samadia, D. K. (2006). Mateera. Book chapter in " Prospects and dimension for utilization of arid foods. (Eds. Madhu Goyal and S. K. Sharm) Yash Publishing House, Bikaner. 79-83 pp.

Samadia, D. K. (2006). Snapmelon. Book chapter in "Prospects and dimension for utilization of arid foods. (Eds. Madhu Goyal and S. K. Sharm) Yash Publishing House, Bikaner. 75-78 pp.

Samadia, D. K., R. C. Aswani and D. G. Dhandar (2005). Collecting genetic variability in gourd cucurbits from tribal areas of Rajasthan and Gujarat. In: Diversification of agriculture through horticultural crops (Eds. Pandey *et al.*) NHRDF Nasik pp. 64-70.

Saroj, P. L. and Awasthi, O. P. (2006). Advances in Arid Horticulture, (Production Technology of Arid and Semiarid Fruits), Vol.II, International Book Distributing Co. Lucknow, p 539.

Saroj, P. L., Dhandar, D. G. and Awasthi, O. P. (2006). Ker (*Capparis deciduas*). In: Advances in Arid Horticulture Vol. 2 (Production technology of Arid and semiarid fruits (Saroj, P.L. and Awasthi, O.P.; Eds.), International Book Distributing Co. Lucknow. pp. 257-266.

Shukla Anil Kumar, Shukla Arun Kumar, Singh, D. (2006) Post harvest handling of horticultural crops. Prospects and Dimensions for Utilization of Arid Foods (Eds Goyal etal) Yash Publishers (Academic Book center) Bikaner pp. 15-21

Singh, D., Shukla A. K., and Meena S. R., (2006) Prospects of biotechnological research in horticulture based farming system. Lecture delivered in winter school on sustainable farming system for arid and semi arid eco system at CAZRI, Bikaner 4-24 Nov. 2006.

Singh, D., Shukla Anil Kumar Shukla Arun Kumar (2006) Maturity standards for value addition. Prospects and Dimensions for Utilization of Arid Foods (Eds Goyal etal) Yash Publishers (Academic Book center) Bikaner pp. 31-47.

Singh, D., Dhandar, D. G. and Shukla, A. K. (2007) *In-vitro* clonal propagation of lasoda (*Cordia myxa* Roxb.) - An arid fruit tree. In Recent Advances Horticultural Biotechnology (Eds Keshavachandran etal)).

## Technical bulletins

Nallathambi, P., Umamaheswari, C. and Dhandar, D. G. (2007). Ber Diseases and Management, Publs. Central Institute for Arid Horticulture, Bikaner, 33 p.

Sanjay Singh, Singh, A. K., Joshi, H. K., Bagle, B. G. and Dhandar, D. G., (2007). Jamun – A fruit for future, Central Institute for Arid Horticulture, Bikaner

Sanjay Singh, A. Nagaraja, Singh, A. K., Joshi, H. K., Bagle, B. G., and Dhandar, D. G., (2007). Post Harvest Management in Aonla and Ber, Central Institute for Arid Horticulture, Bikaner

## Popular articles

यादव, एम.के., अवस्थी, ओ. पी. एवं सिंह, आई. एस., (2006). फलोद्यान में जल प्रबन्ध, *राजस्थान खेती*, 2 (12) : 7–9.

दिलीप कुमार समादिया (2005) शुष्क क्षेत्र में स्नेपमेलान की उपज पर पादप वृद्धि नियामक तत्वों एवं नमी संरक्षण क्रियाओं का प्रभाव। मरू बागवानी (1) : 21 – 26.

एम. के. यादव व आई.एस. सिंह (2006) उद्यानिकी फसलों में प्लास्टिक मल्चींग। नर्मदा कृषि परिवार, 18 (2) : 10–11.

Singh Sanjay, Singh, A. K., and Bagle, B. G., (2006). Chironji (*Buchanania lanzan* Spreng)- A boon for tribals. Intensive Agriculture, March- April, page 1-2.

Singh Sanjay, Singh, A. K., and Bagle, B. G., (2006). Propagation of jamun (*syzygium cuminii* skeels) by *in situ* soft wood grafting. Agriculture Update, 1 (3): 43-44.

Singh Sanjay, Singh, A. K., and Bagle, B. G., (2006). Successful propagation techniques in tamarind. Agriculture Update, 1 (3): 36-38.

Singh, A. K., Singh, Sanjay., Apparao, V.V., Meshram, D. T., Bagle, B. G. and Dhandar, D. G. (2006). Mulching for sustainable production of aonla under rainfed condition. *Agriculture Update*, (3): 6-8.

## Radio talk

Sharma, B. D., *Bagaon mei urvarko ka prayog*, AIR, Bikaner, Dated: 23-09-2005.

Sharma, B. D. *Sichai jal ki upyogita evam prabandh*, AIR, Bikaner, dated: 3-01-2006.

# Research Programmes and Projects

# 9

| Code | Title | Investigators |
|---|---|---|
| **CIAH, Bikaner** | | |
| B1. | Introduction, collection, characterization, conservation and evaluation of arid fruit crops under hot arid environment. | Dr. T. A. More<br>Dr. R. S. Singh<br>Dr. O. P. Awasthi<br>Dr. Arun Kumar Shukla |
| B.1.1 | Introduction, collection, characterization, conservation and evaluation of *Ziziphus* spp. under hot arid environment. | Dr.O. P. Awasthi<br>Dr. P. Nallathambi |
| B.1.2 | Introduction, collection, characterization, conservation and evaluation of Pomegranate under hot arid environment. | Dr. R. S.Singh<br>Dr. S. S. Hiwale<br>Dr. C. Umamaheswari<br>Shri A. Nagaraja |
| B.1.3 | Introduction, collection, conservation and evaluation of date palm (*Phoenix* sp.) under hot arid region. | Dr. R. S. Singh<br>Dr. R. Bhargava |
| B.1.4 | Introduction, collection, characterization, conservation and evaluation of aonla under hot arid environment. | Dr. Arun Kr. Shukla<br>Dr. P. Nallathambi<br>Dr. Dhurendra Singh |
| B.1.5 | Introduction, evaluation and improvement of indigenous and exotic fruits of arid region. | Dr. R. S. Singh<br>Dr. O. P. Awasthi<br>Dr. D. K. Samadia<br>Shri A. Nagaraja |
| 1.6 | Introduction, collection, characterization, conservation and evaluation of Bael (*Aegle marmelos* Correa.) under arid conditions. | Dr. R. S. Singh<br>Dr. Sanjay Singh<br>Dr. A. K. Singh<br>Shri A. Nagaraja |
| B.2. | Introduction, collection, characterization, conservation and evaluation of vegetable crops under hot arid environment. | Dr. T. A. More<br>Dr. D. K. Samadia<br>Dr. P. Nallathambi |
| B.2.1 | Introduction, collection, characterization, conservation and evaluation of cucurbit vegetable crops under hot arid environment. | Dr. D. K. Samadia<br>Dr. P. Nallathambi |
| B3 | Improvement of arid fruits by selection and hybridization under arid environment | Dr. T. A. More<br>Dr. R. S. Singh<br>Dr.O. P. Awasthi<br>Dr. C. Umamaheswari |
| B 3.1 | Improvement in ber | Dr T. A. More<br>Dr. O. P. Awasthi<br>Dr. C. Umamaheswari |
| B 3.2 | Improvement in pomegranate by selection and hybridization | Dr T. A. More<br>Dr. D. K. Samadia<br>Dr C. Umamaheswari |

| Code | Title | Investigators |
|---|---|---|
| B 4 | Improvement in vegetable crops under hot arid environment | Dr. T. A. More<br>Dr. D. K. Samadia<br>Dr. P. Nallathambi |
| B 4.1 | Improvement in cucurbitaceous vegetables under hot arid environment | Dr. D. K. Samadia<br>Dr. P. Nallathambi |
| B5 | Evaluation of aonla based diversified cropping models evluation of aonla based diversified cropping models in arid eco-system | Dr. O. P. Awasthi<br>Dr. T. A. More<br>Dr. R. Bhargava<br>Dr. Arun Kr. Shukla<br>Dr. I. S. Singh |
| B6 | Standardization and commercialization of micro-propagated techniques of horticultural crops under arid agro-eco-system | Dr. Dhurendra Singh<br>Dr. Arun K. Shukla<br>Dr. R. Bhargava<br>Dr. O. P. Awasthi |
| B7 | Studies on growth and development in some cucurbitaceous crops under water stress | Dr. R. Bhargava |
| B8 | Studies on physiological adaptations to water stress in arid fruit species | Dr. R. Bhargava |
| B9 | Response of substitution of manures and fertilizers with vermicompost | Dr. B. D. Sharma<br>Dr. R. Bhargava |
| B10 | Integrated approaches involving organic and biodynamic farming for quality production of some fruit and vegetable crops under arid ecosystem | Dr. B. D. Bharma<br>Dr. T. A. More<br>Dr. R. Bhargava<br>Dr. P. Nallathambi<br>Dr. D. K. Samadia<br>Dr. I. S. Singh |
| B11 | Identification of *in-situ* water conservation measures for increasing the production potential of vegetable crops (brinjal and kachari) grown under arid conditions. | Dr. I. S. Singh<br>Dr. O. P. Awasthi<br>Dr. B. D. Sharma |
| B12 | Exploitation of PGPR for disease suppression, growth promotion and field establishment of planting material of arid fruit and vegetable crops | Dr. P. Nallathambi<br>Dr. T. A. More<br>Dr. C. Umamaheswari<br>Dr. Dhurendra Singh<br>Dr. R. Bhargava<br>Shri. A. Nagaraja<br>Dr. I. S. Singh |
| B13 | Post harvest handling and processing studies in arid zone horticultural crops. | Shri A. Nagaraja |
| B13.1 | Studies on processing techniques in *khejri* (*Prosopis cineraria*). | Shri A. Nagaraja |
| B13.2 | Dehydration of *kachri* (*Cucumis calosus*). | Shri A. Nagaraja |
| B14 | An assessment of arid horticultural status in Bikaner district of Rajasthan | Dr. S. R. Meena<br>Dr. R. S. Singh<br>Dr. Arun Kumar Shukla<br>Dr. I. S. Singh |
| B15 | Study on horticultural development in IGNP area of Bikaner district | Dr. S. R. Meena<br>Dr. T. A. More<br>Dr. O. P. Awasthi |

| Code | Title | Investigators |
|---|---|---|
| **CHES, Godhra** | | |
| G1 | Collection, introduction and evaluation of germplasm of wood apple and other fruits crops | Dr. S. S. Hiwale |
| G2 | Collection, introduction and evaluation of under exploited fruits (jamun, tamarind, bael, mahua and chiraunji) | Dr. Sanjay Singh<br>Dr. A. K. Singh |
| G3 | Standardization of production technology of aonla (*Emblica officinalis* Gaertn) | Dr. A. K. Singh<br>Dr. Sanjay Singh<br>Dr. D. T. Meshram |
| G4 | Standardization of agro-techniques on some semi-arid fruits-ber, pomegranate and phalsa | Dr. S. S. Hiwale<br>Dr. Sanjay Singh<br>Dr. A. K. Singh |
| G5 | Breeding for yield, quality, biotic and drought resistance in cucurbitaceous crops | Dr. S. Raja<br>Dr. B.G. Bagle<br>Dr. H. K. Joshi |
| G6 | Crop regulation in moringa and Inter cropping system under semi- arid condition | Dr. S. Raja<br>DR. B.G.Bagle<br>Dr. V. V. Appa Rao |
| G7 | Nutrient management in aonla and sapota | Dr. V. V. Appa Rao |
| G8 | Soil and water conservation management in water shed management. | Dr. D. T. Meshram<br>Dr. V. V. Appa Rao |
| G9 | Storage studies in aonla and ber | Dr. Sanjay Singh<br>Dr. A. K. Singh,<br>Dr. H. K. Joshi |
| G10 | Standardization of organic farming in some semi arid fruits | Dr. S. S. Hiwale,<br>Dr. V. V. Appa Rao |
| G 10.1 | Organic farming in vegetable crops in semi arid system | Dr. V. V. Appa Rao<br>Dr. H. K. Joshi<br>Shri S. Raja |
| G11 | Integrated orchard management (ber, pomegranate and aonla) | Dr. B. G. Bagle<br>Dr. H. K. Joshi<br>Shri S. Raja |
| G12 | Integrated disease management in semi-arid horticultural crops | Dr. H. K. Joshi,<br>Dr. B. G. Bagle |
| G13 | Biological control of diseases of semi-arid fruits and vegetables. | Dr. H. K. Joshi,<br>Dr. B. G. Bagle |
| G14 | Strategies for adoption of integrated horticultural technologies | Shri V. Lenin |
| **Externally funded projects** | | |
| EF1 | Adhoc scheme: Aonla based cropping system under arid ecosystem. | Dr. O. P. Awasthi |

# RAC, IMC, SRC with Significant Decisions

# 10

## Research Advisory Committee

### Chairman
Dr S. P. Ghosh
Ex-DDG (H), ICAR
37, Qutab New Apartment, Opp. Qutab Hotel
New Delhi 110 066

### Members
Dr. T. A. More
Director
CIAH, Bikaner

Dr. S. N. Sharma
Professor
Department of Agronomy
Institute of Agricultural Sciences
B.H.U., Varanasi

Dr. O. P. Pareek
Ex-Director (CIAH)
A-239, Karni Nagar (Lalgarh)
Bikaner 334 001

Dr. Y. R. Sharma
Ex- Director of IISR, Calicut
Adramam, M-10/5, KSHB Colony
Melaparamba P.O.
Kozhikode 673 009 (Kerala)

Dr. Samarjit Rai
Scientist (Emeritus)
IIVR, Arazilines,
Varanasi 221 005 (U.P.)

Dr. S. N. Pandey
ADG (Hort.), ICAR
KAB–II, Pusa Campus
New Delhi 110 012

Dr. G. C. Srivastava,
Head of the Division of Plant Physiology
IARI, Pusa Campus
New Delhi 110 012

### Member Secretary
Dr. R. Bhargava

### Salient decisions
- Varieties developed at Bikaner had prefixed "Thar" whereas those developed at CHES, Godhra were prefixed as "Goma". The Chairman was of the opinion that the Institute should have only one Prefix name, which the Institute may decide.
- Institute should undertake work on DNA finger printing of released varieties and electrophoretic patterns of germplasm lines of all mandate crops.
- The farmer's field situation should be simulated on the research farm and accordingly experiments may be laid out.
- Rain-fed farming should be attempted both at Bikaner and CHES, Godhra.
- Studies on rainwater harvesting should be taken up.
- The farmers should be encouraged to propagate their own elite plants on their field.
- The studies on evaluation of optimum canopy size need to be worked out.
- The studies on micro-propagation of date palm should be strengthen.
- Methods for managing frost needs to be worked out.
- Escape mechanism of fruit fly needs to be worked out.
- Clones which shows minimum cracking in pomegranate needs to be identified.

- Impact analysis of improved technologies needs to be taken up.
- Studies on PRA should be taken up by the Institute.
- Canopy analysis in fruit crops needs to be taken up.
- Physiological efficiency of arid horticultural crops in terms of carbon, water and nutrient use efficiency should be worked out.
- For understanding the mechanism of fruit cracking parameters such as leaf thickness, relative water content, nitrogen content etc., should be studies.
- The studies on date palm propagation through micro-propagation or horticultural means should be given more emphasis.
- Inter-institutional programmes should be developed.
- The studies on drip irrigation should also taken into account the phonological stage of plant and its economics should be worked out
- Host-plant relationship should be studied.
- Use of trap crops may be tried to manage the major pests and diseases.
- Bio-control of fruit fly, using pheromone traps should be taken up on community basis.
- Impact analysis should be done by laying out demonstrations, etc.
- Institute should make very clear cut programmes which will be adopted during XI plan.
- All the scientists to read the literature and become update with the latest information in their field.
- All the scientists to put their sincere efforts to achieve the goals set in their respective research projects.

## Institute Management Committee

### Chairman

Dr. T. A. More
Director, CIAH, Bikaner

### Memebrs

Dr. Abraham Verghese
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 (Selection Grade), CHES, Vejalpur

### Invited members

Dr. B.G. Bagle
Head, CHES, Vejalpur

Dr. R.S. Singh
Principal Scientist, CIAH, Bikaner

Dr. R. Bhargava
Senior Scientist, CIAH, Bikaner.

Sh. S.C. Sharma
AFAcO, CIAH, Bikaner

Sh. V.K. Pandey
AAO, CIAH, Bikaner.

### Member Secretary

Sh. Mani Ram
Administrative Officer, CIAH, Bikaner

### Salient decisions

- The committee expressed satisfaction over the progress on various points as per Action Taken Report.
- Details of progress made in the field of research activities were briefed by the Director, CIAH, Bikaner and the members expressed satisfaction over the progress made.
- The committee noted the expenditure incurred during 2005-06 with satisfaction and ratified the reappropriation of funds as proposed, since reappropriation was made within overall allocated budget which was essential for full utilization of funds and met out the demands of funds in the respective sub-heads.
- The committee observed that the expenditure under Plan is on very lower side. The Institute should make all out efforts to achieve the targets and utilize the allocation fully.

- The committee observed that progress of procurement of equipments sanctioned under Plan is slow and needs vigorous efforts to expedite so that funds provided for the purpose are fully utilized.
- The committee recommended ensuring the procurement of the equipment promptly. It also noted the progress made for execution of sanctioned works. The furnishing work of Conference Hall and Museum needs concrete efforts with the CPWD and other agencies so that these works are completed
- The committee noted the progress made and emphasized that all out efforts should be made to get all the sanctioned works completed within the current financial year.
- The committee considered the cases of substitution/replacement of equipments/items sanctioned under X$^{th}$ Plan. Keeping in view the period left for procurement and justification for substitution, the committee recommended the substitution as proposed by the Institute vide agenda item No. D(1) since all the proposed Equipments/Items are essentially required for day today work of different laboratories and units of the Institute.
- The committee considered the cases of substitution/replacement of equipments/items sanctioned under X$^{th}$ Plan. Keeping in view the period left for procurement and justification for substitution, the committee recommended the substitution as proposed by the Institute vide agenda item No. D(2) since all the proposed Equipments/Items are essentially required for day today work of different laboratories and units of the Institute.
- On the recommendations of the IMC meeting held on 10.03.2006 the tenure of two Authorized medical Attendants at CHES, Vejalpur was extended for a period of six months (01.04.2006 to 30.09.2006). Now, in order to avoid difficulty to the staff of the regional station, the Committee recommended extension for a further period of Six months for two doctors as AMA of the Station (01.10.2006 to 31.03.2007).
- To provide the medical treatment to the staff and their family members posted at CHES, Vejalpur, the Committee recommended the panel of four doctors for declaring them as AMA for the Regional Station for an initial period of one year w.e.f. 01.04.2007

  Dr. Nandan Parikh, MD Physician, Jivan Jyot Hospital, Godhra

  Dr. Tarun Shah, MD, Child Specialist, Kalrav ospital, Godhra

  Dr. Suzat Vali, MD Gynecologist & Leproscopy Surgeon, Lara Hospital, Godhra.

  Dr. Esufi, MBBS, Skin & VD Specialist, Near Kadia Masjid, Godhra.
- After brief discussion it was unanimously agreed to hold the next meeting of IMC at CHES, Vejalpur.

## Staff Research Council

### Chairman

Dr. T. A. More
Director, CIAH, Bikaner

### Members

All scientists of the institute

### Members Secretary

Dr. P. Nallathambi
Senior scientist (Plant Pathology)

### Salient decisions

- The importance of arid horticulture in India was highlighted. The productivity of horticultural crops is less then the production, where it needs consistent research backing particularly from IPM, IDM, INM etc., for the farmers.
- As far as arid and semi-arid horticultural crops are concerned, the CIAH, Bikaner and CHES, Vejalpur should be the leaders in the country with specific research areas which are not generally repeated in SAUs and other research organizations. Therefore, simple and normal

experiments should be avoided. The basic research works for achieving farmers oriented technologies should be done and the CIAH, Bikaner should be transformed with the latest research strategies and accordingly the existing research programmes need refinement.

- It was emphasized to continue with the ongoing technical programme of various research projects, which have been already approved by the SRC. However, new works or experiments may be added in existing programme but minimum the approved technical programme should be followed scrupulously.
- Since the meetings for various research programmes are not conducted in stipulated period, the House has decided after a detailed deliberation that the SRC meeting will be held during the first week of May and the RAC meeting will be conducted during September–October months every year. The Member Secretaries concerned of these meetings should initiate necessary activities well in time to avoid any lapse in this particular case.
- Having discussed the issue of authorship in research papers for publication, it was decided that the P. I should rationally decide the names of authors considering the the contribution made by the individual scientist.
- It was decided that the two varieties of ber, one of aonla, one of khejri and one of mateera be released by the institute for which concerned scientists (Dr. O. P. Awasthi, Dr. S. S. Hiwale and Dr. D. K. Samadia) would submit the proposals to the Variety Release Committee of the Institute. Varieties of khejri and mateera be released on priority. Relevant data, if any, is with Dr. B. B. Vashishtha, Director, NRCSS, Ajmer and former Principal Scientist, CIAH, Bikaner, be also collected for this purpose.
- The House was in opinion that remaining all P.Is should submit their research projects as per the mandate and specific recommendations of the RAC. ❑

# Conferences, Training and Lectures etc.

# 11

| Scientists | Title | Venue | Duration |
|---|---|---|---|
| Dr. T. A. More | • Short course on Vigilance, administration and management. | NDRI, Karnal | 5-7 December 2006 |
| | • First SAC meeting | CHES, Vejalpur | 11 January 2007 |
| | • Capacity building and skill development for employment generation in Horticulture sector during the 8th Agricultural Science Congress | TNAU, Coimbatore | 15-17 February 2007 |
| | • Meeting on Mega Seed Project | ICAR, New Delhi | 1-2 March 2007 |
| | • Working group meeting of Horticulture. Plantatioan and organic farming for formulation of XI th Five Year Plan (2007-2012) | Yojana Bhavan, New Delhi | 21 March 2007 |
| Dr. B. G. Bagle | • National Seminar on Recent Advances in Production, Protection and post harvest Management of Grape, Mandarin and Arid Fruits. | KNK college of Horticulture, Mandsaur, MP | 17-18 March 2007 |
| | • Participated in XIIIth Biennial Group Worker's meeting of AICRP of Arid zone fruits. | SDAU, S.K.Nagar, Gujarat | 9-12 May 2006 |
| | • National Symposium on Improving import use efficiency in Horticulture | Banglore | 9-11 August 2006 |
| | • High–tech horticulture with special refernce to plant protection. | Jhabua | 15 January 2007 |
| | • Role of CHES, Godhra in tribal development Dahod | N.M. Satguru Trust | 24 January 2007 |
| Dr. R. S. Singh | • Participated in XIIIth Biennial Group Worker's meeting of AICRP of Arid zone fruits. | S.K.Nagar, Gujarat SDAU, | 9-12 May 2006 |
| | • Zonal Research Extension Advisory Committee Meeting for Kharif- 2006 at on | ARS, RAU, Bikaner | 18 August 2006 |
| | • Meeting on Information Bank and Vision-2025 of Director | Horticulture Division ICAR, KAB-II, New Delhi | 24.October 2006. |
| | • Directors Conference of ICAR | NASC Complex, Pusa, New Delhi | 3-4 November 2006 |
| | • QRT meeting | CSWRI, Arid Campus, Bikaner | 30 November 2006 |
| | • Delivered a lecture on Prospect of under utilized fruits in arid eco-system in Winter School on Sustainable Farming System for arid and semi arid system | CAZRI, RRS, Bikaner | 8 November 2006 |

| Scientists | Title | Venue | Duration |
|---|---|---|---|
| | • Dlivered a lecture on value addition in ber | KVK, RAU, Bikaner | 1 March 2007 |
| | • A lecture on Propagation techniques in date palm | KVK, RAU, Bikaner | 5 March 2007 |
| | • Delivered a lecture on Role of Bio-fencing in Pasture land development | KVK, RAU, Bikaner | 19 March 2007 |
| Dr. B. D. Sharma | • Vermicomposting | KVK, RAU, Bikaner | 30 June 2006 |
| | • Delivered a lecture on Role of Horticulture dry land farming, Preparation of Vernicompost, | KVK, RAU Bikaner, | July 2006 |
| | • Attened a training on Developing Winning Proposals in Agricultural Research. | NAARM, Hyderabad | April 27 to May 2, 2006 |
| Dr. S. S. Hiwale | • National symposium on production, utilization and export of under utilized fruits with commercial potentialities | BCKV, Kalyani Nadia West Bengal | 22-24 November 2006 |
| | • Participated in XIIIth Biennial Group Worker's meeting of AICRP of Arid zone fruits. | S.K.Nagar, Gujarat SDAU, | 9-12 May 2006 |
| | • National Symposium on Improving import use efficiency in Horticulture | Banglore | 9-11 August 2006 |
| | • National seminar on Custard apple and fig by Maharashtra state Custard apple council | College of Agriculture, Pune | 10-11 September 2006 |
| | • Delivered a lecture on the improved production technology of aonla | KVK, CHES, Vejalpur | 18 November 2006 |
| | • Advances in arid zone fruit culture | MPKV, Rahuri | 2 January 2007 |
| Dr.Sanjay Singh | • National Symposium on under utilized horticultural crops | IIHR, Bangalore | 8-9 June 2006 |
| | • National symposium on production, utilization and export of under utilized fruits with commercial potentialities | BCKV, Kalyani Nadia West Bengal | 22-24 November 2006 |
| | • Scope of minor fruits under arid conditions. | KNK college of Horticulture, Mandsaur | 17-18th March 2007 |
| | • Recent advances in propagation techniques of arid fruits during the seminar. | | |
| | • Delivered a lecture on the improved production technology of aonla | KVK, CHES, Vejalpur | 18 November 2006 |
| Dr. D. Singh | • National Seminar on Gene construct | IIHR, Bangalore | June 2006 |
| | • National Seminar on Production, development, quality and export of seed spices-Issues and strategies. | NRCSS, Ajmer | 2-3 February 2007 |
| | • Meeting on mega seed project on Agriculture crops and fisheries | NASC, Complex New Delhi | 24-25 June 2006 |
| | • Participated in XIIIth Biennial Group Worker's meeting of AICRP of Arid zone fruits. | S.K.Nagar, Gujarat SDAU, | 10-12 May 2006 |
| Dr. H. K. Joshi | • Delivered a lecture on the improved production technology of aonla | KVK, CHES, Vejalpur | 18 November 2006 |

| Scientists | Title | Venue | Duration |
|---|---|---|---|
| | • Attended Zonal workshop of KVK Zone-VI | S.K.Nagar, Gujarat | 4-6 November 2006 |
| | • National Seminar on KVK | ANGRAU, Hyderabad | 26-27 November 2006 |
| | • Third AGRESCO Meeting | AAU, Anand | 6-7 February 2006 |
| | • State level Seminar on Horticultural crops | Jhabua M.P. | 12 February 2007 |
| | • Attended orientational workshop for KVK | EEI,AAU, Anand | 22-23 March 2007 |
| Dr. A. K. Shukla | • National Seminar oo production, utilization and export of underutilized fruit | BCKV, Kalyani | 22-24 November 2006 |
| | • National Seminar on Production, development, quality and export of seed spices-Issues and strategies. | NRCSS, Ajmer | 2-3 February 2007 |
| Dr. S. R. Meena | • National Seminar on Production, development, quality and export of seed spices-Issues and strategies. | NRCSS, Ajmer | 2-3 February 2007 |
| | • Attendd 21 days winter school training programme on " sustainable farming system for arid and same – arid ecosystem | RRS, Bikaner of CAZRI, Jodhpur | 4-24 November 2006 |
| Dr.V. V. Apparao | • Delivered a lecture on the improved production technology of aonla | KVK, CHES, Vejalpur | 18 November 2006 |
| Dr A. K. Singh | • National symposium on under utilized horticultural crops | IIHR, Bangalore | 8-9 June 2006 |
| | • National symposium on production, utilization and export of under utilized fruits with commercial potentialities | BCKV, Kalyani Nadia West Bengal | 22-24 November 2006 |
| | • National Seminar onRecent Advances in Production, Protection and post harvest Management of Grape, Mandarin and Arid Fruits | KNK college of Horticulture, Mandsaur, MP | 17-18 March 2007 |
| | • Delivered a lecture during workshop of *Krishi Kranti KhaliananiKarya Shivir* on the *topic phalon ki khe* | Jila Kheti Wadi Meeting Hall, Jila Panchayat, Gujarat. | 19, October 2007 |
| | • Delivered a lecture on the topic production technology of aonla | CHES, Vejalpur | 6, December 2007 |
| | • Attended meeting of District watershed Committee | Collector Office, Panchmahals | 03, January, and 10 July 2007 |
| | • Delivered a lecture on the improved production | KVK, CHES, Vejalpur | 18 November 2006 |
| Dr. I. S. Singh | • National symposium on "Improving Input Use Efficiency in Horticulture | Bangalore. | 9-11 August 2006 |
| | • National Conference on "Natural Resource Management for sustainable Development in Western India | Pune | 11-13 October 2006 |
| Sh. R. Nagarjuna Kumar | • Summer School on GIS based decision support systems for sustainable agriculture. | NAARM, Hyderabad | 5-25 July 2006 |
| | • Design & Development of Web based Application using .NET Technology | IASRI, New Delhi | 22 November to 12 December 2006 |
| | • Hindi training | NAARM, Hyderabad | 6.1.2007 to 1.2.2007 |

# Workshops, Meetings and Farmers' Day Organized

# 12

| Programme/activity | Total | Type of beneficiaries | Total No. of beneficiaries (Approx.) | |
|---|---|---|---|---|
| | | | Directly | Indirectly |
| Farmer's training on/off campus | 06 | Farmers | 280 | 1000 |
| Trainers training (on/off campus) | 02 | Extension workers | 38 | 124 |
| Technological demonstrations/trials. (a) Improved varieties of vegetables and their agro-techniques | 07 | Farmers | 07 | 215 |
| (b) Improved arid fruit crops and their agro techniques. | 04 | Farmers | 04 | 153 |
| Visit of farmers to the Institute | 1168 | Farmers | 1168 | — |
| Visit of Scientific group/teachers/experts | 48 | Scientists/educators | 48 | — |
| Visit of students | 77 | Agricultural students | 77 | — |
| Exhibition in farmer's fair/at the Institute | 03 | Farmers/extension workers | 832 | — |
| Exhibition at Institute | 02 | Farmers extension workers and experts | 111 | — |
| Press publicity | Several technical press notes in new papers | Farmers extension workers and experts | — | — |
| Press conferences | 02 | Media persons farmers, extension workers, experts etc. | — | — |
| Farmer's meeting group discussion | 22 | Farmers | 609 | — |
| Formation of self- help group of farmers | 02 | Farmers | 20 | 322 |
| Visit to farmer's field | 37 | Farmers | 148 | 422 |
| Distribution of technical literature | 1806 | Farmers | 1806 | — |

## First scientific advisory committee meeting of KVK, Godhra

The first Scientific Advisory Committee Meeting of KVK was held at the Godhra on 11.1.07 in the Chairmanship of Dr. T. A. More, Director, C.IA.H,Bikaner. The meeting was attended by important dignitaries viz. Dr. M. K. Mandape, Zonal coordinator, ToT, Zone, -VI, ICAR, Jodhpur, Dr. P. P. Patel, Director, EEI, AAU, Anand, Dr. R. H. Patel, Joint Director, Research, AAU, Anand, Dr. C. P. Desai, Joint Director, EEI, AAU, Anand, Sh.M. B. Dhorajia, Joint Director (Horticulture), Panchmahals, District level officers of the line departments, Shri N. C. Mal, Regional Manager of NABARD, representatives of farmers and farm women, and Head and Scientists and officers of CHES,Vejalpur, etc. The Committee gave valuable suggestions for improvement of functioning of the newly established KVK.

# Distinguished Visitors 13

Dr. Mangala Rai, DG, ICAR, visiting High Tech Glass houses complex

Inauguration of Hitch-glass houses complex

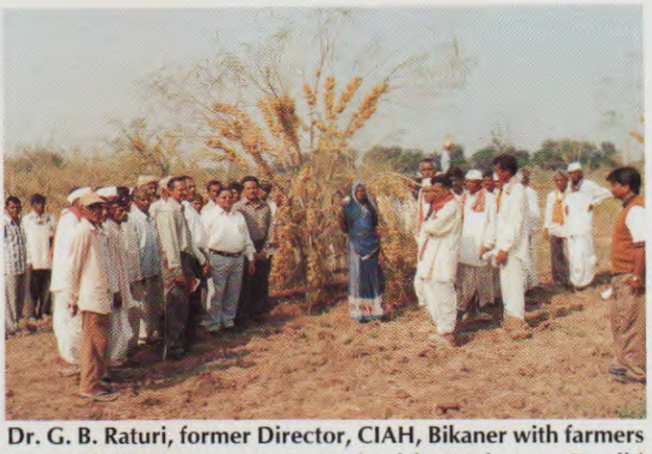
Inauguration of Institute's Exhibition

Inspecting performance of sword bean

Visiting post harvest products of arid fruits and vegetables

Visit of RAC team

RAC meetings at CIAH, Bikaner



Dr. G. B. Raturi, former Director, CIAH, Bikaner with farmers in a training programme organized by Mahatma Gandhi Pratishthan and Krishi Vigyan Kendra, Vejalpur


Dr.T. A. More, Director, CIAH, Bikaner delivered presidential address to the 1st SAC meeting of the KVK, Vejalpur

# Personnel

# 14

| S. No. | Name | Designation/Discipline |
|---|---|---|
| | | **CIAH, Bikaner** |
| **Research Management Position** | | |
| 1. | Dr. D. G. Dhandar | Director up to 30-9-2006 |
| 2. | Dr. T. A. More | w.e.f. 21-11-2006 |
| **Scientific** | | |
| 1. | Dr. R . S. Singh | Principal Senior (Horticulture) |
| 2. | Dr. B. D. Sharma | Senior Scientist (Soil Science) |
| 3. | Dr. R. Bhargava | Senior Scientist (Plant Physiology) |
| 4. | Dr. P. L. Saroj | Senior Scientist (Horticulture) at present on deputation to SVBPUAT, Meerut. |
| 5. | Dr. O. P. Awasthi | Senior Scientist (Horticulture) |
| 6. | Dr. P. Nallathambi | Senior Scientist (Plant Pathology) |
| 7. | Dr. D. K. Samadia | Senior Scientist (Horticulture) |
| 8. | Dr. Dhurendra Singh | Senior Scientist (Plant Biotechnology) |
| 9. | Dr (Smt). C. Umamaheshwari | Scientist Sr. Scale (Plant Pathology) up to 22.01.2006 |
| 10. | Dr. Anil Kumar Shukla | Scientist Senior Scale (Hort.) at present on deputation to MPUAT, Udaipur. |
| 11. | Dr. Arun Kumar Shukla | Scientist Senior Scale (Fruit Science) |
| 12. | Sh. A. Nagaraja | Scientist (Fruit Science) |
| 13. | Dr. S. R. Meena | Scientist (Agril.Extension) |
| 14. | Dr. Indu Shekher Singh | Scientist (Soil Sci.,Soil Phy. & SWC) |
| 15. | Sh. R. Nagarajuna Kumar | Scientist (Computer Application) |
| **Administration** | | |
| 1. | Sh. M. K. Pachauri | Administrative Officer (up to 20-9-2006) |
| 2. | Sh. Mani Ram | Administrative Officer (w.e.f . 16.10.2006) |
| 3. | Sh. V. K. Pandey | Assistant Administrative Officer |
| 4. | Sh. S. C. Sharma | Assistant Finance & Acctt.Officer |
| **Technical** | | |
| 1. | Sh. S. K. Pandey | T-5 (Technical Officer) Farm |
| 2. | Sh. M. K. Jain | T-4 (Senior Computer operator) |
| 3. | Sh. P. P. Pareek | T-4 (Hindi Translator) |
| 4. | Sh. G. R. Baria | T-4 (Field Technician) |
| 5. | Dr.U.V. Singh | T-4 (Field Technician) |
| 6. | Sh.C.L. Meena | T-4 (Field Technician) |
| 7. | Sh. Sanjay Patil | T-4 (Photographer cum Artist) |

## Regional Station (CHES, Godhra)

| S. No. | Name | Designation/Discipline |
|---|---|---|
| **Scientific** | | |
| 1. | Dr.B.G.Bagle | Head |
| 2. | Dr.Sanjay Singh | Sr. Scientist (Hort.) |
| 3. | Dr.S.S.Hiwale | Sr. Scientist (Hort.) |
| 4. | Dr.H.K.Joshi | Scientist (Sel. Grade) (Plant Pathology) |
| 5. | Dr.V.V.Apparao | Scientist Sr. Scale (Soil Science) |
| 6. | Mr.V.Lenin | Scientist Sr.Scale (Agril.Extn.) on study leave) |
| 7. | Dr.A.K.Singh | Scientist Sr.Scale(Hort.) |
| 8. | Mr.S.Raja | Scientist (Hort.)(on leave) |
| **Administrative** | | |
| 1. | Mr.J.B.Saxena | Astt. Admn. Officer |
| 2. | Mr. Ayaz Ahmed | Assistant Finance & Accounts Officer |
| 3. | Smt. R.K.Shah | Assistant |
| 4. | Mr. K.F.Kharkhariwala | Assistant |
| 5. | Smt. R.H.Meman | Personal Assistant |
| 6. | Mr.R.K.Solanki | Personal Assistant |
| **Technical** | | |
| 1. | Mr.D.K.Saraswat | T-8 (Technical Officer) Farm Management |
| 2. | Mr.Nihal Singh | T-6 (Technical Officer) Farm Management |
| 3. | Mr.G.U.Trivedi | T-5 (Librarian) |
| 4. | Mr.A.V.Dhobi | T-4 (Overseer) |
| 5. | Mr.M.N.Makwana | T-4 (Hindi Translator) |
| 6. | Mr. B.J.Patel | T-I-3(Artist-cum-Photographer |

### Promotion

1. Dr.V.V.Apparao,Scientist(Soil Science) has been promoted in the grade of Scientist (Senior Scale) w.e.f. 05.07.2002.

### Administration

1. Shir. Ghanshyam Khatri, SSG-II has been promoted to the post of L.D.C. in February, 2007 through Limited Departmental Competitive Examination.

### Transfers

1. Dr. C. Umamaheswari Scientist (Senior Scale) Plant Pathology- has been transferred as Senior Scientist to I.R.I.R., New Delhi on 22.01.2007 (A.N).
2. Sh.. D. T. Meshram,Scientist (S&WCE) has been transferred from CHES,Vejalpur to NRC on Pomegranate, Sholapur. Relieved in the after noon of 16.06.2006.
3. Shri M. K. Pachauri has been transferred as Senior Administrative Officer at I.A.R.I, New Delhi w.e.f 20-09-2006 (A.N).
4. Sh. P. G. Vankar,T-2 (Field Tech.) has been transferred from IIHR,Bangalore to CHES,Vejalpur and reported for duty in the forenoon of 10.09.2006.

### New Joining

### Research Management Position

1. Dr. T. A. More, joined on 21.11.2006 to the post of Director

### Administration

1. Sh. Mani Ram joined on 16.10.2006 to the post of Administrative Officer

### Superannuation

1. Dr. D. G. Dhandar, Director retired on 30.09.2006.

# Meteorological Data 15

| Months | Temperature (°C) | | R.H (%) | | Rainfall (mm) | Rainy days | Wind Km/hr | Evop. (mm/day) |
|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | | | | |
| April-2006 | 38.8 | 22.3 | 28.0 | 10.6 | – | – | 8.7 | 10.16 |
| May | 42.3 | 29.2 | 46.8 | 46.8 | 15.00 | 1 | 13.2 | 13.65 |
| June | 41.0 | 26.6 | 58.2 | 23.4 | 4.00 | 2 | 11.2 | 11.22 |
| July | 41.0 | 27.6 | 64.7 | 37.4 | 17.70 | 2 | 12.8 | 12.6 |
| August | 36.5 | 24.5 | 73.3 | 45.0 | 2.60 | 1 | 9.6 | 9.75 |
| September | 36.6 | 22.3 | 69.0 | 35.0 | 17.10 | 2 | 8.2 | 8.9 |
| October | 35.7 | 18.5 | 58.7 | 25.7 | 22.00 | 1 | 6.2 | 7.75 |
| November | 30.6 | 14.6 | 69.9 | 33.8 | 0.00 | - | 4.1 | 4.0 |
| December | 24.8 | 9.4 | 55.0 | 32.0 | 3.60 | 2 | 3.0 | 2.75 |
| January-2007 | 21.5 | 4.6 | 52.0 | 25.0 | 0.00 | - | 3.3 | 3.2 |
| February | 24.5 | 6.8 | 48.0 | 24.0 | 95.00 | 2 | 4.2 | 5.3 |
| March | 28.4 | 12.7 | 43.0 | 20.0 | 4.60 | 1 | 4.5 | 6.6 |