वार्षिक प्रतिवेदन
ANNUAL REPORT 2002-2003

भाकृअनुप
ICAR

केन्द्रीय शुष्क बागवानी संस्थान

बीछवाल, बीकानेर - 334 006 (राज.)

Central Institute for Arid Horticulture

Beechhwal, Bikaner - 334 006 (Raj.) INDIA

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बीछवाल, बीकानेर-334 006, राजस्थान

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Cover

Front :

Top Left : Genetic Variability in Luffa.
Top Right : Genetic Variability in Brinjal.
Bottom Left : Genetic Variability in Chilli.
Bottom Right : Genetic Variability in Bean.

Back :

Top Left : Kinnow plant under Microsprinkler irrigation system
Top Right : Fertirrigation system
Bottom Left : Kinnow plant under Drip irrigation system
Bottom Right : A fruiting pomegranate plant under pressurize irrigation.

CONTENTS

S.NO.	Topics	Page No.
1.	Preface by Director	5
2.	वार्षिक प्रतिवेदन सारांश	7
3.	Executive Summary	10
4.	Introduction	14
5.	Germplasm conservation	17
6	Genetic improvement	33
7.	Vegetative propagation	42
8.	Growth and development	47
9.	Integrated nutrient management	54
10.	Planting Models	69
11.	Plant protection	72
12.	Plant production	79
13.	Post harvest technology	85
14.	Agricultural extension	99
15.	Externally funded projects	105
16.	Farm development	155
17.	Staff position	157
18.	Finances	159
19.	Publications	160
20.	Human Resource Development	166

Preface by Director

The arid region is spread over 19.6 m. ha area covering the states of Rajasthan, Gujarat, Haryana, Punjab, Andhra Pradesh, Karnataka and Maharashtra. The region has a blend of strengths and weaknesses such as high temperature, low and erratic rainfall, low relative humidity, high PET, high sunshine, abundant solar energy, low soil fertility which adversely affect the crop production in this region. The region has great potential to produce arid fruits and vegetable provided adequate technologies are adopted.

Keeping this in view and realizing the importance of arid ecosystem, the potential of horticultural productivity of arid zones and the need to achieve nutrition and income security of the people, the Indian Council of Agricultural Research has established National Research Centre for Arid Horticulture that came into existence on 1st April, 1993. This was later upgraded to Central Institute for Arid Horticulture in October, 2000. The research and development work of the Institute is being carried out at CIAH, Bikaner and its regional station CHES, Godhra. A total of 21 research and development projects are under operation at main Institute and its regional station. In addition to this one Adhoc Project and 4 NAT Projects are also under operation.

Over the years, institute has made a rich collection of biodiversity of major arid fruits and vegetables, released 8 varieties of arid vegetables which are popular among farmers of this region, standardized agrotechniques for cultivation of arid fruit and vegetables, standardized propagation techniques, production of vermicompost & its effect on plant production, adaptation mechanisms for drought tolerance in ber and arid vegetables, identified major diseases and development of IPM for them is in progress. The Institute has also standardized technologies for production of value added products of arid horticulture produce.

The Institute is well equipped with several sophisticated equipments and during the period under report has further strengthened its laboratories & field with the procurement of several equipments. The Institute is having well equipped ARIS Cell having computer systems, VSAT and Local Area Network.

I am pleased to publish this Annual Report for the year 2002-2003 which I am sure will be informative and useful to all these who are concerned with the agricultural scenario of this region.

(D.G. Dhandar)
Director

वार्षिक प्रतिवेदन सारांश

भूमिका

शुष्क पारिस्थितिकी ने आजकल योजनाकारों, प्रशासकों, कृषिविदों का ध्यान आकृर्षित किया है। इसका प्रमुख कारण है कि शुष्क क्षेत्र में फलों, सब्जियों तथा औषधीय एवं सुगंधीय पौधों में जैवविविधता विपुल मात्रा में पायी जाती हैं। इसके अतिरिक्त यह क्षेत्र गुणवत्तायुक्त फलोत्पादन में भी सक्षम है। शुष्क क्षेत्र भारत के कुल क्षेत्रफल के लगभग 12 प्रतिशत भूभाग में फैला है। यह क्षेत्र राजस्थान, हरियाणा, पंजाब, गुजरात, महाराष्ट्र, आन्ध्रप्रदेश तथा कर्नाटक राज्यों में है। अब, लगभग यह निश्चित हो गया है कि बहुवार्षिक उद्यानिकी फसलें न केवल यहां के निवासियों की पोषण व आर्थिक स्थिति सुधारने में सफल रही है बल्की उष्मीय जलवायु के प्रभाव को भी सीमित करने में महत्वपूर्ण भूमिका निभा रही हैं। यद्दपि इन कठोर जलवायविक परिस्थितियों में इनको उगाने सम्बन्धित तकनीकियों को और अधिक विकसित करने की आवश्यकता है। इन्हीं उद्देश्यों को फलीभूत करने हेतु सन् 1993 में राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान केन्द्र की स्थापना हुई जिसको सितम्बर, 2000 में कमोन्नत कर केन्द्रीय शुष्क बागवानी संस्थान में परिवर्तित कर दिया गया।

मुख्य ध्येय

- शुष्क एवं अर्द्ध शुष्क क्षेत्र की बागवानी फसलों का उत्पादन एवं उपयोग बढ़ाने के लिए तकनीकियां विकसित करने हेतु योजना लक्षित मूल अध्ययन करना।
- शुष्क एवं अर्द्ध शुष्क बागवानी फसलों के '**राष्ट्रीय जीन बैंक**' के रूप में कार्य करना।
- शुष्क एवं अर्द्ध शुष्क वातावरण में बहु–बागवानी फसलों का प्रभावी फसल–चक्र विकसित करना।
- शुष्क एवं अर्द्ध शुष्क बागवानी से संबंधित वैज्ञानिक सूचानाओं के '**राष्ट्रीय केन्द्र**' के रूप में कार्य करना।
- राज्य कृषि विश्वविद्यालयों तथा अन्य समान कार्य करने वाले संस्थानों के मध्य मुख्य समन्वयक की भूमिका के साथ शुष्क एवं अर्द्ध शुष्क बागवानी के '**मानव संसाधन विकास केन्द्र**' के रूप में कार्य करना।
- शुष्क एवं अर्द्ध शुष्क बागवानी के विकास एवं अनुसंधान के लिए मार्गदर्शी परामर्श उपलाब्ध कराना।

उद्देश्य

1. शुष्क परिस्थितियों में बागवानी फसलों की जैवविविधता की पहचान कर, संग्रह, संरक्षण, मुल्यांकन तथा वर्गीकरण करना।
2. लक्षित फल–फसलों जैसे– बेर, अनार, आंवला, खजूर एवं खीरावर्गीय, फलीदार एवं फलदार (सोलैनीसियस कुल) सब्जियों को उपलब्ध जैव विविधता के प्रयोग द्वारा उच्च गुणवत्ता, उत्पादकता तथा जलवायु के अनुरूप विकसित करना।

3. यथा स्थापित एवं नवीन बागवानी फसलों में द्रुत प्रवर्ध्यगुणन से सम्बन्धित तथ्यों एवं उनकी बढ़वार तथा फल विकास की समस्याओं का अध्ययन करना।
4. पोषक तत्वों, जल एवं मृदा का बागवानी फसलों की शुष्क जलवायु के अनुरूप उत्पादकता बढ़ाने के लिए समुचित उपयोग करने की कृषि तकनीकियों का विकास कर उनका मानकीकरण करना।
5. उच्चताप एवं विकिरण संसाधनों के उपयोग हेतु बागवानी फसल–चक्र पद्धतियों के पारिस्थितिजन्य परिमापकों का अध्ययन करना।
6. शुष्क क्षेत्रीय बागवानी फसलों के उत्पादों की सर्वउपलब्धता हेतु कटाई उपरान्त तकनीकियों का विकास करना।
7. शुष्क परिस्थितियों में बागवानी फसलों हेतु समाकलित कीट एवं व्याधि प्रबन्ध की तकनीकियों का विकास करना।

उल्लेखनीय उपलब्धियां

वर्ष 2002–2003 के मध्य अनुसंधान क्षेत्र में अर्जित महत्वपूर्ण उपलब्धियों का संक्षिप्त विवरण :

1. इस अवधि में संस्थान की संचित जननद्रव्य निधि में उल्लेखनीय वृद्धि दर्ज की गई। हिमाचल प्रदेश से पाला सहिष्णु आंवले के 12 तथा उत्त्रांचल से बेर के 14 जननद्रव्य संग्रहित किए गये। इस प्रकार संचित कुल जनन द्रव्य संग्रह बढ़कर बेर में 338, अनार में 150, आंवला में 43, कैक्टर पीअर में 100, खजूर में 55, काचरी में 558, मतीरा में 193, स्नेपमेलन में 90, मिर्ची में 132, खरबूजे में 55 एवं अन्य विभिन्न फलों के जननद्रव्य संग्रहित एसं संकलित हो गए हैं।
2. बेर में 'पाला से बचाव' अध्ययन में छुआरा, टिकड़ी, काठाफल, खारकी–1, बादामी, ग्लोरी, सफेदा रोहतक प्रजातियॉ पाले से अप्रभावित पाई गई।
3. देशी एवं स्थानीय व एक्जोटिक अवप्रयोगी शुष्क क्षेत्रीय फलों को चिन्हित कर चयनित करने का कार्य आरम्भ किया गया।
4. बोरोन का 0.2 प्रतिशत का घोल अनार में फल–फटने पर नियंत्रण हेतु प्रभावी पाया गया।
5. खजूर में प्रकाश संश्लेषण परिमापकों के अध्ययन में नेट प्रकाश संश्लेषण को फूल आने के समय अधिक दर्ज की गई।
6. बेर की गोला व सन्दूरा किस्मों के साथ–साथ सी.आई.ए.एच. संकर–1 व सी.आई.ए.एच. चयन–1 का स्वादाकार मूल्यांकन किया गया। गूदा व रस के आधार पर जहां संकर–1 को सर्वाधिक पसन्द किया गया वहीं स्वाद में चयन–1 अधिकांश का चहेता रहा।
7. तरबूज में मतीरे के शुष्क वातावरण वाले गुणों को सम्मलित करने के प्रयास में मतीरे की एफ 5 प्रोगेनी ए.एच.डब्ल्यू. 19 को तरबूज को सूगरबेबी किस्म से मिलान करवाया गया। यह फलाकार, मिठास, गूदे की मात्रा व रंग, फल उत्पादन, कठोरता आदि गुणों में सामन्जस्य स्थापित करती दर्ज की गई।
8. अनार में डी.के.एस./एच/97/003 नाम की संकर प्रजाति का चयन किया गया जो मुलायम, चटक लाल रंग व 20 डीग्री ब्रिक्स मिठास लिए हुए है।
9. केर (केपरिस डेसिडुआ) में सूक्ष्म प्रवर्धन तकनीक का मानकीकरण किया।

10. लसोड़ा में बडिंग समय मानकीकरण में 15 अगस्त को की गई बडिंग सर्वोत्तम दर्ज की गई।
11. बेर में उत्पादन एवं इसके अन्य घटकों के मध्य सांमजस्य को जांचा गया।
12. खीरावर्गीय फसलों में सूखे के परिमापकों को निश्चित करने के अध्ययन में पाया गया कि पौधों में बढ़त का दबाव एवं सूखे की स्थिति का दबाव दोनों प्रकारों को प्रयोग में लाया जा सकता है।
13. तुलनात्मक अध्ययन में अनार में अकार्बनिक उर्वरक एवं कार्बनिक खाद को देने की तुलना की गई। वर्मीकम्पोस्ट व अकार्बनिक उर्वरक देने पर पौधे की ऊंचाई व डब्ल्यू.यू.ई. अच्छी दर्ज की गई। वर्मीकम्पोस्ट को स्वतन्त्ररूप में अथवा अकार्बनिक उर्वरकों के साथ देने से पौधे में नत्रजन की मात्रा बढ़ जाती है।
14. चूर्णी फफूंद रोग होने पर जैव नियंत्रण कर्मक के प्रभाव का मूल्यांकन किया। इसमें पाया गया कि अधिकतम पी.डी. सी. (97.59) केराथीन के 0.5 प्रतिशत घोल में 5 प्रतिशत जैविक द्रव्य मिलाकर छिड़कने पर रहती है इसके पश्चात 94.62 प्रतिशत सल्फेक्स के (0.2 प्रतिशत) घोल के छिड़काव पर दर्ज की गई।
15. संस्थान के वैज्ञानिकों ने विभिन्न किसान मेलों व अन्य विस्तार गतिविधियों में सक्रिय भाग लेकर किसानों को नई प्रोद्योगिकियों से अवगत कराया। कृषि विश्वविद्यालय एवं अन्य कृषि संबंधी संस्थाओं के साथ सहयोग में प्रशिक्षण व अध्ययन कक्षाएं आयोजित कर कृषि विद्यार्थियों व किसानों को उचित मार्गदर्शन प्रदान किया।

Executive Summery

Central Institute of Arid Horticulture, Bikaner is devoted towards the Research and Development work on arid horticultural crops. Following are the highlights of the research achievements of the Institute for the year 2002-2003.

Germplasm conservation

During the period under report the survey of ber germplasm was undertaken and 14 genotypes were identified from Uttaranchal and Eastern U.P. Screening of ber cultivars for frost resistance demonstrated that cvs. Chhuhara, Tikkadi, Kathphal, Khariki No. 1, Badami, Glori, Safeda Rohtak were unaffected by frost. In aonla 12 frost tolerant genotype were collected from H.P. With this, a total of 338 germplasm of ber, 150 of pomegranate, 43 of aonla, 100 of cactus pear, 55 of date palm, 558 of kachari, 193 of mateera, 90 of snapmelon, 132 of chillies, 55 of muskmelon are being maintained and evaluated.

At CHES, Godhra, the germplasm evaluation of Aonla, Sapota, Jamun, Tamarind, Bael, Mahua is in progress.

Genetic improvement

Organoleptic taste evaluation of CIAH-Hyb1 and CIAH-selection 1 was performed along with Gola and Sandura. It was recorded that taste of Sel.-1 was liked most where as juiciness and flesh texture of CIAH-Hyb1 scored highest.

During the period under report, 15 hybrids of pomegranate developed during 1997 and 1998 were evaluated at a close planting spacing (2x1m). Of these, the F1 progeny (DKS/H/97/003) depicted excellent fruit quality parameters.

In a pursuit to incorporate drought hardy characters of mateera in water melon, F-6 progenies of Mateera AHW 19 x Sugarbaby were evaluated and found to be promising with respect to fruit yield, fruit size, flesh content, colour, firmness and TSS.

On the basis of quality and yield characters, the advanced progeny [F6(a)] Mateera AHW 19 x Sugarbaby, has been found most potential. Besides, three new Selections viz. AHLS Long-1 and AHLS Round-1 in bottlegourd and AHRM-1 in Roundmelon were evaluated in a replicated trial and found most potential for yield and fruit quality under high temperature conditions.

Kachari and snapmelon cultivars developed by the institute were tested to assess the yield potential over the seasons. The snapmelon variety AHS 10, yielded 207 and 198 q/ha during summer & rainy seasons, respectively.

Vegetative propagation

Studies on propagation of aonla, lasoda, pomegranate and tamarind have been initiated. In aonla, seed germination was better in bigger size (25x15cm) polybags. The vigour of seedlings was better when either pond soil and manures were used as filling mixture.

Studies on propagation in pomegranate conducted at Bikaner revealed that cuttings taken during July-August gave best results. In lasoda, it was observed that budding around 15th August gave best performance.

Studies on vegetative propagation in *Capparis decidua* revealed that semi-hard wood cutting taken during Aug.-Sept. and treated with 7500 ppm IBA + 1000 ppm thyamine gave best sprouting and rooting. The protocol for micropropagation was standardised.

Growth and development

Studies on growth and development under water stress revealed that application of Thiourea @ 100 or 200 ppm improved the photosysnthetic rate in snapmelon.

The correlation between yield and yield attributing parameters demonstrated that yield was positively correlated with photosynthetic rate, fruit dimension and stomatal conductance.

Screening of parameters for drought in cucurbit reveals that plant height stress index and dry matter stress index can be used for screening of germplasm.

Integrated nutrient and water management

The recommended doses of N, P and K were applied through sheep manure, cattle manure, vermicompost and inorganic fertilizers to the pomegranate. The N, P & K nutrient requirements were given through either 100% through each manure or in 50:50 ratio of two types of sources. The results revealed that the application of vermicompost and inorganic fertilizers in 50:50 ratio gave the maximum plant growth parameters, fruit yield followed by combination of sheep manure and vermicompost. The organic fertigation improved the fruit quality parameters such as high total soluble solids and low juice acidity. Application of sheep manure, cattle manure and vermicompost increased the water retention capacity and made the moisture available to the crop for a longer period.

Studies on pressurised irrigation were initiated in ber, pomegranate and kinnow. The drip, sprinkler and bubbler irrigation system were installed in the month of February, 2003. Initial observations on plant height and spread were recorded.

Development of planting models in arid horticultural crops

In aonla based multistorey cropping system, effect of mulching on growth, development, yield and hydrothermal regimes were studied in brinjal. It was observed that plant height, stem girth, biomass,

plant spread and fruit yield was maximum with black polythene mulch. Similarly, black polythene mulch gave better soil water retention.

Plant protection

Effect of promising isolates of Trichoderma (CIAH-240) and Pseudomonas fluoresceus (CIAH-196) was studied on incidene of powdery mildew in ber. The overall results indicate that powdery mildew intensity was 16.29 and 15.66 respectively. Evaluation of different treatments combinations using Trichoderma (CIAH-240) and Pseudomonas fluoresceus (CIAH-196) on control of powdery mildew showed that maximum PDC of 97.59 was resulted by 5% bacterial suspension mixed with 0.05% karathane followed by 94.62 in 0.2% sulfex. Spray of bacterial suspension (5%) alone resulted 77.28 percent disease control efficacy. Spraying 5% culture filtrate of *Trichoderma* (CIAH-240) resulted a maximum of 92.63 per cent disease control by followed by conidial suspension of *Trichoderma* spray at 5 and 10% resulted in 71.82 and 77.4 PDC respectively in case of cv. Umran. In cv. Gola, 5% Trichoderma combined with 0.05% karathane resulted the maximum PDC of 98.4 followed by 96.42 in 5% P. Flurescens and 0.05% karathane spray. Sulfex spray has shown 95.72 per cent efficacy.

In an Ad-hoc scheme on ber powdery mildew, electrophoretic variations in ber germplasm with different level of resistance to powdery mildew were evaluated. It was found that genotypes can be differentiated on the basis of electrophoretic profiles. Biochemical indices like total protein and calcium contents were studied in ber genotypes varying in their resistance as biochemical markers for powdery mildew screening.

Plant production

At Bikaner, two-hectare area has been developed as field repository by planting different arid fruit types. So far, 60 varieties/strains of different fruit trees accommodating 21 genera have been collected from difficult places in India and abroad.

The fruit trees like ber, aonla and pomegranate were multiplied through vegetative propagation at Bikaner and a total of 5000 plants were produced. At CHES, Godhra a total of 24031 planting material of ber, aonla, pomegranate, custard apple, mango, sapota, phalsa, jamun, guava and kagzi lime were propagated and supplied to farmers and developmental agencies.

Post harvest technology

An experiment was carried out to standardize optimum stage and suitable conditions for dehydration of khejri pods. It ws observed that recovery percentage of dehydrated tender pods was more under sun drying. However, under sun drying all the pods were brown-black in colour whereas under shade drying the pods were light brown in colour.

An experiment was carried out to standardise the dehydration of kachari. It was observed that

maximum recovery was in fruits dried in trays. It was further found that powder prepared from samples without peel was good in colour and appearance. In addition to this, value added products from snapmelon, pomegranate and aonla were also prepared.

Agricultural extension

The Institute organized Kisan Diwas on 23rd Dec., 2003 on the eve of birth century of Late Choudhary Charan Singh, Former Prime Minister of India. The technologies developed by the Institute were displayed and seed/planting material and technical literature were distributed to farmers. The Institute also honoured 10 progressive farmers of this day.

Preliminary data related to existing cropping pattern, adoption for improve technology and yield gap, level and constraints in adopting arid horticultural crops were collected and analysed. The data revealed that poverty, low income, high cost of inputs, poor communication and transport facility, lack of seed/planting material, technical guidance etc. are the major constraints in adoption of arid horticultural technologies.

Finances

The budget allocation during 2002-2003 under plan was 102.00 lakhs were as under non-plan it was 231.10. The Institute was able to utilized the allocated fund.

Library

During the period under report, 70 books were procured and 02 International and 21 National journals were subscribed. The library also acquired CAB CD ROM database.

Introduction

In recent years, arid ecosystem has attracted the attention of agriculturist, policy planners and administrators. This is on account of the fact that arid ecosystem harbours a rich bio-diversity of fruits, vegetable, medicinal and aromatic plants. Moreover, it also has environment for quality fruit production. This region is spread on nearly 12 percent of the land area in the States of Rajasthan, Gujarat, Haryana, Punjab, Andhra Pradesh, Karnataka and Maharashtra. It has been established that horticultural crops particularly perennial fruit trees, not only provide nutrition and income security to the people but can also ameliorate the harsh environment of the arid region. However, it requires the development of technologies for production of these crops under such harsh conditions. Hence, NRCAH was established in April, 1993 at Bikaner, which later on was upgraded to Central Institute for Arid Horticulture in September, 2000.

Mandate

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

Mission/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 ecophysiological parameters of cropping system models for utilization of high temperature and radiation resources.
* To develop postharvest 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.

The salient research achievements of the Centre during 2002-2003 were:

1. During the period under report 14 genotypes of ber were identified from Uttranchal and Eastern UP. 12 frost tolerant genotypes of aonla were collected from Himachal Pradesh. With this, a total of 338 germplasm of ber, 150 of pomegranate, 43 of aonla, 100 of cactus pear, 55 of date palm, 558 of kachari, 193 of mateera, 90 of snapmelon, 132 of chillies, 55 of muskmelon and several varieties/strain of different fruit trees are being maintained and evaluated at the Institute.
2. Studies on frost resistance in ber revealed that cvs. Chhuhara, Tikadi, Kathaphal, Kharki No.1, Badami, Glori, Safeda Rohtak were unaffected by frost.
3. Attempts have been initiated to identify and select indigenous and exotic underutilized fruits of arid region.
4. It was observed that application of 0.2% solution of boron was effective in reducing the cracking.
5. The phylogenetic relationship between date palm cultivars were evaluated on the basis of flavanoid spectrum.
6. Organoleptic taste evaluation of CIAH-Hyb1 and CIAH-selection 1 was performed along with Gola and Sandura. It was recorded that taste of Sel.-1 was liked most where as juiciness and flesh texture of Hyb1 scored highest.
7. On the basis of quality and yield characters, the advanced progeny [F6(a)] mateera AHW 19 x Sugarbaby, has been found most potential. Besides, three new selection AHLS Long-1 and AHLS Round-1 in bottlegourd and AHRM-1 in roundmelon were evaluated in replicated trial and found most potential for yield and fruit quality under high temperature conditions.
8. The pomegranate hybrid developed at Bikaner. DKS/H/97/003 depicted excellent fruit quality parameter e.g. soft, bold and red aril having TSS around 20° Brix.
9. The micropropagation technique in *Capparis decidua* was standardised.
10. In lasoda budding around 15th August gave best performance.
11. The correlation between yield and yield attributing parameters in ber were worked out.
12. Screening of parameters for drought in cucurbit revealed that plant height stress index and dry matter stress index could be used for screening of germplasm.

13. Application of organic manure and inorganic fertilizer were compared in pomegranate. It was observed that plant growth parameters and WUE were best under vermicompost or vermicompost+inorganic fertilizer. Vermicompost either alone or in combination with inorganic fertilizer improves N, K content and water holding capacity of soil.
14. The effect of biocontrol agents on incidence of powdery mildew was evaluated. It was observed that maximum PDC of 97.59 was resulted with 5% bacterial suspension mixed with 0.05% karathane followed by 94.62% in 0.2% sulfex.
15. The scientists of the centre took active part in Kisan melas and other extension activities and acted as resource persons for various training programmes and as faculty to teach courses in RAU.
16. The Institute participated in State level kisan mela organized by RAU, Bikaner and bagged first prize in stall exhibition. The Institute also celebrated the birth centunary of former Prime Minister, Late Sh. Chaudhary Charan Singh and honoured 10 progressive farmers of Bikaner district.

Germplasm conservation

Mission A: Introduction, collection, characterization, conservation and evaluation of horticultural biodiversity.

At CIAH, Bikaner

A 1. Introduction, collection, characterization, conservation and evaluation of arid fruits under hot arid environment

A 1.1 Introduction, collection, characterization, conservation and evaluation of *Ziziphus* species

(i) Survey and identification of *Ziziphus* sp.

Two survey were undertatken for the identification of the elite plants of ber from Uttranchal and Eastern U.P. during 11.02 .03 to 21 .02 .03 and 06.03.03 to 13.03.03, respectively. During the exploration of Uttranchal 14 genotypes were identified out of that 06 were *Ziziphus mauritiana* types, 03 were *Ziziphus nummularia* and 05 were *Ziziphus* species. Among the five *Ziziphus* species identified from the Uttranchal one specific strain was identified as climbing ber in the forest of the Khatima Tanakpur road. In the survey of Eastern Uttar Pradesh from 6th March to 13th March 2003, another 14 genotypes were identified out of which two were *Ziziphus* species and 12 were *Ziziphus mauritiana* types. During this exploration one genotype was identified near Faizabad district (Mau Ka Shiwala) is baramasi in nature. The bud wood of identified genotypes will be collected in the month of July- August 2003.

(ii) Status of ber Germplasm

At present 318 genotype/strains of ber have been maintained in the National Repository of CIAH, Bikaner.

(iii) Study of floral biology in ber

Observations with regards to flowering period (Initiation, peak and end), number of flower per clusters and fruit set period (initiation, peak and end) were recorded for the important commercial cultivars and germplasm collected through exploration.

(iv) Study on frost resistance/tolerance in ber

Observation was recorded with regards to frost incidence for the third time during the year 2002-2003 and observed that cultivars Chhuhara, Tikadi, Kathaphal, Kharki No1, Badami, Manukhi, Glori,

Safeda Rohtak,etc. were unaffected from the frost. Further, the same observation will continue in next year.

(v) Study on fruit fly tolerance in ber

Observation with regard to infestation of fruit fly among the cultivars/ genotype were recorded during the year 2002-2003. Although the infestation of fruit fly was not so severe during this year, even though the cultivars Gola, Seb, Kaithali, Banarsi Pewandi showed more susceptability than Tikadi, Illaichi, Katha and Umran. It needs indepth study combining others parameters so as to arrive at a definite conclusion regarding the ability of cultivar's tolerance/resistant against fruit fly.

(vi)Fruit set study in ber

Due to very less rain after pruning and high temperature at the time of anthesis, pollination and fertilization there was severe flower and fruit drop in most of the cultivars of ber. However, Gola, Umran Seb, Katha, Illaichi, Banarsi Penwandi, Reshmai etc. gave the best performance in respect to fruit set and fruit yield.

(vii) Varietal evaluation in ber

Morphological observation with respect to plant height, spread and diameter were recorded and found that the maximum plant height was recorded in variety Thornless (5.5m) followed by Gola (4.58m), Jogia , Chhuhara (4.5m), Reshmi (4.4), Seb , Maharwali and Kaithali (4.3m). The maximum plant spread was in Chhuhara (5.5 x 5.2m) and maximum stem diameter was recorded in CAZRI Gola (21.3cm) followed by Thornless (18.0cm). The observations with regards to size of leaf and length of petiole was also recorded. Data with respect to average fruit weight, fruit size, pulp thickness, stone weight, stone size, TSS etc. were also recorded. It was observed that the maximum fruit weight was in Umran (50g) followed by Seb (42g) and Gola (35g). The TSS was maximum in Reshmi25% and minimum in Thornless (17%). The pulp thickness was maximum in Seb (1.6) followed by Gola (1.4cm) and minimum in Dandan (0.8cm) and Illaichi (0.9cm).

(viii) Pruning of ber germplasm

Based on the finding of severity of pruning from pruning experiment, the germplasm was pruned at three timing ie. mid of April, end of April and first week of May. The pruning in mid April gave better response with respect to plant growth and fruit yield.

(ix)Evaluation of *Ziziphus rotundifolia*

22 strains of *Ziziphus rotundifolia* were evaluated for their morphological characters.

(x) Study on level and severity of pruning in ber cv Kaithali

An experiment was conducted with three different levels of pruning (25%, 50%, & 75%) and four timing (20 April, 30 April, 10 May and 20 May) in RBD design, replicated thrice. The observations were

recorded with respect to number of days taken to sprout initiation, profuse sprouting, plant growth characteristics (height, spread and diameter), fruit yield, fruit size, fruit weight, stone size, stone weight, pulp thickness, total sugar, ascorbic acid, and protein content etc. Among all the treatment combinations pruning with 50% intensity in the month of mid April gave better response in respect to plant growth and fruit yield.

The maximum canopy volume (28.29m^2) and fruit yield (29 Kg / plant) was recorded when pruning was done in the month of mid April with 50% intensity.

A 1.2 Introduction, collection, characterization, conservation and evaluation of pomegranate (*Punica granatum* L.) under hot arid environment

(i) Germplasm repositories

About 150 genotypes collected since 1995 were evaluated and maintained. Different morphological, flowering, fruiting and various physico-chemical characteristics of fruits were recorded. Out of 150 genotypes, 55 types were decidous in nature and rest 95 were evergreen. Flowering and fruiting was recorded for mirgbahar. Fruit set of various varieties varied from first week of August to end of November, depending upon genotype. About 77 genotypes were studied for their growth, flowering and fruiting characteristics. Maximum height (2.9 m) was recorded in Achikdana, maximum spread (2.98m) in Khog, girth (6.65 cm) in P-23 and maximum size of fruit was recorded in Jodhpur collections (282g) and P-23 (235g). The acidity of the fruits varied from 0.51% in Alah to 4.35% in Bocha lines. Maximum TSS was recorded in Jodhpur collections (22.0° Brix) and minimum was recorded in Agah (14.0° Brix).

(ii) New introduction

In addition to early introductions two Anardhana types of pomegranate were collected one from Himachal Pradesh and another from IIHR Bangalore.

(iii) Collection and evaluation

Single plant seedling progenies of 52 collections and 9 clonal collections of Jalore seedless types planted in close spacing are under evaluation.

(iv) Effect of Boron and GA_3 for control of fruit cracking in pomegranate

A preliminary trial was conducted in pomegranate variety Jalore seedless to see the effect of Boron and GA_3 to control cracking of fruits.

Results obtained during 2001-2002 reveals that all the chemical treatments were found effective to control cracking of the fruits. Boron 0.2% was found most effective to check the cracking. In this treatment, only 15.2% of fruits were damaged due to cracking compared to control in which it was

40%. There was no adverse effect of these chemicals on TSS and acidity of the fruits. Maximum yield of 10.7 kg/tree was recorded in case of Boron 0.2 % whereas it was only 4.5 kg/tree. General observation on cracking intensity reveals that maximum cracking was recorded during Dec. 15th to Jan. 15th)

A. 1.3 Introduction, collection, characterization, conservation and evaluation of date palm (*Phoenix dactylifera* L.) under hot arid environment.

(i) Collection and evaluation of germplasm

Fifty seven date palm varieties/ collections including exotic germplasm were maintained in repository. Gap filling of offshoots were done. Suckers of five local as well as imported varieties were collected from Date palm Research Centre, G.A.U., Mundra , Kachchh. The offshoots were treated with IBA 1000 ppm and Bavistin 0.2 % and were kept in the nursery for hardening and rooting. Sucker of cultivar Medjool collected from Jetsar Farm was planted in the germplasm block. The offshoots of date palm cultivars Zagloul, Nagal Hillali, Bint Aisha were collected from RAU, Bikaner. Three date palm cvs. Khalas, Degletnoor, Khairpur-Pakistan were also collected from R.F.R.S.,Abohar and were planted in the field in the month of September.

Under date palm species collection, a seedling of *Phoenix reclinata* was planted in the field during the month of September, 2002 and plant is growing well.

Seeds of 46 collections made from Kachchh region were raised in the nursery and maintained for attaining proper growth. These collections are to be transplanted in the field for further evaluation.

Under germplasm evaluation, palm height were ranged from 2-3 m at an age of four years. Spathe emergence was started in eleven genotypes from middle of the February and completed in second week of March. Flowering and fruiting was observed in four years old plant of Halawy, Zahidi, Dayari, Shamran, Medini, Saddami, Muskat, Khuneizi, Hayani and Tayer cultivars. Late emergence of spathe (first week of March) was recorded in Shamran, Tayer and Chipchap. First time spathe emergenece was observed in exotic variety chipchap introduced from Iraq during the year 1998. The spathe opening was also earlier in those varieties in which emergence of spathe was earliest. There was no spathe emergence in Sabiah, Sewi, Sayer, Umshok and Khadrawy cultivars during this year. However, Halawy, Dayari, Shamran, Zahidi produced sapthes and fruiting during both the years of evaluation.

The average number of bunch/palm varied from 01 (Chipchap, Khuneizi, Tayer, Hayani and Muskat) to 6 (Dayari) during the second year of fruiting. On an average 04 bunch/palm were observed in Halawy, Saddami, Zahidi and Medini cultivars.The initiation of doka stage was early in variety Halawy followed by Shamran, Khuneizi, Muskat, Tayer, Dayari, Saddami and Medini. Maximum bunch length was 84 cm in Saddami followed by Halawy (76.5 cm) and Dayari (76.2 cm) while minimum 25 cm was in Chipchap. Number of berries per strand varies from 7.0 (Hayani) to 22.0 (Zahidi). Maximum number of strand per bunch was in Halawy followed by Saddami, Muskat, Medini and Zahidi (Table 1). The range of number of strand per bunch was 9 to 38. Maximum average weight of berry 10.0 g was recorded in Dayari while 5 to 8 g weight of berry was recorded in Saddami and MedIni. Big size berries were

observed in cultivar Dayari in comparison to other genotypes. Small size berry was formed in Zahidi (2.60 x 1.70 cm) and Saddami (2.74 x 1.75 cm) during the year. Yellow berry colour was noted in maximum genotypes except Hayani and Dayari. Seed weight varies from 0.60 g to 1.33 g (Table-1).

(ii) Varietal evaluation

Development of a block of promising date cultivars (Halawy, Khalas, Zahidi, Medjool, Shamran and Khadrawy) was under taken. Gap filling in varietal block was done after procuring offshoots from Bikaner and Abohar. Survival of plants were observed and it was noticed that rate of mortality was more in Medjool and Halawy in comparison to Zahidi cultivar. Earlier planted suckers of Halawy and Khalas started flowering and fruiting after four years of planting. Two to three bunches per palm were harvested during the year. However, maximum palms are under vegetative growth stage.

(iii) Evaluation of tissue culture plants

Tissue culture plants of cultivars Dhamas, Khasab, Khalas, Khuneizi, Nubsully, Yakoobi, Fard and Nagal supplied by M/S A.V. Thomas Co., Cochin, Kerala were maintained under field conditions. Vegetative growth in all plants except one plant of Dhamas variety were better with respect to number of leaves / plants, trunk diameter and palm height. On an average more than 1.5-2 m height of plant was recorded. In cultivar Khasab, Fard, Khuneizi and Yakoobi 1 to 4 new suckers were also recorded. However, as far as flowering and fruiting is concerned, spathe emergence was observed in Dhamas cultivar only. First time one bunch of 500 g weight was harvested from a Dhamas plant after four years of planting. Berry colour was yellow and sweet in taste, however, stone size was medium in weight (1.0 g).

(iv) Performance of date palm Seedlings

Seedlings of seven exotic date palm (procured from Iraq) cultivars Sayar, Zahidi, Braim, Khastavi, Khadrawy, Chip chap and Barhee were transplanted in the field. On an average seedlings of 50-60 cm height of 6-7 leaf stage were planted during the month of October. On the boundary of date palm block, seedlings of date palm were transplanted at 2 x 4 m spacing. Seedlings were planted with a view to assess of plant growth, sex ratio, variability/fruiting behaviour in seedling palms under arid environment. Survival and seedlings growth was very poor during the year due to severe drought conditions.

(v) Photosynthetic parameters in tissue culture and sucker plants of date palm

An experiment was carried out to compare the photosynthetic parameters in 4 years old tissue culture/sucker plants of date palm cv. Khalas and Khuneizi at vegetative growth stage. It was observed that in cv. Khuneizi the plants obtained from tissue culture/sucker do not differ much in their photosynthetic parameters. However, in cv. Khalas the rate of photosynthesis at vegetative growth stage in tissue-cultured plants was higher as compared to plants obtained from sucker. A similar trend was observed for other parameters also such as transpiration rate, carboxylation efficiency and water use efficiency. Data on morphometry also revealed that leaflets of cv. Khuneizi (Tissue cultured and sucker) were at par but, in cv. Khalas the leaflets of tissue-cultured plants were significantly larger than that of sucker plants. Therefore, the results indicate that tissue cultured plants are at par with sucker plants in photosynthetic parameters as well as vegetative growth in arid region.

Table 1. Flowering/fruiting and berry characters of date palm cultivars under hot arid environment.

Cultivars	Spathe emergence	Opening of spathe	No. of bunch/ plam	Length of bunch (cm.)	Colour of berry	Doka stage	No. of strand/ bunch	No. of berry/ strand	Av. berry wt. (g)	Size of berry (cm) LxB	Seed weight
Halawy	19.02.02	06.03.2002	5	76.5	Yellow	02.07.02	38.3	20.6	8.62	3.77x1.89	0.63
Shamran	04.03.02	18.03.2002	4	64.3	Yellow	05.07.02	18.7	13.5	6.52	3.23x1.87	0.83
Zahidi	23.02.02	16.03.2002	5	55.0	Light Yellow	02.07.02	25.0	22.0	4.26	2.60x1.70	0.69
Chip chap	18.03.02	27.03.2002	1	25.0	Yellow	15.07.02	9.0	9.0	6.18	3.38x1.82	0.87
Khuenezi	11.03.02	22.03.2002	1	40.0	Red	10.07.02	10.0	20.0	6.37	3.13x2.20	0.60
Dayari	19.02.02	05.03.2002	6	76.2	Red	16.07.02	21.5	10.0	10.13	3.94x2.16	1.17
Medini	26.02.02	08.03.2002	3	60.0	Reddish Yellow	30.07.02	26.0	8.0	6.70	3.10x1.96	1.33
Hayani	26.02.02	06.03.2002	1	39.0	Red	22.07.02	10.0	7.0	7.20	3.21x1.80	0.76
Saddami	20.02.02	12.03.2002	6	84.0	Yellow	10.07.02	36.0	12.0	5.08	2.74x1.75	0.89
Tayer	02.03.02	18.03.2002	1	45.0	Yellow	20.07.02	20.0	8.0	6.13	2.89x1.78	0.61
Muscat	21.02.02	05.03.2002	1	35.0	Yellow light grayish	20.07.02	33.0	11.0	6.28	3.21x1.76	0.84

A 1.4 Introduction, collection, characterization, conservation and evaluation of aonla (*Emblica officinalis* Gaertn.)

(i) Bud wood collection of 12 genotypes of aonla from Himachal Pradesh

Bud wood of twelve elite type frost tolerant genotypes (six from Shimla and another six form Solan) of aonla were collected during August,2002 which was identified during October 2001. In Shimla district, bud wood was collected from Rampuri Kewthal, Banoda, Laddi, Galot, Panesh and Chamba villages and where as in case of Solan collection was done from Ayal, Lavighat, Raipur and Ranu villages. Bud wood was subjected to in-situ budding in field repository of aonla at the institute. Further, evaluation of same is being initiated for frost tolerant traits. Presenty, 34 aonla genotypes are being maintained at field repository of aonla.

(ii) Survey and identification of aonla genotypes from Rajasthan

An exploration was undertaken during December 2002 to identify elite type aonla plants. For the purpose, Jaipur (Chomu region) and Ajmer (Pusker region) districts were selected. Consequent upon exploration, nine genotypes were identified out of that five plants were identified from Jaipur district i.e. Nimri, Villpur and Morija villages and another four were identified in Ajmer district i.e.from Basoli, Thawla and Raghunathpura. In village Basoli, (Pushker valley) a cluster bearing type plant (AKS/CIAH-EO-24) was identified and branches of which were laden with good size fruits. While identifying the genotypes ten fruits were randomly collected from each direction of the plants and physico- chemical analysis was done. Based on observation recorded (Table-2) it was found that there was great genetic diversity with respect to fruit size (2.55cm x to 3.15x3.65 cm), fruit weight (10.4 to 28.8g), TSS (15-27%), Acidity (1.6-2.69%), and juice content (52.1-66.8%). Further, bud wood of identified genotypes will be collected during July,2003.

(iii) Varietal evaluation of aonla.

During the year 2002-2003 good fruiting was observed in cv. NA-7, NA-6, Chakaiya, Krishna, Kanchan and NA-10. Based on observation recorded with respect to yield and yield attributing traits, it was found that NA-7 performed better over other commercial varieties under hot arid ecosystem. The maximum yield/plant was found in cultivar Narendra Aonla-7 i.e. 96kg/plant. Besides, fruit weight varied from 31.0-51.0g depending on cultivars with the average of 48.3g in Krishna which is found to be maximum followed by NA-6 (40.8g), NA-7 (36.5g), Chakaiya (33.4g) and Kanchan (31.2g). The average number of fruits / branchlet varies from 3-5 (Chakaiya) to 6-12 (NA-7) depending upon variety (Table 3.).

(iv) Effect of Calcium and Boron in relation to fruit set, fruit yield and quality of aonla

Different concentrations of Calcium and Boron 0.2%, 0.4%, and combinations i.e. mixed concentration of both (0.2% and 0.4%) were used in experiment. The Calcium was applied as Calcium

Table 2. Genetic diversity of aonla in Central part of Rajasthan

S No.	Name of genotype	Fruit Size (cm)		Fruit weight (g)	Stone weight (g)	Pulp weight (g)	Seed weight (g)	Stone size (cm)		Stone (%)	Seed (%)	Plup (%)	Plup/ stone ratio	Juice (%)	Acidity (%)	TSS (%)
		Length	Diameter					Length	Diameter							
1	AKS/CIAH/EO-18	2.27	3.24	18.80	2.27	16.53	0.332	1.98	1.54	12.0	0.017	87.92	7.28	59.83	2.56	17.50
2	AKS/CIAH/EO-19	2.90	3.40	21.00	1.83	19.47	0.356	1.54	1.62	8.70	0.015	92.71	10.63	62.71	2.48	18.00
3	AKS/CIAH/EO-20	2.50	2.90	13.60	1.28	12.32	0.380	1.48	1.26	9.40	0.027	90.58	9.62	61.20	2.69	22.20
4	AKS/CIAH/EO-21	2.34	2.61	10.40	1.12	9.28	0.390	1.42	1.22	10.70	0.037	89.23	8.28	55.60	2.34	15.50
5	AKS/CIAH/EO-22	2.82	2.32	18.80	1.37	17.43	0.380	1.55	1.20	7.20	0.020	92.71	12.72	61.51	2.45	15.00
6	AKS/CIAH/EO-23	2.80	3.20	17.50	1.34	16.16	0.410	1.40	1.25	7.60	0.023	92.34	12.05	62.46	2.12	15.20
7	AKS/CIAH/EO-24	3.15	3.65	28.80	2.19	26.61	0.420	1.70	1.50	7.60	0.014	92.39	12.15	62.71	2.15	18.30
8	AKS/CIAH/EO-25	2.85	3.45	22.00	1.37	20.63	0.390	1.30	1.35	6.20	0.017	93.77	15.05	66.88	2.37	17.10
9	AKS/CIAH/EO-26	2.55	2.75	12.80	1.12	11.63	0.260	1.95	1.40	8.70	0.020	90.85	10.38	52.10	1.60	27.00

carbonate and Boron as Borax, which was sprayed at the interval of one month on cultivars NA-6 and NA-7. The spray was started after completion of flowering and observation with respect to fruit set, yield and quality parameters was recorded and it was found that application of 0.4% mixed (Ca+B) gave better results which was followed by 0.4% concentration of Borex and $CaCO^3$ as individual application.

(v) Frost management studies in aonla

Different concentrations of H_2SO_4(0.1%, 0.2%, 0.3%) Nacl(1%, 2%, 3%) and KNO_3 (0.5%, 1.0%, 1.5%) were applied on commercial varieties as well as seedling plants through foliar spray. Since severe incidence of frost was not reported during 2002-2003, therefore experiment will be repeated to find out the effect of treatments in forthcoming year.

Table 3: Varietal evaluation of aonla for yield parameters

Varieties	Fruit Size (cm)		Fruit weight (g)	Plup weight (g)	Plup content (%)	Stone weight (g)	Stone content (%)	No. of fruits/ branch let	Seed weight (g)	Seed content (%)	Plup/ Stone ratio
	L	W									
Chakaiya	3.6	4.1	33.4	32.0	95.9	1.4	4.2	3-5	0.034	0.102	2.9
Krishna	3.7	4.6	48.3	45.9	95.1	2.3	4.8	4-6	0.036	0.071	9.6
Kanchan	3.6	3.9	31.2	29.7	95.0	1.6	4.9	5-8	0.031	0.091	9.3
NA-6	3.6	4.4	40.8	39.0	95.8	1.7	4.2	4-8	0.034	0.082	2.9
NA-7	3.5	4.0	36.5	34.9	95.6	1.6	4.3	6-12	0.028	0.072	1.9
NA-10	3.5	3.8	30.2	28.4	95.4	1.4	4.6	4-7	0.030	0.092	0.7

A. 1.5 Introduction, evaluation and improvement of indigenous and exotic underutilized fruits of arid region.

(i) Karonda

A seedling of karonda (green fruit colour type) was collected from Ajmer. The rich variability in karonda was observed in Pushkar-Ajmer Area. Total six collections are maintained.

(ii) Phalsa

Out of four phalsa collections, flowering and fruit setting was started in three collections after two year of planting. These collections are of bushy type.

(iii) Lasora (*Cordia myxa*)

32 lasora collections are being maintained under field conditions. No genotype started flowering and fruiting. Further, 32 types were planted at 6x6 m. in the field during the month of February, 2003 for evaluation. Survival of plants were better.

(iv) Ker (*Capparis decidua*)

Seedling of 32 ker collections were transplanted in the field for evaluation. Three saplings of each collections were transplanted in the ker germplasm block.

(v) Collection, conservation and evaluation of Cactus pear

Ninty nine genotypes were maintained for multiplication and evaluation for different purposes. Better plant growth was observed in clones 1269, 1270, 1271, 1280, 1281, 1269, 1378, 1458 under multiplication. Indigenous cactus types were started flowering and fruiting during winter season while flowering and fruiting in exotic ones was observed during summer season. Local indigenous types were produced red colour fruits of small size and sour sweet in taste. Better sprouting and growth in cactus genotypes were observed in spring season in comparison to other growing seasons. Vegetable type (1308) can be grown under assured irrigated conditions to produce nopalitos for green vegetable. Under shade condition, better plant growth was observed in cactus pear type 1270, 1271,1280.

Maximum fruiting was noted on the top of cladodes than that of other sides emerging cladodes and the number was 5-6 fruits per pad. Clone 1269 is a fodder type but it may be used as vegetable. It has less thorns and fast growing type in arid region. However, better plant growth, flowering and fruiting was noticed in clone 1270 and 1271 under hot arid environment. During the year, few number of fruits were formed in clone 1270 and 1271. However, other genotypes have not started flowering and fruiting.

(vi) Introduction and evaluation of exotic species

During the year, Nopalea (EC 497194), Argan (EC 497195) and white sapote (EC 497196) were introduced from Israel through NBPGR, New Delhi during the month of May, 2002.Exotic fruit plants (Carob, Chinese jujube, ber, Marula nut) are being maintained in nursery block, which has been introduced earlier.

For exotic fruits, a block of 0.5 ha was prepared for transplanting of exotic species. Better plant growth was observed in Marula nut (*Sclerocarryo caffra*) planted during the year 2002 under field condition. Vegetative growth in Carob (*Ceratonia siliqua*) and Argan plant was slow. Effect of frost was minimum in Chinese jujube, Argan and Carob while Marula nut plant was susceptible to low temperature/frost during winter season.

a) Nopalea :

A small size cladode was procured from Israel. The cladodes of Nopalea was planted in earthen pot after proper treatment with fungicides. Nopalea, a vegetable type cactus could not survive possibly be due to tender and small piece of cladode.

b) Argan (*Argania spinosa*)

Seeds of Argan (*Argania spinosa*) an oil yielding hardy tree, were sown in nursery. Only 50% seeds were germinated after 25 to 30 days of sowing. Plant growth was very slow in this species under field condition.

c) White sapote (*Casimora edulis*)

White sapote (*Casimora edulis*) seeds were not germinated either in petridishes or in nursery. Seeds were sown twice in a year during the month of August and February.

A.1.6 Collection, conservation and evaluation of *bael* (*Aegle marmalos*) genotypes.

For planting of root stock/genotypes, pits were prepared in one hectare area at 8x8 m distance. Rootstocks were planted in well prepared pits during the month of September, 2002 to raise *in situ* orchard. Three plants of each genotypes were planted and maintained during the year. Low temperature during winter season also affected the survival and growth of plants. During the year of establishment, plant growth was very slow. Irrigation, removal of sand from pits, plant protection practices were followed as and when required. A total of 16 genotypes are maintained under field conditions. A seedling selection of bael was collected from Ajmer in the month of August and planted in the field. Ninty per cent survival of plants was recorded at the end of March, 2003. Further work on identification of better genotype and collection is in progress.

At CHES, Godhra

A 1.7 Collection, introduction and evaluation germplasm of some semi-arid fruits:

i) Wood apple

About seven accessions were collected from Panchmahals- 3 accession, Kheda- 1 accession, Anand-1 accession, Buldana (Maharashtra)-1 accession and Bhopal (Madhya Pradesh) - 1 accession. The fruits collected and evaluated for Physico-chemical character (Table 4.).

The data recorded on various Physico-chemical characters revealed that there is variation in most of Physico -chemical characters of fruits. The fruit weight ranged from 187 g to 350 g / fruit. Similarly fruit length from 71.5 mm to 95.08 mm, fruit diameter from 69.84 to 86.00 mm, pulp weight per fruit from 83.23 to 155.69 g, skin weight from 82.93 to 164.49, T. S. S. from 10.67 to 14.33, No. of seeds / fruit varied from 224 to 505 and seed weight / fruit varied from 7.00 g to 15.00 g. Significant variation in respect of all the parameters has been observed. The seeds collected have been raised in nursery and are budded successfully on one another.

0.5 ha block have been developed and all the collection will be planted there during coming rainy season.

ii) Pomegranate

Germplasm lines obtained from IIHR, Bangalore were evaluated for growth, fruit set, fruit retention, physico-chemical characteristics of fruit. There were significant differences amongst different lines under evaluation.

As regards vegetative growth parameters , maximum plant height was recorded in line-A (3.32 m) and it was minimum in lineH (1.87m). North-South plant spread was maximum in line A (2.84 m) whereas East-West plant spread was maximum in lineE (3.27 m) whereas least plant spread was recorded in lineD (1.43 m and 1.27 m, respectively). Stem diameter was highest in line - E (54.78 mm) and it was least in line D (25.92 mm)

Maximum fruit weight and fruit diameter were recorded in line- H (137.33 g & 75.16 mm ,respectively). Fruit length and fruit skin weight were recorded maximum in line - A (68.33 mm and 53.33 g, respectively). Maximum percent acidity (8.37 %) was noted in line- H. T.S.S. was however maximum in line E (18.53 ^{0}Brix) . The weight of 100 aril was maximum in line H (96.66 g) and it was minimum in line-B (42.33g) . Juice percentage was recorded maximum in line -K (134.14 %) and minimum in line- A (48.93 %).(Table 5).

(iii) Aonla

Aonla clonal selections were further evaluated. It was observed that in vegetative growth parameters all the lines were on par. Observations recorded on number of branchlet per shoot, number of empty branchlet per shoot, number of branchlet with female flowers, number of fruit set per shoot, number of fruit retained per shoot, percentage retention differed significantly.

Number of branchlet per shoot was recorded maximum in selection -3 (367.33) and minimum in Selction-6 (182.00) . maximum no. of empty branchlet per shoot was noted in selection- 1 (238.66) and minimum in selection -6 (53.33). Whereas no. of female flower per branchlet was found maximum in selection- 7 (16.66).Yield (kg/ plant) was highest in plant selection 6 (98.66 kg), Maximum number of fruit were set (762.33), fruit retention (284.33)& percent (42.89) were recorded in selection-7.(Table 6).

iv) Sapota

Seven cultivars of Sapota viz., Kalipatti, Pilipatti, Cricketball, Singapore, Jumakhia, Co-1 and Co-2 were evaluated for growth, yield and physico-chemical characteristics during the year. All the vegetative growth parameters showed significant differences amongst different cultivars. (Table 7.)

Plant height was maximum (4.50 m) in Co-1 whereas stock and scion diameter was maximum in Singapore (24.00, 24.00 cm, respectively). Plant spread (N-S and E-W) was highest in Kalipatti (7.18 m). The data on flowering per shoot was recorded at the beginning of the shoot in the middle of shoot and at the bottom of shoot. No. of flower cluster / shoot, no. of flower / cluster and no. of fruit retained / shoot were found to be significantly influenced by different varieties. Maximum no. of flower cluster with per shoot were recorded in Kalipatti (82.33). Similarly , no. of flower per cluster were maximum in Co-1 (8.83) and Jumakhia (8.78). No. of fruits retained / shoot were maximum (26.00) in Co-2. Due to prevalent draught condition, further development of fruit was severely hampered.

Table 4. Evaluation of wood apple germplasm (2002-03)

ACC No.	Fruit wt. (g)	Fruit length (mm)	Fruit Dia. (mm)	Plup wt. (g)	Skin wt. (g)	TSS	No. of seed	Seed wt. (g)
1	289.83	81.9	80.33	106.72	125.86	12.67	409.67	9.00
2	257.16	74.73	82.33	83.23	116.84	12.33	262.00	7.00
3	217.83	73.06	79.53	92.47	87.72	14.33	505.00	15.00
4	215.16	75.13	77.33	92.03	82.93	11.33	224.00	13.07
5	350.53	86.20	84.16	155.69	164.48	14.33	451.33	12.67
6	328.67	95.06	86.00	148.15	158.92	10.67	239.67	3.99
7	187.00	71.50	69.84	86.63	86.30	12.50	247.00	7.33
C.D. (5%)	34.13	3.87	7.90	18.45	16.05	1.79	28.45	1.53

Table 5. Evaluation of pomegranate germplasm (2002-03)

Treatment	Plant height (m)	Dia-meter (mm)	Plant spread (m)		Fruit wt. (g)	Fruit length (mm)	Fruit dia. (mm)	Skin wt. (g)	Aril wt. (g)	Juice (%)	TSS (^{0}Brix)	Acidity (%)
			N-S	E-W								
A	3.32	45.59	2.84	2.87	131.66	68.33	58.90	53.33	95.33	48.94	17.13	2.73
B	2.39	39.59	2.38	2.53	67.00	54.03	48.40	23.33	42.33	67.95	11.13	0.78
C	2.78	44.92	2.61	2.40	104.00	59.83	62.00	44.00	83.66	49.68	17.00	3.65
D	2.32	25.92	1.43	1.27	86.33	50.50	53.30	33.33	53.00	68.66	18.53	2.40
E	3.20	54.78	3.50	3.27	77.66	54.66	50.00	24.33	44.33	79.48	11.50	0.69
F	2.48	34.78	2.13	2.27	71.33	53.83	50.00	24.66	53.00	73.84	15.86	0.73
H	1.87	33.67	1.55	1.63	137.33	57.33	75.16	35.00	96.66	69.51	16.33	8.37
I	2.34	39.83	1.73	1.75	88.66	49.33	55.40	37.33	62.00	62.71	16.66	0.80
J	2.74	37.62	2.24	2.45	95.66	54.33	55.13	20.00	71.66	73.57	14.63	0.71
K	2.47	33.31	2.02	2.05	71.66	51.66	48.33	21.66	44.66	66.59	16.66	
CD (5%)	0.28	10.69	0.59	0.49	44.95	11.09	11.68	16.05	32.62	16.60	1.40	NS

Table 6 :Performance of aonla selection (2002-03)

Treatments	No.of fruit set /shoot	No.of fruit retained /shoot	Percent retention	No. of branchlet/ shoot	No. of empty brachlet/ shoot	No. of branchlet with female flower	No. of female flower/ brachlet	Yield / plant
1	222.33	46.66	18.47	348.33	238.66	107.66	12.66	79.00
2	375.00	67.83	17.20	220.00	115.66	104.33	8.66	78.66
3	733.33	87.00	17.99	367.33	219.00	148.39	16.00	80.00
4	165.00	65.33	42.69	187.67	188.66	32.33	14.66	71.00
5	516.00	171.66	33.36	189.33	94.86	94.66	14.33	81.33
6	749.00	269.33	41.55	182.00	53.33	129.00	15.66	98.66
7	762.33	284.33	42.89	249.00	112.00	137.00	16.66	87.00
8	248.33	62.33	62.88	237.33	165.33	72.00	6.66	64.00
CD (5%)		127.33	14.86	1 08.51	65.29	NS	3.19	14.60

Table 7 : Evaluation of sapota germplasm (2002-03)

Collection	Plant height (m)	Stock diameter (cm)	Scion diameter (cm)	Plant spread (m)		No. of flower cluster/shoot	No. of flower/ cluster	No. of fruit retained/shoo
				N-S	E-W			
1	4.18	23.13	23.83	7.18	7.18	82.33	7.61	6.67
2	4.10	19.33	21.66	4.90	4.48	59.17	3.50	8.67
3	4.43	21.00	20.50	3.91	4.91	59.17	8.55	4.00
4	3.10	24.00	24.00	6.60	5.28	66.83	8.78	10.67
5	2.95	15.33	14.83	4.08	4.18	76.33	1.67	5.67
6	4.50	21.66	19.00	4.70	5.00	53.83	8.83	5.33
7	3.10	16.50	16.33	3.83	4.06	68.83	8.77	26.00
C.D. (5%)	0.877	3.14	5.33	1.09	1.11	12.08	1.47	6.52

v) Tamarind:

Thirty promising genotypes were selected and evaluated for their flowering, fruiting and fruit quality attributes. Highest pod weight and length (26.00 g. and 17.00 cm respectively) were recoded in collection No.13. However, the maximum percentage of pulp was found in collection No.10 (54.13) followed by collection No. 18 and 20.

vi) Jamun:

Thirty-three promising genotypes were selected and evaluated for their flowering, fruiting and fruit quality attributes. Length of panicle ranged from 9.00 cm to 17.00 cm and number of fruits per panicle 4.00 to 26.00 in different genotypes. Individual fruit weight ranged from 9.80 to 21.50g and pulp percentage 79.6 to 86.37. The TSS percent varied from 9.60 to 12.30, total sugar 7.40 to 9.14 percent and vitamin C 33.00 to 43.00 mg/100g. On the basis of overall performance GJ-2, GJ-3 and GJ-8 were found to be promising.

vii) Bael:

Two varieties of bael i.e. N.B.5 and N.B.9 were collected from NDUAT, Faizabad. Plantation of collected genotypes will be done in the month of July 2003.

viii) Mahua:

Thirty-five genotypes were selected evaluated for flowering, fruiting and fruit quality attributes. Highest number of fruits per cluster (14.00) was found in collection No.2. Corolla (Mahua flowers) of collection No.5 had maximum weight (2.5 g) and Juice (68.00 percent). TSS (26.00%) and total sugar (22.10) was also found to be highest in the same genotype. Studies pertaining to fruit quality attributes are in progress.

ix) Chiraunji:

Fifteen promising genotypes were selected and evaluated for their flowering, fruiting and fruit quality attributes. Maximum panicle length (41.50 cm) was recorded in collection No.1, however fruit set per panicle (38.00) was found to be highest in collection No.12.Studies pertaining to fruit quality attributes are in progress.

A 2. Introduction, collection, characterization, conservation and evaluation of vegetable crops under hot arid environment.

A 2.1 Introduction, collection, characterization, conservation and evaluation in cucurbit vegetables under hot arid environment

Realizing the importance of cucurbit vegetables particularly the drought hardy species of *Citrullus* and *Cucumis* in arid and semi arid regions of northwestern parts of India, research initiates were under taken since 1994 at CIAH, Bikaner. In this direction, a large number of semi cultivated and land races of *mateera* (*Citrullus lanatus*), *kachri* (*Cucumis callosus*), snapmelon (*Cucumis melo* var. *momordica*), muskmelon (*Cucumis melo*), *kakdi* (*Cucumis* spp.), roundmelon (*Citrullus fistulosus*), bottlegourd (*Lagenaria siceraria*) were collected over the years for systematic evaluation and conservation of indigenous germplasm of cucurbits. As a result of crop specific explorations and collections from target variability pockets and vegetable based institutions and NBPGR, over the years this institute is maintaining active collections of *mateera*, snapmelon, *kachri*, muskmelon, roundmelon

(*tinda*), bottlegourd, ridgegourd and spongegourd. During the collection and preliminary evaluation of germplasm (1997 to99), the number of accessions was very high therefore during the year 2002-03 only data were analyzed for categorization of *mateera* and snapmelon germplasm to develop limited number of accessions for the maintenance and conservation. In February 2003, some samples were drawn and tested for seed-viability so that maintenance work can be under taken accordingly. After testing, it was realized that there is need to rejuvenate *mateera* and snapmelon in between 2003-04 for the maintenance. The present germplasm holding in cucurbit vegetables is as under (Table 8).

Table 8. Active cucurbit vegetable germplasm at CIAH

Crop	Accession	Crop	Accession
Mateera	210	Bottlegourd	20
Kachri	510	Ridgegourd	19
Snapmelon	90	Spongegourd	15
Muskmelon	55	Bittergourd	04
Roundmelon	10	Pumpkin	04
Kakdi	15	Ivygourd	01

At CHES, Godhara

At CHES, Godhra the germplasm of following vegetable crops were evaluated:

i) Cucurbits:

The germplasm of bitter guard, ridge guard and pumpkin have been collected from different parts of IIVR-Varanasi. About 18 lines of bitter guard, 15 lines of ridge guard and 17 lines of pumpkin were collected. Presently, there are 37 lines in bitter guard, 25 lines in ridge guard and 17 lines of pumpkin available for the breeding work.

ii) Drumstick:

Seventeen perennial and eleven annual types of drumstick were collected and evaluated for their yield attributes characters. No flowering was observed in the perennial type during the study period. Whereas much variability was observed in annual type for different characters. The fruit length ranged between 33.5 cm. (Accession no. 8) to 128 cm. (Accession no. 4).

Fruit diameter ranged between 1.34-cm. to 2.8 cm. The highest fruit pulp was observed in Accession no. 9 (12 Seeds), where on the highest of the same was observed in Accession No. 2 (27 seeds/ fruit). The fruit stalk thickness ranged from 0.5 cm. (Accession No. 3) to 1.95 cm. (Accession no.11).

Genetic improvement

Mission B: Genetic Improvement in arid horticultural crops.

At CIAH, Bikaner

B. 1 Improvement in Ber

i) Evaluation of Hybrids and Selection

Evaluation of BCF1 :

The observations were recorded with respect to infestation of fruit fly, fruit yield, fruit weight, stone weight, TSS etc. The range of infestation of fruit fly was between 12 to 18%.

CIAH Hybrid 1:

Developed by the hybridization of Seb x Katha. It is result of plant no 2 obtained by growing of F1 hybrid seed. Further, it was multiplied by the patch budding for early assessment of genotype through in situ budding. The plant growth habit of hybrid-1 is semi spreading, the average plant height is about 2.25m, canopy spread is 4.88 x 5 m, stem diameter is 11.75cm.Blooming period is between 30th August to 10th November. The peak time of flowering is between14th September to 30th October however, the period of peak fruit setting is between 10th October to 30th October. Average number of flower per cyme is 27. The average fruit weight is about 25g, TSS 24.3%, total sugar is 5.02%, ascorbic acid content is 88 mg/100 g fruit, stone weight is 1.26g, dry matter content is 21.32%,. It is early maturing variety. Fruit yield from five year old plant is 28-30 Kg/tree.

CIAH Hybrid 2:

It was observed as mid season cultivar plant have spreading growth habit, average plant height was 3.75 m, stem diameter was 11.4 cm, size of leaf was 5.86 x 5.38 cm, length of petiole was 2.16 cm . It is less juicy. Observations were also recorded with respect to yield and yield attributes.

CIAH Selection 1:

It is selection from the local material of Bhusawar area (near Bharatpur district) of Rajasthan. It is also early maturing variety. Plant growth habit is upright, average plant height is 3.3m, spread is 4.75x3.56m and stem diameter is 11.53 cm. Blooming period is first week of September to First week of November and peak flowering period is mid of September to end of October. The average number of flower per cyme is 25, peak time of fruit set is 14th October to 30th October. Average fruit weight is 27g, TSS 23%, total sugar is 4.29% and ascorbic acid content is 60mg/100 g fruit. Average stone weight is 1.3g, dry matter content is about19.87%. Fruit yield from five year old plant is about 30-35 Kg/ tree. It is free from fruit rot.

To estimate shelf life of ber CIAH Selection-1 and CIAH Hybrid-1

A Preliminary experiment was conducted to estimate the shelf life of ber selection and hybrid of CIAH along with Gola (check). Fully matured green fruits were harvested and kept in different material i.e. polythene bag. Paper bag, gunny bag, corrugated fibreboard boxes and in open condition under room temperature during February. Observations were made on physiological loss in weight, number of days taken for colour change from green to yellow to red and pathological infection. The TSS was found to increase as the days increased. PLW was also increased; the maximum was noticed in Gola under gunny bag while the minimum in polythene bag. The number of days taken for colour chage is minimum in polythene bag in all three varieties; maximum days took in hybrid and selsetion in paper bag and corrugated fibre boxes. Pathological infection was noticed in Gola kept in polythe bag. The ber selection and hybrid can be kept in room condition for four five days after harvest.

ute level meeting as and when desired.

B. 2 Improvement in pomegranate by selection and hybridization

i) Genetic variability components:

After preliminary evaluation and categorization of all the open pollinated seedling progenies during 2000-01 (OP/JS/98), developed through fruits of selected plants in seedling originated orchard of pomegranate cv. Jalore Seedless, six desirable progenies bearing fruits similar or better than the Jalore Seedless were marked for detailed characterization and analysis of fruit quality components. Similarly, three open pollinated seedling progenies (OP/AHPG/98) developed through high quality fruits from Iran and 15 F_1 progenies of desirable parental combinations were also evaluated for fruit yield and quality parameters. All the open pollinated and F_1 hybrid seedling progenies are at closer spacing of 2 x 1 m for preliminary evaluation of the evolved pomegranate breeding material. During, the period under report, the data were recorded to generate the information on genetic variability and also to identify selection indices for identification of promising progenies or elite plants after ensurering the fruit quality. Mean, range, SD and CV (%) for the important fruit quality and yield contributing characters of 25 progenies are given in the Table 9. The high value of CV (%) indicating the considerable variability for fruit yield per plant (53.6%) followed by number of fruits/plant (35.1%) and fruit weight (24.2%) in the source material.

ii) Evaluation of promising progenies:

The objectives of pomegranate breeding under extremes of arid environment is to evolved an ideal genotype having big sized fruits with appealing outer rind and dark red, bold, soft and sweet aril and also consistence fruit quality for longer period of harvesting. Out of 15 F_1 hybrids, the F_1 progeny (DKS/H/97/003) produced better quality fruits, while 12 progenies produced sour type fruits. Among open pollinated seedling progenies of Jalore Seedless, the fruits of progeny (AHP/OP/JS/98/10/45) were superior to cv. Jalore Seedless. Whereas the fruits of open pollinated progenies developed from Iranian

type were sour. The important fruit quality characteristics of promising plants of desirable progenies are given in Table 10. Among soft and sweet type F_1 progeny DKS/H/97/003, plant number 3, 16, 21, 17 and 22 and open pollinated progeny AHP/OP/JS/98/10 plant number 45 have been found promising for large scale testing. The heavy bearing sour and blood red colour aril producing plant number 9 of F_1 progeny DKS/H/97/001 has been found to be promising for preparations of *anardana*.

Photo for Pomegranate

Table 9: Variability in fruit quality and yield characters in F_1 and open pollinated progenies of Pomegranate

Characters	Minimum	Maximum	Range	Mean	Sd	CV %
Fruit weight (g)	54.25	144.12	89.87	99.03	24.01	24.2
Fruit length (cm)	4.09	6.93	2.83	5.41	0.91	16.8
Fruit diameter (cm)	4.10	6.59	2.50	5.29	0.77	14.6
Weight of 100 aril (g)	13.45	33.12	19.67	23.13	3.34	14.4
Aril length (cm)	0.82	1.10	0.26	0.93	0.06	6.3
Aril width (cm)	0.80	0.98	0.18	0.87	0.04	4.9
Number of fruits/plant	3.21	18.67	15.46	9.35	3.28	35.1
Fruit yield /plant (kg)	0.22	2.41	2.01	0.94	0.49	53.6

Table 10: Fruit quality characters of promising plants in pomegranate progenies

Name of progenies with plant number	Fruit weight (g)	Percent aril	Percent rind	Percent juice	Percent seedaril waste	Aril length (mm)	Aril width (mm)	TSS °Brix	Acidity (%)
DKS/H/97/003/3	84.28	60.35	38.07	43.74	13.43	1.16	0.75	17.56	0.55
DKS/H/97/003/16	122.35	61.26	36.44	42.26	12.72	1.02	0.76	18.44	0.58
DKS/H/97/003/21	118.47	60.86	34.82	43.04	17.35	1.03	0.76	17.65	0.40
DKS/H/97/003/17	90.73	57.41	40.89	36.35	14.64	1.11	0.75	17.53	0.40
DKS/H/97/003/22	149.31	66.75	30.71	38.30	16.21	1.02	0.77	17.60	0.58
DKS/H/97/001/9	99.30	55.45	40.26	37.36	14.15	1.12	0.65	18.42	3.25
OP/JS/98/10/45	130.88	59.60	36.04	36.43	17.59	1.04	0.78	16.41	0.38
Mean	113.62	60.24	36.75	39.64	15.15	1.07	0.75	17.66	-

B.3 Improvement in cucurbit vegetables under hot arid environment

i) Evaluation of advanced progeny blocks for quality improvement in *mateera* (*Citrullus lanatus*).

Summer 2002: In continuation of the results of work done in drought hardy *mateera* landraces and thereafter hybridization to improve drought hardy *mateera* selections for higher TSS and quality fruit yields *at par* with standard watermelon types under hot arid conditions, during summer 2002, two *mateera* varieties (AHW 19 and AHW 65), four watermelon varieties (Sugar baby, Durgapura Meetha, Charleston and Mahobobi) and advanced progeny block (F_6 AHW 19 x Sugar baby) were evaluated. The characters related to earliness, fruit yield and quality, tolerance to fruit cracking, flowering and fruiting behaviour under extremes of high temperature (> 40 °C) and reaction to insect-pest and diseases were recorded to screen the genotypes. Consistent trends were observed for both the *mateera* varieties for fruit yield per plant and that was better (> 4 fruits/plant) as compared to standard watermelon varieties (< 1.5 fruits/plant). In *mateera* varieties, fruit quality for wider acceptability among the people of urban market, is the only standing problem, otherwise both the varieties are stable in fruit yield components and tolerating extremes of aridity.

After assuring fruit quality components, only four progeny blocks (F_6/a/3, F_6/a/7, F_6/a/9 and F_6/a/10) of cross combination M*ateera* AHW-19 x Sugar Baby, showed very desirable trends in growth, earliness, and fruit yield, number of fruits/plant and fruit size, shape and flesh characters (Table-11 and Fig. 1). The fruits of advanced progeny F_6/a/10 block were superior and highly acceptable in quality depicting internally as good as sugar baby and outer as *mateera*.

Rainy 2002: On the basis of the highest fruit quality and early yields in four progeny blocks (F_6/a/3, F_6/a/7, F_6/a/9 & F_6/a/10), the same seed material was used for evaluation as a rainy season crop.

Observations on growth, flowering and fruiting behaviour, earliness, fruit yield and quality-attributing traits were recorded and analyzed (Table 11.). The advanced progeny block (F_6/a/10) of *Mateera* AHW 19 x Sugar Baby depicted desirable fruit quality characters and high yielding.

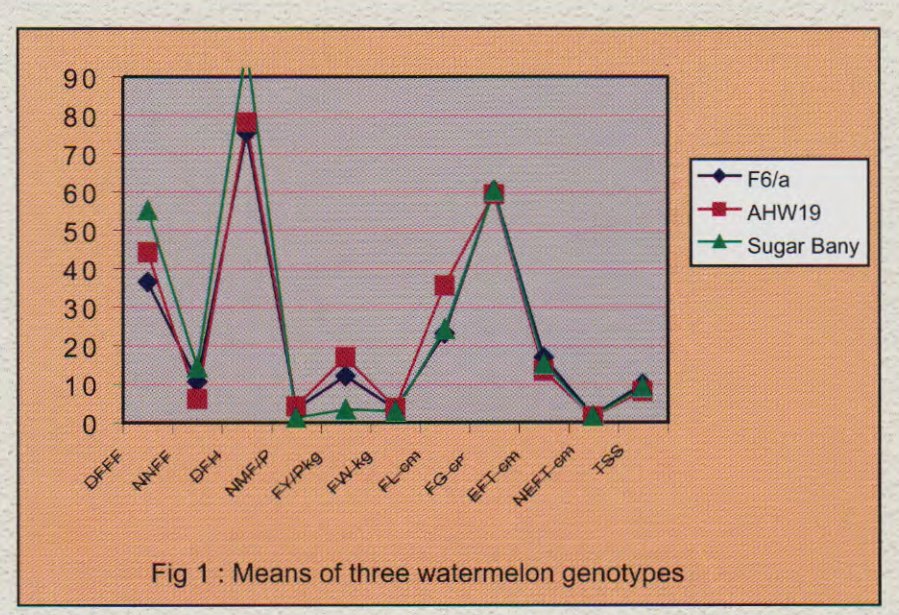


Fig 1 : Means of three watermelon genotypes

Table 11 : Performance of advanced progenies of drought hardy *mateera* (watermelon)

Season	Summer season 2002				Rainy season 2002			
Progeny block Character	F_6/a/3	F_6/a/7	F_6/a/9	F_6/a/10	F_6/a/3	F_6/a/7	F_6/a/9	F_6/a/10
Days to first female flower	42.2	41.2	42.2	40.43	2.5	31.3	30.2	32.2
Node to first female flower	10.2	8.4	9.2	10.21	2.2	10.2	11.2	14.2
Days to first harvest	77.5	78.3	79.5	75.57	4.2	72.5	73.5	72.5
Marketable fruits/plant	3.2	3.7	3.5	3.9	3.0	3.1	3.5	3.8
Fruit yield/plant (kg)	12.8	14.4	14.3	17.5	8.4	8.5	9.8	10.8
Fruit weight (kg)	4.0	3.9	4.1	4.5	2.8	2.7	2.8	2.8
Fruit length (cm)	24.5	25.5	26.2	26.5	20.2	21.2	20.2	21.5
Fruit girth (cm)	64.5	64.8	65.5	66.2	55.5	56.5	53.8	55.6
Edible flesh thickness (cm)	17.2	18.2	17.3	19.1	15.2	16.2	15.2	16.2
Non edible flesh thickness (cm)	1.8	1.9	2.0	2.0	1.6	1.6	1.5	1.5
TSS (^{0} Brix)	10.1	10.4	11.2	11.2	9.0	9.1	9.2	9.4
Flesh characters	Firm-red	Firm-red	Firm-red	Firm-red	Firm-red	Firm-red	Firm-deep pink	Firm-red

ii) Improvement for higher yields in *kachri* (*Cucumis callosus*)

Yield performance of *kachri*: *Kachri* variety AHK119 was tested in large scale area during summer 2002 using open pollinated seeds from selected plants of first and second harvest seeds separately to assess the earliness and yield potential and also stability over the season under variable weather conditions of arid agro-climate. Besides, some more production treatments were also imposed *i.e.* channel to channel and plant to plant spacing which were deviated from the recommended for the improvement in the yield potential through production technology. Observation on growth, earliness, days to first harvest, number of fruits/plant and total yield was recorded. On analysis of data, on an average the *kachri* (AHK119) accounted yield potential of 92.5 q/ha under normal production system. In comparison to recommended technology, the imposed treatments showed variable results and that was not excelled ± 1.2 q/ha.

iii) Improvement in snapmelon (*Cucumis melo* var. *momordica*)

Yield performance of snapmelon varieties: Snapmelon varieties recommended by CIAH *i.e.* AHS 10 and AHS 82 were tested during summer and rainy season 2002 respectively adopting normal packages of production to assess the yield potential and stability over the years under varying agro-climatic conditions. The year 2002 experienced continued high temperature (April-October) and severe drought. With the supplemental irrigations, the variety AHS 10 bears 4.56 fruits during summer with an average yield potential of 205 q/ha. The variety AHS 82 recorded average yield potential of 231 q/ha in rainy season with 5.55 fruits/plant.

Improvement in yield of snapmelon through production practices: Snapmelon variety AHS 82 was tested during rainy season of 2002 as a late sown crop (first week of August) on which two types of treatments were imposed. Half of the field area was kept for moisture conservation practices and half for the plant growth regulating substances. The year 2002 was the most drought-affected year with only two rainy days during the crop growth period and the crop experiences around 38-40 ^{0}C temperature during vine spread and flowering and fruit set period. The crop was raised with supplemental irrigation (three with IGNP water and two with tubewell water). The variety AHS 82 recorded yield potential of 231 q/ha (5.55 fruits/plant) even as a late sown crop in *kharif* season under normal recommended production technology. The moisture conservation practices *i.e.* (i) two additional hand hoeing in the channel and near by ridges (1.2 m) after 15 and 45 days of sowing, (ii) organic hay mulch using locally available weeds/grasses (*bui, khimp* and *sewen*) in channel and near by ridges (1.2 m), and (iii) black polythene strips mulch (1.2 m width) in the channel significantly improved the number of marketable fruits and fruit yield/plant (Fig 2). The increased fruit yield/plant was 18.7, 58.2 and 42.7 percent over the control under moisture conservation practices.

Plant growth regulators and nutrients are playing important role in sex modification, flowering and fruit set resulting in improvement in fruit yield potential of cucurbit vegetables. On the basis of preliminary results on plant growth regulating substances and chemicals in snapmelon, twelve

treatments were imposed in this exeriment comprising of two concentration each in GA_3 (20 and 40 ppm), NAA (50 and 100 ppm), thiourea (100 and 200 ppm), ethral (50 and 100 ppm) and $CuSO_4$ (15 and 30 mM) at 2-4 true leaf stage and foliar application of urea 2 % (25 and 35 DAS). Variable and significant results were obtained for growth, flowering and fruit set and fruit yield components (Fig 3). The highest fruit yield (8.24 kg) per plant was obtained with the application of GA_3 20 ppm followed by foliar application of urea (7.33 kg) in comparison to control (5.05 kg) and this was about 63 and 45 percent higher than the control, respectively.

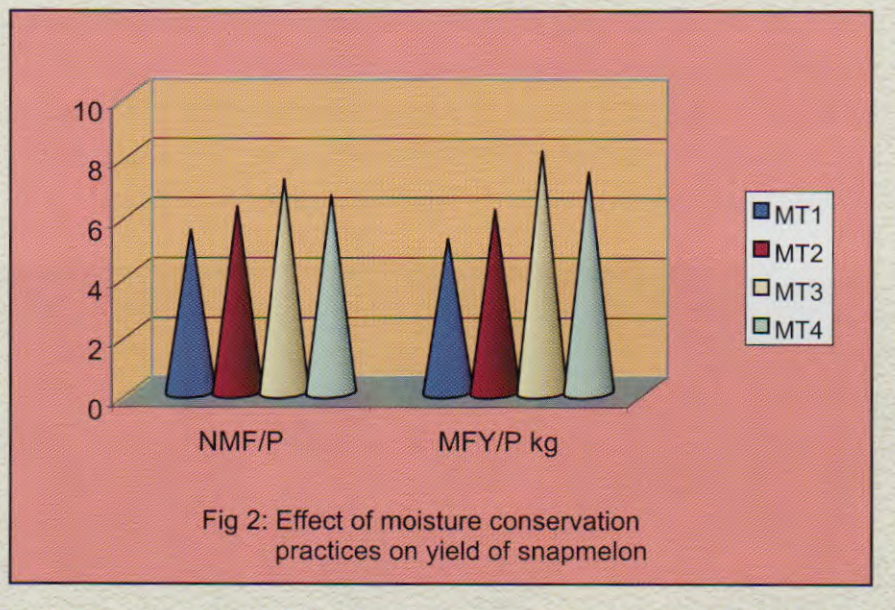


Fig 2: Effect of moisture conservation practices on yield of snapmelon

NMF/P : Number of marketable fruits/plant **MFY/P kg : Marketable fruit yield/plant (kg)**

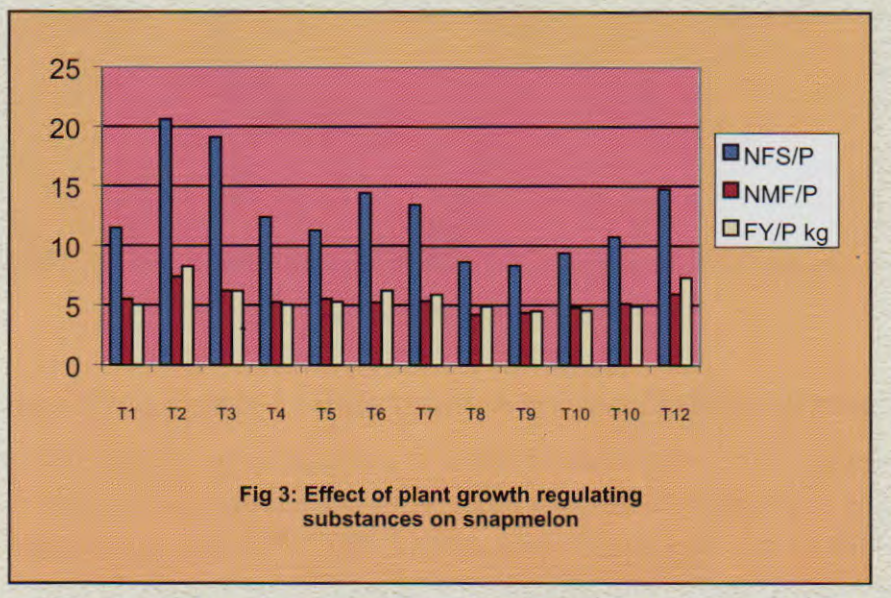


Fig 3: Effect of plant growth regulating substances on snapmelon

NFS/P : Number of fruit set/plant **FY/P kg : Fruit yield/plant (kg)**

iv) Improvement in *salad kakdi*

Advanced progeny of *salad kakdi* var. AHC 2 was evaluated for fruit shape (straightness), earliness and yield potential during summer 2002 and selected potential plants were selfed for further evaluation. Data for earliness and fruiting behaviour under extremes of high temperature and yield contributing characters were recorded in both the *salad kakdi* varieties AHC 2 and AHC 13 for stability analysis over the seasons and years under varying agro-climate.

v) Improvement for yield potential in advanced selection of cucurbit vegetables

Four advance selections developed at CIAH in vegetable type cucurbits for high yield potential under extremes of aridity and temperature were evaluated during rainy season 2002 and these were in bottlegourd (AHLS Long 1 and AHLS Round 1), round melon (AHRM-1) and ridgegourd (AHRG-1). Data were recorded on growth, flowering and fruiting behaviour, fruit set, tender fruits per plant and total marketable yields (Table 12.) for the assessment of yield potential over the years.

Photo for Bottlegourd

B 4. Improvement in chilli (*Capsicum annum)* under hot arid environment

The main objective of improvement in chilli is to recognize the original *Mathania* type (popular landrace), which is at present completely a mixture for cultivation, low yielding and lost its quality attributes for which it was popular in north-western parts of India. Four-advance progeny block developed on the basis of fruit quality characters of previous year crop were evaluated during rainy-winter season *i.e.* August 2002 to January 2003. Detailed observations on plant growth, flowering, days

to first harvest (green and red ripe fruits), number of fruits and fruit yield /plant and fruit quality components were recorded and presented (Fig. 4). On an average fruits of all the progeny blocks were more or less similar in phenotypic characters, when fruit of all the progenies (green/ red ripe fruits) were collected in a single lot and resembles to *Mathania* type. However, between the progenies there were slight variations in fruit yield component charecters.

Table 12. Performance of advanced selections in cucurbit vegetables.

Crop	Bottlegourd	Bottlegourd	Ridgegourd	Roundmelon
A. Selection Character	**AHLS Long-1**	**AHLS Round-1**	**AHRG 1**	**AHRM 1**
Days to male flower (DAS)	52.58	51.48	30.58	30.25
Node to male flower	9.12	8.26	10.25	3.55
Days to female flower (DAS)	60.48	58.64	42.68	38.42
Node to female flower	14.25	11.25	17.35	5.25
Days to harvest (DAS)	71.45	70.25	54.65	46.75
Marketable fruits/plant (No.)	8.24	4.85	14.25	19.12
Fruit weight (Tender stage, g)	750.5	980.59	150.25	98.45
Fruit length (cm)	22.42	18.25	22.50	6.12
Fruit girth (cm)	18.41	39.56	12.54	17.45
Fruit yield (kg/plant)	6.15	4.68	2.10	1.86

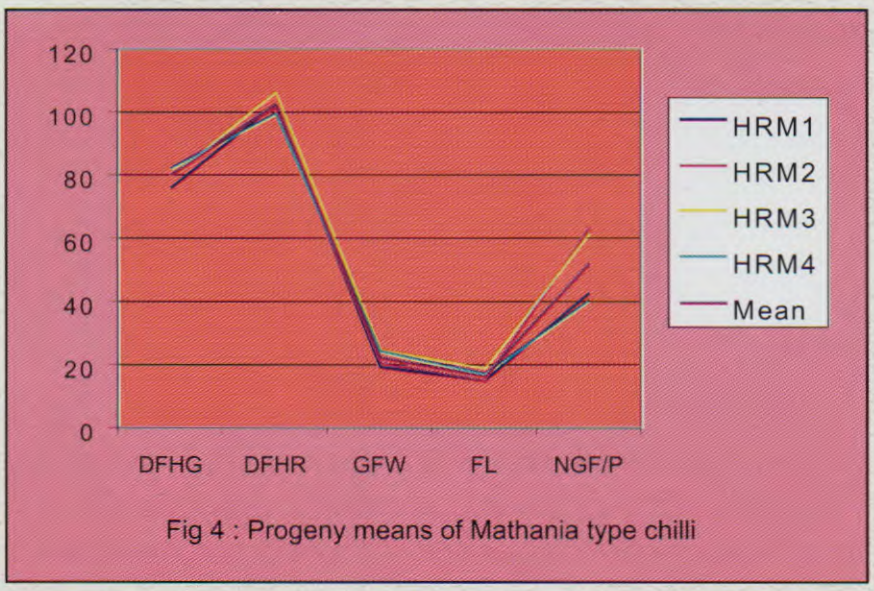


Fig 4 : Progeny means of Mathania type chilli

DFHG (Days to first harvest, green), GFW : Green fruit weight (g)
DFHR : Days to first harvest, Red) FL fruit length (cm)
NGF/P : Number of green fruits/plants

Vegetative propagation

Mission C: Rapid multiplication of propagules of fruit crops.

At CIAH, Bikaner

C 1. Standardization of plant propagation and root stocks in arid fruits

The propagation of arid fruits like aonla (*Emblica officinalis*), lasoda (*Cordia myxa*), pomegranate (*Punica granatum*) and tamarind (*Tamarindus indica*) was initiated at CIAH, Bikaner to standardize vegetative propagation technique for mass multiplication of these important arid fruits. The aonla, lasoda and tamarind were propagated by budding while pomegranate was propagated by hardwood and semi-hardwood cutting.

Aonla:

In case of aonla, the experiment was laid out to see the effect of filling mixture and type of polycontainers on seedling vigour and budding success.

Treatments

A. Filling mixture	B. Polycontainers
T1: Sand	PC1: Polythene bag (15 x 10 cm)
T2: Sand + Sheep Manure (1:1)	PC2: Polythene bag (25 x 10 cm)
T3: Sand + Sheep Manure (2:1)	PC3: Polythene bag (25 x 15 cm)
T4: Sand + Sheep Manure (1:2)	PC4: Polythene tube (25 x 10 cm)
T5: Sand + FYM (1:1)	
T6: Sand + FYM (2:1)	
T7: Sand + FYM (1:2)	
T8: Sand + Compost (2:1)	
T9: Sand + Pond Soil + Compost (1:1:1)	

The data obtained under various treatments indicated that the seed germination varied from 69.09% to 82.76% under different filling mixture indicated that merely use of sandy soil is not a good filling mixture. Among polycontainers, bigger size of polybags had given better seed germination. Similarly, highest percentage of seedling stock was also observed in big size of polythene bags (25 x 15 cm) filled with sand: pond soil: compost in the ratio of 1:1:1 respectively. The vigour of seedling stock was also measured in term of seedling height and stock girth. It was found that the seedling vigour was poor ine sand mixture and it was better where either pond soil or manures were used as filling mixture.

There was a wide variation in the height of the seedlings but variation in the stock girth was less under different treatments.

From the first year of observations, it was observed that the budding success was not very appreciable. The success of budding varied from 30.91 per cent to 44.83 per cent. Among various treatments, there was no much difference in success of budding, however, the lowest success was recorded when sand was used as filling mixture. This indicated that the vigour of rootstocks has some influence on success of budding in aonla. Among different polycontainers, the bigger size of polybags had given better response than smaller size of polybags. The highest budding success (52.40 %) was recorded in 25 x 15 cm size of polybags filled with sand + pond soil + compost (1:1:1).

Table 13. Effect of filling mixture and polycontainers on budding success in aonla (%)

Treatment	Polythene bag (15 x 10 cm)	Polythene bag (25 x 10 cm)	Polythene bag (25 x 15 cm)	Polythene tube (25 x 10 cm)	Mean
T1	25.50	33.50	32.15	32.50	30.91
T2	27.60	37.00	36.50	36.15	34.31
T3	32.70	42.15	44.55	40.00	39.85
T4	33.00	46.00	47.55	44.00	42.64
T5	33.55	46.00	50.15	44.25	43.49
T6	32.80	45.00	48.50	43.25	42.39
T7	29.50	48.00	51.15	44.55	43.30
T8	34.50	49.50	50.00	43.50	44.38
T9	34.50	49.50	52.40	42.50	44.83
Mean	31.52	44.07	45.88	41.18	

Pomegranate:

In pomegranate, two types of cuttings i.e. (i) hardwood cutting and (ii) semi-hardwood were used by treating with the IBA 2500, 5000 ppm as quick dip, 50, 100, 200 ppm as prolonged dip and water dip as control. Data presented in table 14 indicated that July-August followed by January-March were the best time for planting of pomegranate cuttings. The maximum sprouts were recorded in the month of July (94.8%) and minimum in the month of November (48.7%). Among two types of cuttings, semi-hard wood cuttings had given better response than hardwood cuttings. Among various concentrations of IBA, there was not much difference but with the increasing concentrations, the sprouting of cuttings increased upto 2500 ppm and there after it decreased further. The appreciable sprouting was also observed under control, thus indicated that the season of taking cuttings and planting under shade net had more impact than exogenous application of IBA.

The fibrous root system is essential for proper establishment of plant. In present investigation, the number of roots/cutting was also increased with the increasing concentration of IBA but the length of roots/shoot showed reversed trend (Fig. 5 and Fig. 6). All the sprouted cuttings did not survive and after

45 days the final success as percentage rooting under different treatments were recorded. The data given in table 15 indicated that 80.5% to 86.5% rooting was recorded in hardwood and semi hard wood cuttings respectively in the month of July even under control. The highest percentage of rooting (90.5%) was recorded in the month of July under semi hard wood cutting with the treatment of 2500 ppm IBA.

Table 14. Effect of time, type of cutting and exogenous application of IBA (ppm) on percentage sprouting of pomegranate cuttings.

Time	Hard wood cutting							Semi-hard wood cutting						
	00	50	100	200	2500	5000	Mean	00	50	100	200	2500	5000	Mean
Jan.	82.0	81.5	82.0	84.3	85.0	84.3	83.2	90.0	92.0	90.0	91.5	94.15	91.0	91.4
Feb.	81.5	80.0	82.3	85.6	84.3	82.0	82.6	86.5	85.0	85.3	85.0	86.0	85.0	85.5
March	80.5	81.3	81.0	84.3	85.0	81.2	82.2	84.0	84.0	84.3	84.5	86.5	83.0	84.4
April	70.0	73.0	73.3	74.0	76.1	74.1	73.4	70.4	75.2	75.0	75.3	76.0	74.0	74.3
May	49.9	60.2	63.2	63.5	64.3	61.2	60.2	60.2	65.3	65.5	65.4	67.4	65.0	64.8
June	40.5	50.2	51.0	53.6	53.6	51.5	50.1	51.5	56.0	54.0	53.0	60.0	51.5	54.3
July	91.2	90.5	93.6	94.3	93.0	90.3	92.2	94.0	94.5	94.6	95.3	96.0	94.3	94.8
Aug.	86.0	85.0	86.0	86.3	88.5	85.0	86.1	87.5	88.8	89.0	91.5	93.3	88.0	89.7
Sept.	75.0	76.5	78.0	78.0	78.6	75.4	76.9	77.0	76.0	78.0	78.0	79.3	77.5	77.6
Oct.	50.0	50.2	54.3	54.3	55.0	56.0	53.3	49.0	55.0	57.0	58.0	60.0	54.0	55.5
Nov.	44.5	48.4	48.0	50.6	50.7	50.0	48.7	50.0	52.0	52.2	53.0	53.4	53.0	52.3
Dec.	46.0	50.5	51.0	50.0	53.0	50.2	50.2	48.0	54.0	56.2	51.0	56.0	54.3	53.3
Mean	60.3	68.9	70.3	71.6	72.3	70.1		70.7	73.2	73.4	73.5	75.7	72.6	

Table 15. Effect of time, type of cutting and exogenous application of IBA (ppm) on percentage rooting of pomegranate cuttings.

Time	Hard wood cutting							Semi-hard wood cutting						
	00	50	100	200	2500	5000	Mean	00	50	100	200	2500	5000	Mean
Jan.	39.5	39.0	39.0	40.0	44.5	40.0	40.3	42.5	41.0	41.0	41.5	46.5	46.0	43.1
Feb.	42.5	43.0	43.0	43.5	48.5	42.0	43.8	44.0	44.0	45.0	45.5	55.4	45.0	46.5
March	36.0	35.5	36.5	38.5	38.0	35.0	36.6	40.5	41.5	40.5	40.2	46.5	46.8	42.7
April	16.5	16.8	18.5	18.5	20.0	20.0	18.4	20.5	24.5	24.5	25.6	25.0	26.0	24.4
May	14.0	13.0	12.5	13.6	14.7	15.0	13.8	16.0	16.0	17.0	16.5	18.5	18.0	17.0
June	10.5	13.0	13.0	13.5	12.0	11.80	12.3	15.0	15.6	14.7	13.4	15.0	14.6	14.7
July	80.5	79.5	79.0	80.0	80.5	80.6	80.1	86.5	86.0	86.5	85.9	90.5	85.6	86.8
Aug.	71.5	70.5	70.5	72.0	74.0	71.5	71.7	78.5	78.0	79.0	80.0	80.1	78.5	79.1
Sept.	50.4	46.0	45.0	48.5	47.5	46.0	47.2	49.5	49.5	50.5	50.3	51.4	51.0	50.4
Oct.	21.5	22.0	22.0	23.5	24.0	25.0	23.0	26.5	24.9	25.0	26.5	26.0	27.0	25.9
Nov.	10.5	11.0	10.5	10.8	11.5	10.0	10.7	12.5	12.6	12.8	14.5	15.0	13.1	13.4
Dec.	6.3	4.8	4.5	6.5	6.40	6.0	5.8	6.10	9.5	11.5	11.0	12.0	7.3	9.6
Mean	33.3	32.8	32.5	34.1	35.1	33.6		36.5	36.9	37.3	37.6	40.2	38.2	

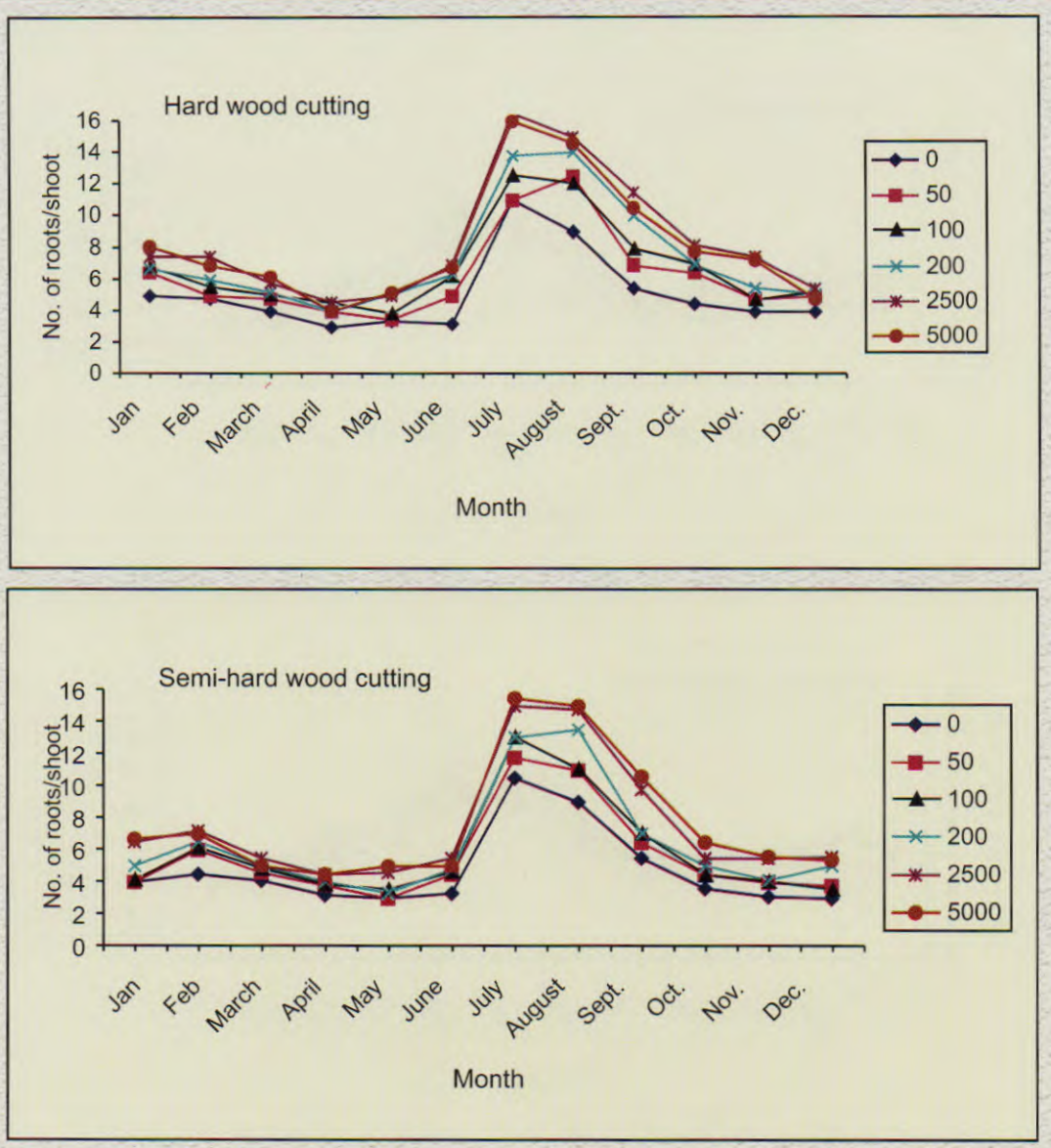


Fig. 5 Effect of different treatments on number of roots /shoot in pomegranate

Tamarind

To standardize vegetative propagation in tamarind under Bikaner conditions, an experiment was initiated by using rootstocks raised from the seeds collected from Jagdhalpur (M.P.). The budding was done at regular intervals starting from 1st June to 15th October. The results indicated that the maximum bud sprouting was recorded in between the period from 15th July to 15th August (90.0-100.0%). The bud take, linear growth, radial growth of budlings were also recorded. The first year observations indicated that the tamarind can be successfully propagated by budding during rainy season. However, under western Rajasthan conditions, the young plants of tamarinds are affected by frost during winter. Therefore, preliminary survey was made in some part of western Rajasthan to find out resistant source of frost-free materials.

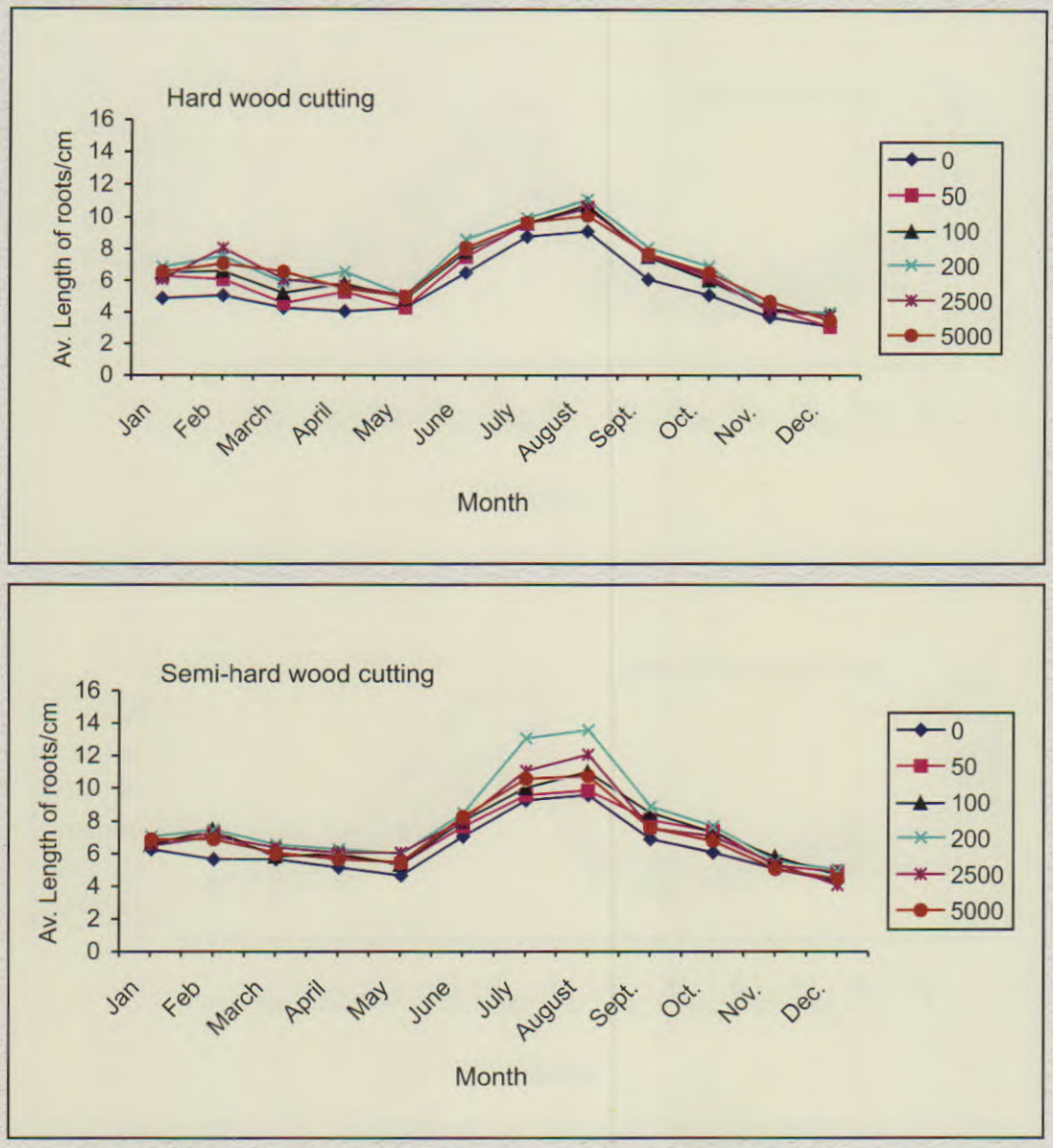


Fig. 6 Effect of different treatments on length of roots /shoot (cm) in pomegranate

Lasoda

Lasoda (*Cordia myxa*) is an important crop of the arid region growing naturally under marginal lands. The regeneration is mostly through seeds, owing to variability in growth and fruiting. Therefore, an attempt was made at CIAH, Bikaner to standardize vegetative propagation of lasoda through budding during 2001 and 2002. The budding was performed at 15 days internal from July to September. The results obtained in this investigation indicated that lasoda can be successfully propagated through budding in the middle of August.

Growth and development

Mission D. Growth and development of horticultural crops under abiotic stresses

At CIAH, Bikaner

D.1 Studies on growth and development of some cucurbit crops under water stress

D.1.1 Effect of spraying plant growth regulators on photosynthesis and associated parameters in snapmelon.

A field experiment was conducted to study the effect of plant growth regulators on photosynthesis and associated parameters in snapmelon. The various treatments tried are listed in Table 16. Perusal of Table reveals that in all treatments the rate of P_N increased significantly over water spray. The maximum rate of photosynthesis was observed with Thiourea 200 ppm spray (17.670 µmol $m^{-2}s^{-1}$) followed by Ethernal 50 ppm (12.339 µmol $m^{-2}s^{-1}$). Similarly perusal of data on water use efficiency revealed that application of PGR improved the water use efficiency in snapmelon. The maximum value (437.26) was observed when plants were sprayed with Thiourea 100 ppm. Similarly, the carboxylation efficiency was also improved, when plants were sprayed with 200 ppm Thiourea solution. The results revealed that spraying thiourea (100 or 200 ppm) improved the photosynthesis efficiency in snapmelon (Table 16).

Table 16. Effect of Plant Growth Regulators on Photosynthesis and associated parameters in Snapmelon

Treatment	Pn (µmol $m^{-2}s^{-1}$)	Transpiration (mmol $m^{-2}s^{-1}$)	PWUE	Carboxyl. Effect
Water spray	7.022	0.0223	314.89	0.02
GA 20 ppm	11.07	0.0256	432.42	0.06
GA 40 ppm	8.614	0.0196	439.49	0.05
NAA 50 ppm	10.019	0.0276	363.01	0.06
NAA 100 ppm	4.687	0.0168	278.90	0.02
Thiourea 100 ppm	9.401	0.0215	437.26	0.06
Thiourea 200 ppm	17.670	0.0479	368.89	0.12
Etheral 50 ppm	12.339	0.0410	300.95	0.07
Etheral 100 ppm	7.921	0.1474	53.74	0.04

D.1.2 Effect of spraying thiourea on physiological parameters in Brinjal.

Effect on photosynthetic rate and associated parameters.

A field experiment was conducted using Brinjal as the test material in order to ascertain the effect of thiourea applied either as seed or foliar treatment. The seeds were dipped in 100 ppm thiourea solution for 1 hrs. and after air drying was sown in the field. For foliar treatment, the plants were sprayed with 100 ppm thiourea solution during vegetative growth stage. The observations were recorded on photosynthesis and associated parameters.

a) Photosynthesis and associated parameters

The data obtained on net photosynthesis, transpiration rate and carboxylation efficiency is presented in Table 17. Perusal of data reveals that net photosynthesis rate increased significantly in treatment combination seed+foliar spray. Similar results were also observed with respect to other parameters also.

Table 17. Effect of Thiourea (100 ppm) on Photosynthesis and associated parameters in Brinjal

Treatment	Pn ($\mu mol\ m^{-2}s^{-1}$)	Transpiration ($mmol\ m^{-2}s^{-1}$)	Carboxylation Efficiency
Control	14.56	0.0332	0.08
Seed	15.92	0.0305	0.10
Foliar	12.57	0.0391	0.07
Foliar+Seed	17.46	0.0436	0.10

b) Dry matter partitioning

The data on dry matter partitioning is presented in table 18. Perusal of data reveals that dry matter partitioning is not affected by the thiourea application. However, more dry matter is allocated towards stem when foliar spray of thiourea was applied.

Table 18. Dry matter partitioning (%) after application of Thiourea in Brinjal

Treatment	Stem	Leaves	Root	Fruit
Control	23.93	58.22	10.76	7.09
Seed	25.20	55.21	8.91	10.66
Foliar	30.45	50.01	8.22	11.30
Seed+Foliar	22.63	45.69	8.06	23.59

c) Relative water content

The data on Relative Water Content of leaves demonstrated that leaves of plants treated with thiourea has higher RWC as compared to control. Showing thereby that application of thiourea maintains the turgidity in leaves (Table 19.)

Table 19. Effect of Thiourea on relative water content (%) of different plant parts of Brinjal

Treatment	Relative Water Content (%)
Seed+Foliar spray	40
Seed treatment	38
Foliar spray 100 ppm	38
Control	34

D.1.3 Photosynthetic activity in advance hybrid lines of mateera and watermelon.

The advanced lines of mateera and watermelon were screened for their photosynthetic efficiency and compared with standard mateera and watermelon cultivars. It was observed that both the cultivars of watermelon (viz. Mehboobi and Sugar baby) have higher rate of photosynthetic rate as compared to mateera (AHW-63). Perusal of data on advance lines revealed that ADV 3, ADV 4, ADV 6, ADV 9, and ADV 11 have higher rate of photosynthetic rate as compared to other advance lines (Table 20). The data on transpiration rate also reveals that all the advanced lines have low transpiration rate. In terms of carboxylation efficiency, ADV 1, ADV 3, ADV 4, ADV 6, ADV 9, ADV 11, shows better carboxylation efficency (more than 0.08) as compared to other lines. Thus, on the basis of photosynthetic parameter the above advance lines are better suited for this region.

Table 20. Photosynthetic activities in mateera, watermelon and hybrid lines of mateera x Watermelon

Treatment	Pn ($\mu mol\ m^{-2}s^{-1}$)	Transpiration ($mmol\ m^{-2}s^{-1}$)	Carboxyl. Effect
ADV 1	17.05	0.075	0.08
ADV 2	16.33	0.074	0.06
ADV 3	24.60	0.098	0.10
ADV 4	21.48	0.084	0.09
ADV 5	9.76	0.059	0.03
ADV 6	24.40	0.109	0.08
ADV 7	17.68	0.088	0.07
ADV 8	16.25	0.072	0.06
ADV 9	19.97	0.082	0.08
ADV 10	14.00	0.029	0.05
ADV 11	22.26	0.099	0.08
ADV 12	17.15	0.085	0.06
AHW 65	19.77	0.166	0.07
Mehboobi	27.59	0.088	0.120
Sugar Baby	29.04	0.070	0.118

D.1.4 Screening parameters for stress tolerance

In a persuit to identify the parameters which correlates with stress tolerance various characteristics were studied in drought resistant and susceptible plants.

i) Germination per cent

The germination percentage in materials listed in Table 21 were investigated in presence of water (control) and 1MP of PEG (stress) condition. It was observed that this parameter did not show much difference.

Table 21. Germination per cent

Plant Type	Control	Stress
Snapmelon AHS 10	91.65	93.30
Kachari AHK 200	100.00	98.33
Mateera AHW 65	41.65	41.65
Tinda	90.00	88.33
Musk Melon	98.33	98.33

ii) Stress index

The dry matter stress index and plant height stress index was calculated during the present study on materials listed in Table 22. The data revelaed that both, plant height stress index and dry matter stress index differ significantly in tolerant and susceptible cultivars. Hence, these can be used to evaluate the plant species for their tolerance to water stress.

Table 22. Stress Index

Genotype	Dry Matter	Plant Height
Water Melon		
Sugar Baby	34.10	71.63
Mahoboby	47.48	50.93
Kachari		
AHK 119	72.44	88.59
AHK 200	69.78	95.13
Snapmelon		
AHS 82	91.11	80.95
AHS 10	88.70	72.32
Tinda	49.00	82.37
Mateera AHW 65	66.75	77.58

iii) Degree of leaf rolling

The observation an degree of leaf rolling was recorded in field under irrigated and stressed plants. The data presented in Table 23 reveal that in tolerant cultivars such as kachari and mateera the leaf rolling was upto 45% under stressed condition whereas in susceptible cultivars the leaf rolling was more that 55% in both cultivars. Thus, this parameter can be employed to assess the level or drought tolerance in plants..

Table 23. Leaf rolling 20 days after withholding of irrigation.

Variety	Irrigated (%)	Stressed (%)
Kachari	-	42.25
Mateera	-	45.00
Muskmelon	-	58.82
Watermelon	2.45	60.00

D 2. Studies on physiological adaptation to water stress in arid fruit species.

D 2.1 Studies on water status, photosynthetic activity and productivity in *Ziziphus* spp.

During the period under report, growth and development studies were repeated in 6 cultivars of ber. Of these 3 (Gola, Umran and Banarsi Pewandi) were not showing mid day depression whereas 3 (Kathaphal,Sanaur-5 and Kaithali) showed mid day depression. The attempt was to compare the growth and development of these two groups.

The data on morphometeric parameter is presented in Table 24. The perusal of data for plant height reveals that the plant height is not affected by the mid day depression in photosynthetic rate. This is illustrated by the fact that in both the groups, the plant height ranged from 3.0-4.5 m. Similar results were also observed for plant spread where the variation was very less in both the groups.

Table 24. Morphometric parameters of ber cultivators.

Variety	Plant height (m)	Spread (m)		Cir. (cm)
		E-W	N-S	
Gola	4.58	5.30	5.2	51.00
Umran	4.30	2.30	2.8	26.00
Banarsi Pewandi	3.10	3.00	3.0	28.30
Katha Phal	3.00	4.30	4.0	44.76
Sanaur- 5	3.00	5.60	4.5	53.00
Kaithali	3.80	3.10	2.8	40.70

Perusal of Table 25 reveals that the cultivars showing mid day depression produced more pruned wood as compared to cultivars which do not show mid day depression. This is illustrated by the fact that cv. Gola produced 34.00 kg. pruned wood as compared to Katha Phal which produced only 12 kg.

Table 25. Morphometric Parameters of ber cultivars

Variety	Pruned wood weight (kg.)	Yield (kg/tree)
Gola	34.00	35.00
Umran	14.00	42.00
Katha Phal	12.00	28.00
Sanaur-5	14.00	13.50
Kaithali	24.00	22.00

The diurnal variation in RWC in leaves of ber cultivar was also recorded. It was observed that the leaves of Gola, Umran and Banarsi Pewandi maintained RWC as high as recorded in forenoon and evening, but cultivars Katha Phal, Sanaur-5 and Kaithali shows reduction in RWC during mid day. (Table 26).

Table 26. RWC Per eCnt of Ber Cultivars

Variety	RWC (%)		
	9 AM	12 Noon	4 PM
Gola	67.58	64.65	75.02
Umran	76.08	75.87	70.56
Banarasi Pewandi	73.98	73.22	75.79
Katha Phal	71.26	61.76	69.45
Sanaur-5	72.06	66.57	68.20
Kaithali	78.73	68.73	73.26

An Attempt was also made to assess the correlation between yield and yield contributing parameters in ber. It was observed that yield was significantly related to net photosynthesis rate, fruit length, fruit breadth and significantly negatively correlated with stomatal conductance (Table 27).

The photosynthesis rate and transpiration was measured in hybrids and their parents. The data is presented in Table 28-29. Perusal of data in Table 28 revelas that hybrids have more photosynthetic rate as compared to parents. Both in hybrids as well as in parents the mid day depression was very low.

Table 27. Correlation between Yield and Yield Attributing parameters in ber

Parameter	Correlation (r)
Photosynthesis rate	0.373
Stomatal conductance	-0.338
Transpiration	-0.077
Plant height	-0.176
Spread	-0.299
Leaf length	0.130
Leaf breadth	-0.015
Fruit length	0.480
Fruit breadth	0.631
Fruit weight	0.288
Pruned wood weight	0.105

Table 28. Diurnal variation in photosynthesis in selected germplasm.

Germplasm	Pn (µmol/ m^2/s)		
	10 AM	12 Noon	4 PM
Hybrid 1	17.71	13.91	17.82
Hybrid 2	19.35	17.71	13.67
Selection 1	11.05	16.49	19.76
Katha	11.76	11.22	10.46
Seb	12.01	12.09	12.07

Table 29. Diurnal variation in transpiration in selected germplasm.

Germplasm	Transpiration (mmol/m^2/s)		
	10 AM	12 Noon	4 PM
Hybrid 1	0.026	0.033	0.044
Hybrid 2	0.023	0.035	0.035
Selection 1	0.012	0.025	0.039
Katha	0.032	0.031	0.028
Seb	0.028	0.023	0.024

Integrated nutrient management

Mission F: Integrated nutrient management in horticultural crops

At CIAH, Bikaner

F.1 Response to substitution of manures and fertilizers with vermi-compost to the growth and fruit production of crops.

F 1.1 Growth and production of pomegranate (*Punica granatum*) fruit crop with organic and inorganic farming.

The recommended doses of NPK (625g N, 250g P and 150g K) per plant per year were applied through 10 treatments along with control (N_0, P_0, K_0). The treatments comprised of i) sheep manure (SM) @ 18 kg/plant; ii) cattle manure (CM) 25 kg/plant; iii) vermi-compost @ 12 kg/plant; iv) inorganic fertilizers (IF) through urea, single super phosphate and muriate of potash; v) CM: SM in 50:50 ratio; vi) CM: VC in 50:50 ratio; vii) CM:IF in 50:50 ratio; viii) SM: VC in 50:50 ratio, ix) SM:IF in 50:50 ratio; x) VC:IF in 50:50 ratio and xi) control (NoPoKo) in the month of June, 2002. The growth parameters like plant height, plant spread and tree volume was recorded in every month. The leaf sample for nutrient analysis were collected in the month of September, 2002 and analyzed for N, P, K, Ca, Mg, Zn, Cu, Mn & Fe nutrients following the standard procedures. The physiological activities of the plant were measured during fruiting stage and soil moisture contents were measured in September and October 2002 to monitor the moisture retention in different treatments. The average fruit weight, fruit yield, fruit quality such as juice acidity, total soluble solids and ratio of TSS and juice acidity were measured in November and December 2002. The soil samples were collected from all treatments and analyzed for fertility build up especially with regards to organic carbon, available, nitrogen, phosphorus and potassium in February 2003.

Plant growth

The growth was measured every month but in report, the growth measured in the month of October 2002 have been presented in table 30. The mean plant height data was in the range of 1.50 to 1.85 m and maximum plant height was recorded in T_{10} treatment and it was statistically at par with T_1, T_3, T_6 and T_8 treatments. The percent increase in plant height over control treatment was also worked out. Data revealed that that maximum increase (65.2%)was estimated in T_{10} and minimum (17.4%) in T_4 treatment over control treatment (T_{11}).

The plant spread was also measured every month and in report, the data pertain to October 2002 months have been given. The data presented in table 30 revealed that maximum tree spread (1.75 x

1.65m) was recorded in T_{10} followed in T_3 T_1, T_8 they were statistically at par while other treatments (T_2, T_4, T_5, T_6, T_7, T_9 and control) are significantly lower over T_{10}, T_3, T_1 and T_8 treatments. The minimum spread (1.20 x 1.25m) was recorded in control. Data also revealed that plant spread was more in E-W direction in comparison to N-S direction.

Table 30. Effect on plant growth parameters to integration of manures and fertilizers

Treatment	Plant height		Plant spread (m)	
	(m)	% Increase	E-W	N-S
T1	1.70	48.0	1.60	1.55
T2	1.55	35.0	1.65	1.40
T3	1.80	56.5	1.70	1.65
T4	1.35	17.4	1.35	1.20
T5	1.60	39.1	1.55	1.45
T6	1.70	48.0	1.58	1.45
T7	1.60	39.1	1.45	1.40
T8	1.65	43.5	1.60	1.55
T9	1.55	34.8	1.50	1.40
T10	1.85	65.2	1.75	1.65
T11 (control)	1.15	-	1.20	1.25
SEm±	0.11	-		
CD (5%)	0.23	-		

Fruit weight

In pomegranate crop, fruit weight is also an important character and was recorded at the time of harvest of the crop in each treatment. The data presented in table 31 revealed that fruit weight in different treatments was in the range of 120 to 250 g and average maximum fruit weight (250 g) was recorded in T_{10} and it was statistically par with T_1, T_3, T_6 and T_8 treatments and average minimum fruit weight (115 g) was recorded in T_{11} treatment (control).

Fruit yield

The data pertain to average fruit yield (q ha^{-1}) have been presented in table 31. The data revealed that fruit yield was found in the range of 18.40 to 38.00 q ha^{-1}. The maximum and significantly higher fruit yield (38.00 qha^{-1}) was recorded in T_{10} treatment and which was statistically at par in T_1, T_3, T_8 and T_6 treatments and minimum fruit yield was recorded in control treatment. The increase in fruit yield in different treatments over control was also estimated and found that maximum (106.52%) increase in fruit yield was recorded in T_{10} treatment while minimum increase over control was estimated in T_4 treatment.

Table 31. Effect on fruit and fruit yield to integration of manures and fertilizers

Treatment	Average Fruit Weight (g)	Fruit Yield ($q\ ha^{-1}$)	% Increase
T1	230	35.0	89.64
T2	205	29.0	57.80
T3	225	36.0	95.45
T4	140	24.0	30.41
T5	185	28.0	52.20
T6	225	28.0	52.80
T7	185	25.5	38.60
T8	245	35.0	90.2
T9	185	28.5	54.89
T10	250	38.0	106.52
T11	115	18.40	-
SEm±	11.85	1.85	-
CD (5%)	31.42	4.12	-

Fruit quality

The fruit quality of pomegranate is also being evaluated (Table 32). The total soluble solids, juice acidity and their ratios were estimated in different treatments. The total soluble solids in different

Table 32. Response of different manures and fertilizers to TSS, Acidity and TSS/Acidity of pomegranate fruits

Treatments	TSS (° brix)	Juice acidity (%)	TSS/ Acidity
T1	19.5	0.20	97.5
T2	19.0	0.19	100.0
T3	19.5	0.15	130.0
T4	18.5	0.20	92.5
T5	19.0	0.20	95.0
T6	19.0	0.16	118.8
T7	19.0	0.20	95.0
T8	19.5	0.13	150.0
T9	19.0	0.22	88.6
T10	19.5	0.16	121.8
T11	18.5	0.29	62.1
SEm±	-	0.009	11.20
CD (5%)	NS	0.030	35.20

treatments were in the range of 18.00 to 19.50 degree brix. The maximum TSS content (19.50° brix) was estimated in T_3, T_6, T_8 and T_{10} treatments and minimum TSS was estimated in T_{11} treatment. Overall data revealed that total soluble solids were statistically at par in all treatments. The fruit juice acidity was estimated in different treatments and was found in the range of 0.13 to 0.29 percent. The minimum juice acidity (0.13 per cent) was recorded in T_8 treatment and maximum (0.29%) in T_{11} (control) treatment. Although juice acidity in T_3, T_6, T_8 and T_{10} treatments were statistically at par. 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 62.10 to 150.00 and the maximum value (150.00) 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 shows the additive factor of fruit quality.

Leaf mineral composition

The data regarding leaf mineral composition are given in table 33. The data revealed that the nitrogen content was in the range of 1.78 to 2.50% and maximum N content was recorded in T_{10} and T_8 and minimum in T_{11} treatment. The P content was in the range of 0.22 to 0.27%. The maximum P content was estimated in T_3, T_6 and T_8 treatments. Except control treatment, other treatments were having the P content near to the maximum P content. The K content was found in the range of 1.62 to 1.84% and maximum K content was recorded in T_3 treatment and minimum K content was estimated in control treatment. Among the micronutrients, Zn, Cu, Mn and Fe contents were measured and data presented in table 33 revealed that zinc was in the range of 32 to 45 ppm and maximum Zinc content was measured in

Table 33. Effect on concentration of macro and micro nutrients to different sources of manures and fertilizers

Treatment	Macronutrients			Micronutrients					
	N	P	K	Ca	Mg	Zn	Cu	Mn	Fe
	(%)			(ppm)					
SM	2.00	0.24	1.65	2.35	0.30	35	4	45	70
CM	2.00	0.24	1.68	2.35	0.25	32	4	40	60
VC	2.25	0.27	1.84	2.55	0.35	40	4	50	75
IF	1.90	0.25	1.65	2.05	0.20	35	3	40	60
CM:SM	2.15	0.24	1.60	2.45	0.25	38	4	40	70
CM:VC	2.05	0.27	1.75	2.45	0.26	40	4	45	80
CM:IF	2.05	0.24	1.70	2.25	0.22	32	3	40	75
SM:VC	2.50	0.27	1.68	2.45	0.25	45	4	50	55
SM:IF	2.05	0.24	1.65	2.35	0.20	38	3	40	60
VC:IF	2.50	0.25	1.80	2.45	0.25	41	4	50	75
Control	1.78	0.22	1.62	2.00	0.18	32	3	40	52

T_8 treatment and minimum in T_2, T_7 and control (T_{11}) treatments. The Copper content was more or less same in all treatments. The iron content was in the range of 52 to 75 ppm. The maximum iron content was observed in T_{10}, T_3 and T_7 treatment while minimum was in control treatment. The Manganese content was in the range of 40 45ppm and results revealed that in all treatments, the level of Mn is more or less same.

Physiological activity

The physiological parameters like photosynthetic activity, transpiration rate, water use efficiency; stomatal conductance and stomatal resistance were measured during fruiting stage. Data given in table 34 revealed that photosynthetic activity (P_N) was recorded in the range of 0.4180 to 0.6200 mg CO_2 m^{-2} s^{-1}. The maximum P_N activity was recorded in T_8 followed in T_3 (0.6100 mg CO_2 $m^{-2}s^{-1}$), T_6 (0.5960 mg CO_2 $m^{-2}s^{-1}$). The minimum activity (0. 4180 mg CO_2 m^{-2} s^{-1}) was recorded in T_4 and T_{11} treatment.

The transpiration rate was recorded in the range of 1.200 to 1.520 mg H_2O m^{-2} s^{-1}. The mean maximum transpiration rate (1.520 mg H_2O $m^{-2}s^{-1}$) was recorded in T_{11} treatment followed in T_1 (1.440 mgH_2O $m^{-2}s^{-1}$) and T_8 and T_6 treatments (Table 34) and minimum water transpired (1.200 mg H_2O m^{-2} s^{-1}) was in treatment T_{10} followed inT_8, T_2 T_3 and T_6 treatments. The maximum water use efficiency (49.60%) was estimated in T_8 treatment followed in T_{10}, T_3, T_6 and T_5 treatments. The minimum water use efficiency (27.5%) was recorded in T_{11} control treatment.

Table 34. Effect of manure and fertilizers on physiological activity of pomegranate plant

Treatments	PN (mg $CO_2M^{-2}s^{-1}$)	Transpiration rate (mg m^{-2} s^{-1})	Water use efficiency (%)	Stomatal resistance (s cm^{-1})	Stomatal conductance (cm s^{-1})
SM	0.5830	1.440	40.05	0.500	2.00
CM	0.5200	1.265	41.11	0.500	2.00
VC	0.6100	1.270	48.03	0.435	2.30
IF	0.4180	1.320	31.67	0.590	1.70
CM:SM	0.5565	1.350	41.22	0.530	1..89
CM:VC	0.5960	1.340	44.48	0.455	2.19
CM:IF	0.5000	1.260	39.68	0.550	1.82
SM:VC	0.6200	1.250	49.60	0.440	2.27
SM:IF	0.5265	1.255	42.30	0.580	1.72
VC:IF	0.5800	1.200	48.33	0.450	2.22
Control	0.4180	1.520	27.50	0.560	1.79
SE±	0.0613	0.091	05.12	-	-
CD (5%)	0.1392	0.251	11.52	NS	NS

The stomatal resistance was ranging to 0.455-to 0.590 s cm^{-1}. The minimum stomatal resistance was observed in T_3 followed by T_8 and T_{10} treatment and maximum resistance was found in T_4 followed by T_9 treatments. Stomata conductance was in the inversely proportionate to resistance values and stomatal conductance was observed in the range of 1.70 to 2.22 cm s^{-1}.

Soil moisture status

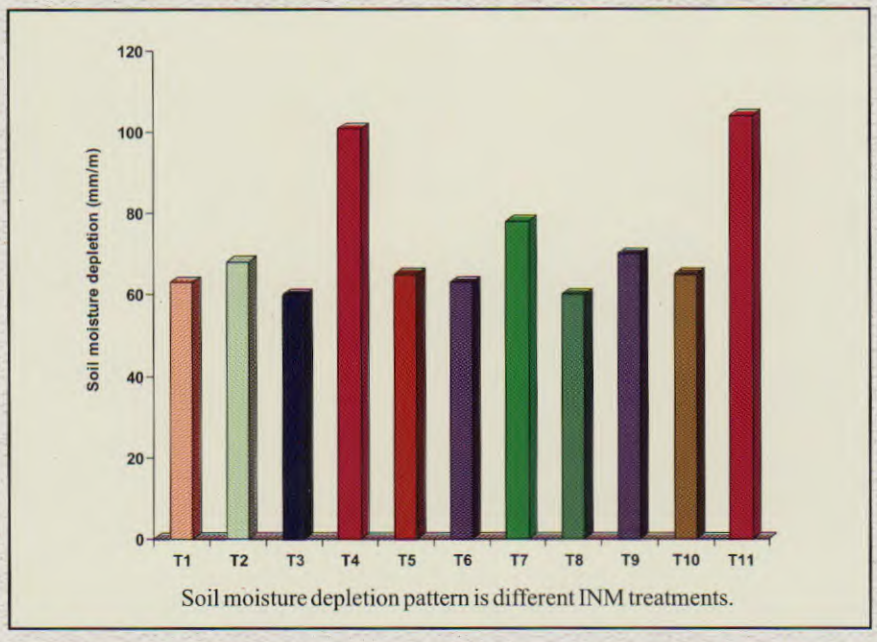
The soil moisture status was measured in different treatments on 3rd, 5th and 7th day after irrigation on alternate months. The mean moisture data have been presented in table 35. It was noticed that on 3rd day after irrigation, soil moisture was in the range of 6.50.0 to 11.2% and maximum moisture content was measured in $T_{6 \text{ and }} T_7$ followed in T_1, T_3 andT_8 and T_1 treatments while minimum soil moisture content was observed in control (T_{11}) treatment. On 5 and 7th day, trends in soil moisture content with respect to different treatments was almost same as it was on 3rd day. On 7th day, the soil moisture content was in the range of 3.5 to 6.5%. The soil moisture depletion pattern was also studied in different treatments and it was observed the maximum soil moisture was depleted in control treatment while minimum soil moisture depletion was observed in T3 and T8 treatments (Fig. 7). 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. Thus organic material helped in checking soil moisture losses especially in root zone.

Soil fertility builds up:

To document the changes in soil fertility over the time due to application of different types of treatment, soil samples were collected before initiation of experiment and after three years from each treatment (Table 36). The samples were analyzed for organic carbon, available nitrogen, phosphorus and potassium content. The organic carbon content was only 0.09 per cent and reached to 0.25 per cent after four years. The maximum organic carbon (0.25%) was estimated in T_3, T_5, T_6 and T_8 treatments. In control treatment the organic carbon content was recorded lower (0.07%) than initial organic carbon (0.09%). The available N content has increased in all treatments except control where the value was more or less same as initial value. The maximum available nitrogen build up was observed in T_{10} followed in T_4.The available P content was only 11.5 before deployment of treatments and reached maximum (22.5 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 treatment except control one. The K content has increased from 186.4 kg ha^{-1} to 225 kg ha^{-1} in T_{10} treatment followed in T_3 and T_8 treatments

Table 35. Soil moisture (%) pattern as influenced by different treatments

Treatments	3rd day	5th day	7th day
SM	10.20	8.50	6.50
CM	10.00	6.50	4.20
VC	9.50	8.50	6.80
IF	7.20	4.50	3.80
CM: SM	10.00	8.50	6.50
CM: VC	11.20	9.00	6.50
CM:IF	10.80	7.00	6.50
SM:VC	9.80	7.00	6.50
SM:IF	9.50	5.40	3.80
VC:IF	10.00	6.50	4.20
Control	6.50	4.20	3.50



Soil moisture depletion pattern is different INM treatments.

Table 36. Changes in organic carbon, available N, P, K contents over the three period.

Treatments	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T1	0.22	185	18.0	200
T2	0.20	175	18.0	200
T3	0.25	168	20.0	218
T4	0.09	175	16.5	192
T5	0.25	170	16.0	205
T6	0.25	165	17.5	208
T7	0.18	170	16.0	205
T8	0.25	170	17.0	215
T9	0.18	165	17.0	205
T10	0.19	180	22.5	225
T11	0.07	125	11.0	186
Initial level	0.09	124.6	11.5	186.4

At CHES, Godhra

F. 2 Standardisation of agro-techniques of some semi arid fruits

Effect of bio fertilizers on growth, yield and quality of pomegranate cv. Ganesh

Application of different doses of bio-fertilizers like phosphate solublizing bacteria, *Azospirillium* culture, VAM and phosphate Solubilized bacteria + *Azospirillium* resulted in significant effect on all the vegetative, physico-chemical and yield attributes of pomegranate cv. Ganesh . There were non significant effect of application of bio-fertilizer on plant height, stem diameter, plant spread (N-S & E-W), fruit diameter, fruit length and Juice percent. Number of fruit set and fruit retained per plant were recorded maximum in *Azospirillium* (144.75 and 83.00) and minimum in Treatment-5 (72.50 and 51.00). Maximum fruit weight (213.00g) and aril weight (137.37g) was noted in application of Phosphate solublized bacteria + *Azospirillium* and minimum in control (153.25 g and 95.12g). Similarly maximum phosphorus (%), Potassium (%), juice percent skin weight (g) and T.S.S. were recorded in Phosphate solublized bacteria + *Azospirillium*. i.e. 0.178 %, 0.84 %, 74.62 %, 66.62g and 16.05 , respectively.

Highest number of fruit set (98.7), number fruit retained (66.5), per cent retention (67.84) and yield (11.08 kg / plant) per plant was in phosphate + *Azospirillium* culture application. Data on Nitrogen percent in leaf samples revealed that different treatments had significant influence on N content. Maximum N content (2.88 %) was recorded in application of and phosphate + *Azospirillium* culture application one month after bio-fertilizer application. (Table 37)

Effect of Organic and Inorganic sources of N on growth, yield and quality of pomegranate cv. Ganesh.

There was beneficial effect of partial replacement of inorganic sources of Nitrogen with organic source like castor cake and F.Y.M. on plant growth, fruit development, chemical characters of fruit , yield per plant and NPK content of leaf.(Table 38)

Data on no. of fruit set per plant (220.00), yield of fruit per plant (18.95 kg) , fruit weight (215.37g) , fruit length (74.50 mm) , fruit diameter (67.00 mm) was obtained maximum in Castor cake 100% and minimum in Urea (100%) i.e. 93.50 , 9.57 kg/plant , 132.50 g , 58.50mm and 55.87mm, respectively. Whereas no. of fruits retained per plant were maximum (91.75) in FYM 50% + Castor cake 25 % + Urea 25%. They were minimum in (100%) Urea (72.25).

Partial replacement of inorganic source of Nitrogen with organic source like castor cake and F.Y.M. found to have non significant effect on fruit skin weight , total soluble solids , leaf Nitrogen (%)and phosphorus content.

Maximum aril weight (170.00 g) and juice weight per fruit (121.33g) was recorded in treatment-1 and minimum in treatment- 6 i.e. 85.50g and 78.67 g , respectively. Treatment-3 & 5 showed most beneficial effect on leaf K content (0.74 ppm) whereas application of Castor cake 100% and Urea 100% treatments noted least leaf K content (0.66 ppm).

Table 37: Effect of bio-fertilizer application on growth ,yield and quality of Pomegranate cv. Ganesh (2002-03)

Treatment	Pl. ht. (m)	Stem dia (mm)	Plant spread (m) N-S	Plant spread (m) E-W	No. of fruit set /pl.	No. of fruit retaind /pl.	Fruit wt. (g)	Fruit dia. (mm)	Fruit length (mm)	Aril wt. (g)	Fruit yield/ pl.	N (%)	P (%)	K (%)	Juice (%)	TSS	Skin wt. (g)
1	2.34	44.20	2.32	2.32	123.50	73.50	201.25	67.62	76.41	136.75	114.96	2.92	0.156	0.68	72.57	15.17	62.50
2	2.34	43.20	2.31	2.30	144.75	83.00	173.75	67.27	74.75	106.25	14.30	2.67	0.177	0.71	73.89	14.65	53.25
3	2.30	39.90	2.37	2.43	135.50	78.25	213.00	70.12	78.87	137.37	16.61	2.88	0.178	0.84	74.62	16.05	66.62
4	2.20	47.00	2.35	2.56	136.50	80.00	188.75	68.02	72.75	117.00	14.95	2.79	0.173	0.76	73.29	15.86	58.12
5	2.17	42.45	2.27	2.35	72.50	61.00	153.25	67.50	68.75	95.12	8.82	2.52	0.121	0.70	74.46	15.43	43.87
C.D. (5%)	NS	NS	NS	NS	34.77	NS	24.97	NS	NS	24.30	3.26	NS	0.017	0.06	NS	0.86	6.59

Table 38 :Effect of organic - inorganic fertilizer on growth ,yield and quality of Pomegranate cv. Ganesh (2002-2003)

Treatment	No. of fruit set/pl.	No.of fruit retained /pl.	Yield /pl (kg)	Fruit wt. (g)	Fruit length (mm)	Fruit dia. (mm)	Skin wt. (g)	Aril wt. (g)	Juice wt. /fruit	TSS	N %	P %	K %
1	210.50	82.25	16.82	204.50	68.00	61.87	65.33	170.00	121.33	15.83	2.83	0.13	0.69
2	220.00	88.00	18.95	215.37	74.50	67.00	66.00	139.00	101.33	15.70	2.68	0.13	0.66
3	155.00	73.25	14.50	198.00	66.50	63.62	67.00	129.66	93.33	15.73	2.78	0.14	0.74
4	206.50	91.75	17.51	191.00	68.50	61.34	66.50	112.00	60.50	16.20	2.60	0.12	0.73
5	103.25	79.75	12.19	153.00	66.00	61.20	59.67	96.00	81.50	16.00	2.63	0.11	0.74
6	93.50	72.25	9.57	132.50	58.50	55.87	49.33	85.50	78.67	15.87	2.45	0.11	0.66
CD (5%)	46.00		2.19	21.40	5.67	5.12	NS	42.65	31.84	NS	NS	NS	0.068

NUTRIENT MANAGEMENT IN FRUIT CROPS-AONLA & SAPOTA

Sapota nutritional survey has been carried out in Valsad, Navasari, Junagarh and Bhavnagar districts of Gujarat state for developing Diagnosis Recommendation Integrated System (DRIS). In this survey approach the population was divided in to two sub populations viz low yielding and high yielding with a cut off value of 100kg fruits/tree.The nutrient norms for sapota leaf from high yielding population are classified In to low, optimum and high (Table 39).The optimum values for Nitrogen ranged from 1.25-2.38%, where as for Phosphorus, Potassium, Calcium, Magnesium and Sulphur the optimum values are 0.05-0.17%, 0.36-0.77%,1.01-2.04%,0.48-0.92% and 0.38-0.82% respectively.

Table 39. Nutrients norms for dris in sapota

NUTRIENT	LOW	OPTIMUM	HIGH
NITROGEN	<1.25	1.25-2.38	>2.38
PHOSPHORUS	<0.05	0.05-0.17	>0.17
POTASSIUM	<0.36	0.36-0.77	>0.77
CALCIUM	<1.01	1.01-2.04	>2.04
MAGNESIUM	<0.48	0.48-0.92	>0.92
SULPHUR	<0.38	0.38-0.82	>0.82

Standardization of production technology in aonla

a). Effect of planting system cum planting density on Aonla.

Five planting systems viz; Square, Hedge row, Double Hedge row, Paired and Cluster planting system were followed to study the growth, Flowering, fruiting and quality attributes in Aonla cv. NA-7. Vegetative parameters were recorded in second year of plantation, maximum plant height was recorded in double hedge row system but difference could not reach up to the level of significance when compared with other systems of planting.

b) Effect of mulches on soil properties, growth, yield and quality of Aonla under semi-arid rainfed condition.

Different mulching treatments were imposed in newly planted cv. NA-7 of aonla. Black polythene mulch was found to be best for retaining soil moisture in the soil.

High-density orcharding in ber:

High density orcharding in ber with four varieties and three spacing revealed that during the year, plant height, scion diameter, E-W plant spread was significantly influenced by variety whereas spacing significantly influenced scion diameter, and N-S plant spread only. Maximum plant height was recorded in Mundia in 5 x 5 m spacing, stock & scion diameter was highest in *Seb* and *Gola*, respectively. In respect of spacing, it was highest in 10 x 10 m spacing in both the cases. Plant spread was maximum in Umran and in respect of spacing, it was maximum in 10 x 10 m spacing in N-S and E-W spread.

Data analysis on Physico-chemical characters revealed that most of the characters were significantly influenced by both variety and spacing except in respect of fruit diameter. Yield of fruit per hectare was significantly influenced by both spacing and variety.

Fruit weight was highest in *Seb* (18.65 g) and it was highest in 10 x 10 m spacing (18.85 g). Fruit length was maximum in Mundia (35.19 mm) and in 10 x 10 m spacing. T.S.S. of the fruit was highest in Umran (20.22 ^{0}Brix) and in 10 x 10 m spacing (17.90 ^{0}Brix). Similar results were recorded in respect of pulp stone ratio. Yield (q/ ha) was maximum in Umran (49.56 q / ha) in respect of spacing; it was highest in 5 x 5 spacing (59.95 q /ha).

HIGH DENSITY ORCHARDING- BER - 2002-03

Plant height (m)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	3.10	2.95	3.20	3.08
UMRAN	3.10	3.10	3.20	3.13
SEB	2.70	2.80	2.70	2.73
MUNDIA	3.40	3.10	3.30	3.26
Mean	3.07	2.98	3.10	

C.D. (5%) : Variety- 0.234 , Spacing- NS, Interaction- NS

Stock diameter (cm)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	21.60	21.50	20.30	21.13
UMRAN	22.30	19.80	20.80	20.96
SEB	23.30	22.30	21.50	22.36
MUNDIA	23.30	20.60	20.30	21.40
Mean	22.62	21.05	20.72	

C.D. (5%) : Variety- NS, Spacing- NS, Interaction- NS

Scion diameter (cm)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	21.60	19.50	19.16	20.00
UMRAN	20.60	19.50	18.80	19.63
SEB	21.50	20.30	18.17	19.99
MUNDIA	21.17	19.00	19.50	19.89
Mean	21.21	19.57	18.90	

C.D. (5%) : Variety- NS, Spacing- 1.439, Interaction-NS

Plant spread (m)- N-S

Variety	Spacing (m) 10 X 10	7.5 X 7.5	5 X 5	Mean
GOLA	3.42	2.92	3.87	3.40
UMRAN	4.63	4.37	3.92	4.30
SEB	3.62	3.40	3.53	3.51
MUNDIA	3.07	2.90	3.02	2.99
Mean	3.68	3.39	3.58	

C.D. (5%) : Variety- 0.238 , Spacing- 0.206, Interaction-0.413

Plant spread (m)-E-W

Variety	Spacing (m) 10 X 10	7.5 X 7.5	5 X 5	Mean
GOLA	3.97	3.92	3.82	3.90
UMRAN	4.47	4.47	4.33	4.42
SEB	3.37	3.33	3.28	3.32
MUNDIA	3.23	3.10	3.20	3.17
Mean	3.76	3.70	3.65	

C.D. (5%) : Variety- 0.451 , Spacing- NS, Interaction-NS

Fruit weight (g)

Variety	Spacing (m) 10 X 10	7.5 X 7.5	5 X 5	Mean
GOLA	18.47	18.37	17.10	17.98
UMRAN	20.10	18.20	17.40	18.56
SEB	18.60	19.00	18.37	18.65
MUNDIA	18.23	18.37	17.80	18.13
Mean	18.85	18.48	17.66	

C.D. (5%) : Variety- NS, Spacing- 0.54, Interaction-1.070

Fruit diameter (mm)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	30.43	29.43	28.33	29.39
UMRAN	29.10	29.63	29.10	29.27
SEB	29.33	28.73	28.77	28.94
MUNDIA	28.00	27.70	29.23	28.31
Mean	29.21	28.87	28.85	

C.D. (5%) : Variety- NS, Spacing- NS , Interaction- NS

Pulp stone ratio

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	13.00	11.77	11.67	12.14
UMRAN	18.97	18.80	18.13	18.63
SEB	11.47	11.20	10.70	11.12
MUNDIA	16.73	15.33	14.97	15.67
Mean	15.04	14.27	13.86	

C.D. (5%) : Variety- 0.542 , Spacing- 0.469, Interaction-NS

Fruit length (mm)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	28.17	27.73	28.00	27.96
UMRAN	34.90	34.50	34.80	34.73
SEB	32.03	30.80	30.27	31.03
MUNDIA	35.77	35.00	34.80	35.19
Mean	32.71	32.00	31.96	

C.D. (5%) : Variety- 0.690 , Spacing- 0.598, Interaction- NS

TSS (°Brix)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	19.20	18.67	17.87	18.58
UMRAN	20.47	20.40	19.80	20.22
SEB	15.87	15.53	16.00	15.80
MUNDIA	16.07	16.00	16.27	16.11
Mean	17.90	17.65	17.48	

C.D. (5%) : Variety- 0.488 , Spacing- NS, Interaction- NS

Yield (q/ha)

Variety	Spacing (m)			Mean
	10 X 10	7.5 X 7.5	5 X 5	
GOLA	19.60	36.40	72.40	42.80
UMRAN	24.83	39.33	84.53	49.56
SEB	18.07	29.78	61.27	36.77
MUNDIA	14.73	25.57	50.17	30.15
Mean	19.30	32.77	59.59	

C.D. (5%) : Variety- 0.234 , Spacing- 0.203, Interaction-0.406

High density orcharding in Aonla

High density plantation in Aonla cv. NA-7 is laid out in the one hectare area with different spacing viz., 10 x10 m, 5 x 5 m, 10 x 5 m , 10 x 7.5 m , 7.5 x 7.5 m and 7.5 x 5.0 m. Percentage success in in-situ budding was found to be 80 %. Maximum plant height (2.32 m) , stock diameter (57.31 mm) and scion diameter (51.55 mm) was recorded in 10 x 7.5 m spacing under purely rainfed condition.

Vegetable crops:

Nutritional studies on vegetables:

Drumstick:

The drumstick var. PKM-2 had significantly recorded the highest yield (29.0 kg. /ha.) at a spacing of 5 X 2.5 cm.; giving an yield of 24.8 t/ ha. Though the yield of 46.35 kg/ ha. recorded at 5 X5 m spacing, the total yield per ha. was 18.4 t. only.

Cucurbits:

Among the treatments, the pit size 1.5 X 1X1 m with 5 % (60 Kg.) FYM has recorded the highest yield per ha. which recorded 13.4 t (Pumpkin), 10.10 t(bottle gaurd) and 10.72 t (drumstick). The highest net income Rs. 1.18 lakh was recorded in the same treatment with cost benefit ratio of 6:81.

F.3 Standardization of agro techniques in semi-arid vegetables:

Experiment on *in-situ* harvesting of rainwater for utilization of growing inter crop in Moringa based cropping system was conducted. The result revealed that pit size 1.5m with 60Kg. of FYM/pit had given highest yield of 36.6, 39.3 and 14.35 kg., respectively, for pumpkin, bottlegourd and bitter gourd.

Planting Models

Mission G: Development of planting models in horticultural crops for arid ecosystem

G.1 Multistrata aonla based cropping system

1.1 Establishment, growth and survival of main and understorey crops

Multistorey aonla based cropping system studies with six different cropping models viz., Aonla+ber+brinjal+mothbean+cumin (Model 1); Aonla+bael+brinjal+moth bean+cumin (Model 2), Aonla+ber+karonda+mothbean+cumin (Model 3); Aonla+bael +karonda+mothbean+cumin (Model 4); Aonla+drumstick+saji+mothbean +cumin (Model 5) and Aonla+khejri+saji+mothbean+cumin (Model 6) was initiated during the year 2002 in RBD with three replications.

In situ field planting of main and component crops in 1.5 ha area was completed during October 2002 and data with respect to establishment, survival and growth parameters were recorded. Survival of base crop aonla recorded six month after planting was >80% whereas in case of component crop 100% survival was recorded. Saji (*Suaeda fruticosa*) was observed to be an excellent crop that put forth profused and luxuriant growth. Data on other parameters are being recorded. Aonla and component crops viz., bael, ber, khejri is proposed to be budded during the next season.

1.2 Physico chemical properties of soil

Ten random soil samples collected from the experimental site at different depths viz., 0-15, 15-30, 30-45 and 45-60cm were subjected to Physico-chemical analysis (Table 40). The samples were analysed for the various constituents and the particulars of analysis are tabulated as under.

Table 40. Physico-chemical properties of soil of experimental site.

Depth (cm)	Text.	Bulk density Mg m^3	Porosity (%)	pH	EC dS m^{-1}	Org. C (%)	$CaCO_3$ (%)	Av. nutrients (Kg ha^{-1})		
								N	P	K
0-15	Loamy Sand	1.58	43.1	8.4	0.16	0.030	5.0	105	3.0	172
15-30	Loamy Sand	1.59	42.6	8.4	0.18	0.030	5.0	101	4.8	232
30-45	Loamy Sand	159	42.6	8.3	0.12	0.032	3.0	107	4.8	280
45-60	Loamy Sand	1.60	42.6	8.4	0.18	0.092	3.0	110	4.4	244

1.3 Effect of mulches on soil hydrothermal regimes growth and yield of brinjal grown in aonla based cropping system

During the period under report an experiment was undertaken to study the comparative effect of seven mulch treatment including control on soil, crop growth, fruit yield and hydrothermal regime of brinjal grown as ground storey crop between two aonla plants ($6m^2$) in the cropping models Aonla+ber+brinjal+mothbean+ cumin and Aonla+bael+brinjal+mothbean+cumin in RBD with three replications. The experimental findings are presented below.

1.3.1 Crop growth and fruit yield

Mulching treatments affected the growth and development of brinjal crop. Observations recorded 180 days after mulching (DAM) revealed that plant height, stem girth and plant spread was maximum in plots mulched with black polyethylene followed by white polyethylene. Among the organic mulches, it was recorded to be maximum in plots mulched with lasoda (*Cordia myxa*) leaves followed by kheep (*Leptodania pyrotechnica*) clippings as compared to control (Table 41).

Table 41. Effect of various mulches on growth and fruit yield of brinjal (80 DAM).

Treatments	Pl.ht (cm)	St.girth (cm)	Plant spread (cm)	No. of fruits/plant	Fruit Yield/plant (g)
Black polyethylene	40.22	3.4	54.31	33.0	832
White polyethylene	31.88	3.0	45.26	24.0	596
Lasoda leaf	26.00	2.9	39.76	16.0	400
Neem leaf	22.45	2.5	36.11	10.0	250
Sewan grass clippings	19.67	2.5	36.00	11.0	270
Kheep clippings	24.33	2.7	40.25	15.0	320
Control	16.28	2.0	31.88	5.0	135
C.D. (P=0.05)	5.41	0.5	4.11	6.5	30.01

DAM= Days after Mulching

Fruit yield recorded at different intervals were pooled to get the cumulative yield. Number of fruits/plant and yield/plot (g) followed similar trend as that of vegetative parameters. Fruit yield/plant was 84.0 and 77.0 per cent more in plots mulched with black and white polyethylene. Among the organic mulches, mulching with lasoda leaves gave 66 per cent more yield followed by kheep clippings, which was 58% per cent more than control.

1.3.2 Soil moisture

Soil moisture content was measured by Neutron moisture meter at weekly intervals starting from September 2002-March 2003. Mean monthly observations indicated higher moisture retention under black and white polyethylene at all stages of crop growth. Maximum moisture retention (46.0-50%) was recorded under black polyethylene followed by white polyethylene (26-61%) as compared to control. Among the organic mulches, plots mulched with neem (*Azadirachta indica*) leaves showed maximum moisture retention (25-57%) followed by grass clippings of sewan (*Lasiurus sindicus*) 22-50% and kheep (20-45%) respectively over control (Table 42).

Table 42. Influence of soil covers on soil moisture (%) 30 cm below the mulch.

Treatments	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Black polyethylene	8.1	7.8	9.7	7.0	7.1	8.9	3.8
White polyethylene	6.8	7.3	7.9	9.7	10.0	11.6	4.2
Lasoda leaf	6.0	5.2	6.2	6.8	6.8	8.6	4.5
Neem leaf	6.8	6.3	7.0	9.4	9.6	10.5	6.7
Sewan grass clippings	5.6	5.9	6.7	7.3	7.8	9.0	6.0
Kheep clippings	5.7	6.0	6.9	6.8	7.3	8.2	4.7
Control	3.9	3.9	5.2	5.4	5.0	4.5	3.1
C.D. (P=0.05)	0.7	0.9	0.6	0.7	1.5	1.4	1.0

1.3.3 Soil temperature

Difference in soil temperature was recorded at different months due to various mulches. In general soil mulched with organic mulches showed beneficial effect in lowering soil temperature at 20 cm depth during summer months (1.1-5.6° C), while increase in soil temperature was recorded during the peak winter months i.e. December-January. The other two treatments i.e. black and white polyethylene although did not curtail the soil temperature during summer months but was lower than control. However significant increase in soil temperature was recorded in these treatments during the winter months December-January (2.7-5.1°C) over control (Table 43).

Table 43. Effect of different mulch treatments on soil temperature (°C) 20 cm below the mulch.

Treatments	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Black polyethylene	32.0	29.6	27.6	22.7	22.9	22.2	29.5
White polyethylene	31.0	29.1	27.7	22.2	21.2	22.6	29.0
Lasoda leaf	30.0	28.0	24.0	20.8	20.5	21.8	27.0
Neem leaf	28.1	26.9	23.0	18.5	19.2	22.2	26.2
Sewan grass clippings	29.7	28.5	23.8	18.4	19.5	21.5	26.7
Kheep clippings	28.9	27.1	24.5	18.2	19.0	22.3	26.6
Control	32.4	30.8	28.6	17.6	18.5	23.4	30.2
C.D. (P=0.05)	2.94	2.02	3.92	2.21	1.55	2.33	1.94

1.4 Effect of mulching on biomass and leaf nutrient status of brinjal

To study the impact of mulching on biomass, uniform plants were uprooted from different treatments 180 days after mulchimg (DAM). Biomass was recorded to be maximum in black and white polyethylene mulches. Among the organic mulches it was higher under lasoda mulch and lower in neem and sewan mulch as compared to control.

Leave samples collected 180 days after mulching was subjected to nutrient analysis. Comparatively higher N, P, K, Na, Ca and Mg were recorded in all the treatments except control. Higher N, P, K status was observed in plots mulched with kheep chipping followed by black polythene, whereas Ca, Na and Mg were recorded to be maximum in black polyethylene.

Plant protection

Mission I. Integrated pest and disease management in arid zone horticultural crops

At CIAH, Bikaner

I.1 Studies on biological control of major diseases of arid zone fruits and vegetables

Management of ber powdery mildew using bioagents

Powdery mildew incidence was not appeared under Biknaer conditions and therefore, the field experiments on management of this disease has been laid out at CHES, Godhra, Gujarat. The promising isolate of *Trichoderma* (CIAH-240) and *Pseudomonas fluorescens* (CIAH-196) after a sequence of screening were used for filed testing. Two concentrations (5% and 10%) of these were prepared to a total volume of 20 liters per tree. Less concentration (0.05%) of fungicide (karathane) and bioagents, 5% culture suspension of fungal were mixed to test these combined efficacy. Two sprays at monthly intervals were given in powdery mildew occurred susceptible ber cultivars (Gola and Umran) bearing the pea stage of fruits. Each treatments were replicated twice and powdery mildew incidence were recorded from each tree. The overall results in figure 8 and 9 depicted that in case of cv. Umran and Gola, the powdery mildew intensity was 16.29 and 15.66 respectively.

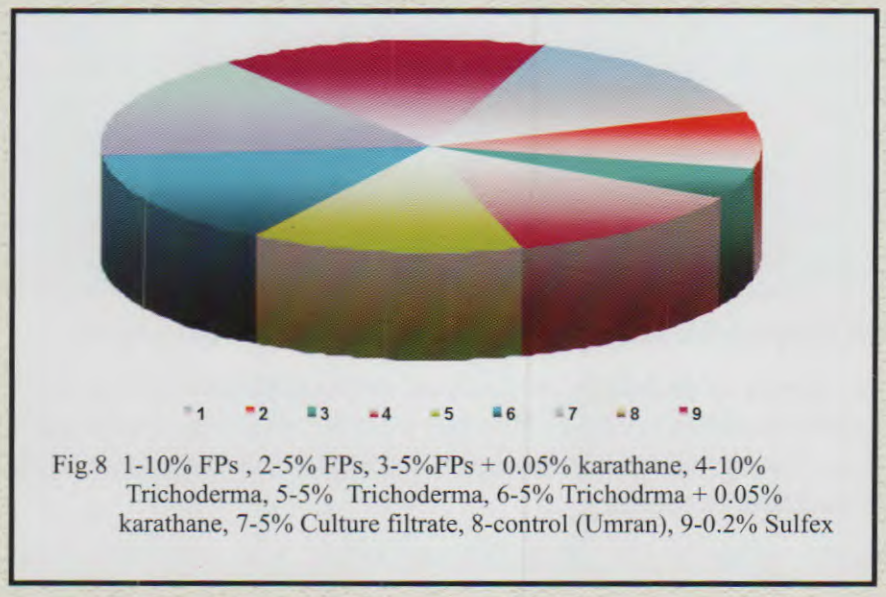


Fig.8 1-10% FPs , 2-5% FPs, 3-5%FPs + 0.05% karathane, 4-10% Trichoderma, 5-5% Trichoderma, 6-5% Trichodrma + 0.05% karathane, 7-5% Culture filtrate, 8-control (Umran), 9-0.2% Sulfex

Fig.8 PDC of powdery mildew after biocontrol treatments under field conditions

Evaluation of different treatments combinations using above bioagents showed that the maximum PDC of 97.59 was resulted by 5% bacterial suspension mixed with 0.05% karathane followed by 94.62% in 0.2% sulfex. Spray of bacterial suspension (5 %) alone resulted 77.28 percent disease control efficacy. Spraying 5% culture filtrate of *Trichoderma* (CIAH-240) resulted a maximum of 92.63 per cent disease control by followed by conidial suspension of *Trichoderma* (5 and 10%) spray resulting 71.82 and 77.4 PDC in case of cv.Umran. In cv.Gola, 5% *Trichoderma* combined with 0.05% karathane resulted the maximum PDC of 98.4 followed by 96.42 in 5% P.fluorescens and 0.05% karathane spray. Sulfex spray has shown 95.72 percent efficacy (Fig 9).

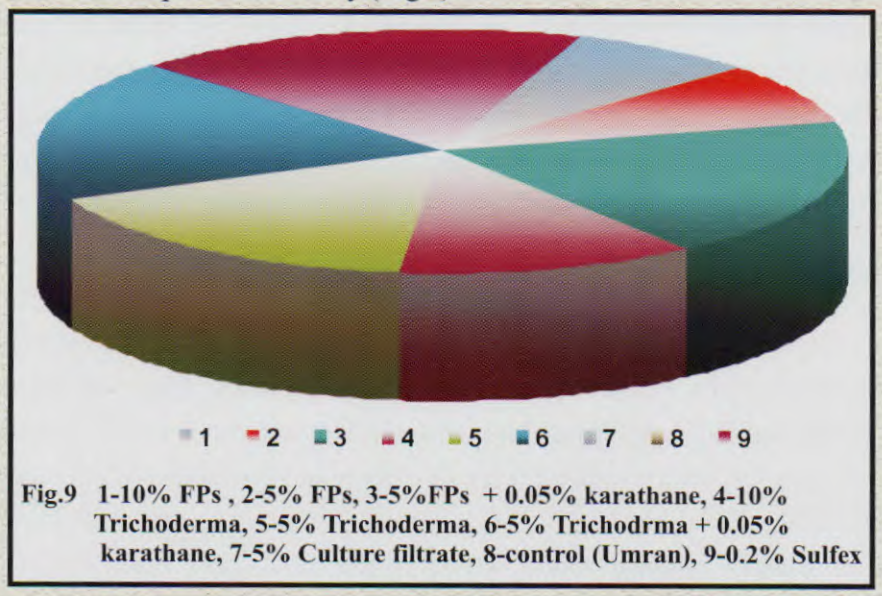


Fig.9 1-10% FPs , 2-5% FPs, 3-5%FPs + 0.05% karathane, 4-10% Trichoderma, 5-5% Trichoderma, 6-5% Trichodrma + 0.05% karathane, 7-5% Culture filtrate, 8-control (Umran), 9-0.2% Sulfex

Fig.9 PDC of powdery mildew after biocontrol treatments under field condition

Similarly field experiments for the management of virus diseases of *mateera* have been conducted. Two isolates of *Trichoderma* (CIAH-151 and CIAH-240) and three isolates of *P.fluorescens* (CIAH-111, CIAH-196 and CIAH-311) have been selected and five treatments viz., seed treatment, foliar spray, seed treatment and foliar sprays, insecticide spray and control were experimented with these isolates. Seed germination, and incidence of virus diseases were recorded. Out of three isolates, CIAH-196 showed higher seeds germination (92.1%) followed by 86.65% in isolate CIAH-31 compared to 66.75% in untreated control. The overall results revealed that none of the isolates was able to completely check the incidence of diseases. However, isolate CIAH- 111 showed 71.69 percent control efficacy when the bacterial antagonist was applied with seed treatment and foliar spray followed by seed treatment and foliar spray alone.

Evaluation of ber germplasm against major diseases

Genotypes of ber have been evaluated for their reactions against major diseases. There was no incidence of powdery mildew and therefore, genotypes were not evaluated against this disease. Fruit rots of ber is second major diseases in ber under arid conditions. The available genotypes were evaluated

against this particular disease. Out of these genotypes, there was no fruit set in 23 per cent plants irrespective of the genotypes. One hundred and three genotypes were free from fruit rots incidence. The remaining genotypes expressed only less than 5% incidence. Perhaps, the inoculum level and the environmental conditions play major role in disease incidence. In order to ascertain the actual resistance level, some of the genotypes were evaluated under laboratory conditions using major fruit rot pathogen *Alternaria alternata* and its toxin in separate experiments. When the tender fruits were inoculated with conidial suspension, infection was rapid and colonization was also severe. Where as in toxin treated fruits, the symptoms development was slow and subsequently, necrosis was common (Plate 1). However, some of the genotypes showed resistant reaction. Out of 185 genotypes tested, 53 genotypes expressed comparable results between fungal and toxin treatment under laboratory conditions. Genotypes viz., Chhuhara,Bagwadi, Khura B.Bawandi,Reshmi and Ponda showed immune response to conidial inoculation. However, these genotypes showed resistance reaction when the fruits were inoculated with suspension of crude toxin. The remaining genotypes showed variability in fruit rot reaction.

Evaluation of Pomegranate hybrids against major diseases

Fourty five lines of selection and hybrids of pomegranate were evaluated for disease reactions under arid conditions. Majority of the lines were free from diseases. However, three open pollinated progenies viz., AHPG/S4aL2-22, AHPG/S4bL3-14 and L314 were severely affected by Culvularia leaf spot (Plate). This disease has been recoded for the first time in hybrid lines with severe intensity. Almost all these genotypes defoliated within 15 days of incidence. Alternative spray of 0.2% chlorothalonil and 0.2% mancozeb at weekly interval could suppress the leaf spot. Line JS/C/C1-C9- L3-9 and Ahp/OP/JS/08 L9-4 recorded less incidence of Cercospora leaf spot. Rest of the hybrids/selections were free from diseases.

I.2 Evaluation of arid cucurbits germplasm and hybrids against major diseases

During summer season (2002), arid vegetables viz., snap melon, advanced lines of mateera and kakdi were evaluated against major diseases under arid conditions. All these vegetable lines were free from fungal and bacterial diseases. However, incidence of virus diseases was noticed in almost all the genotypes. Snapmelon AHS-10 was observed with yellow mosaic diseases with virus disease incidence ranging from 20-23%. Out of 12 advance lines of *mateera* AHW-11a/12 recorded minimum incidence of 16.6% followed by 18.0% in AHW-11a/6. The maximum incidence (41.6%) was observed in AHW11a/10.

Thirteen lines of *Citrullus lanatus* (CL/kcm/BKP-18, CL/kcm/BKP-19, CL/DPY-117, CL/DPY-119, CL/DPY-120, CL/DPY-124, CL/DPY-140, CL/DPY-142, CL/DPY-149, CL/DPY-157, CL/DPY-160 and CL/DPY-164) were evaluated during summer season. Out of these, CL/DPY-164 recorded minimum incidence of 9.5% virus disease. None of these lines was infected by fungal diseases. Twenty eight lines of long melon were also evaluated during summer season. Out of these, lines

CMU/KCM BKP-2, CVF/KCM/BKP-85, CMU/DPY/113, CMU/DPY135, CVF/KCM/BKP-8 and CVF/BKP-20 were found free from diseases. Some lines viz., CMU/DPY1-132, CVF/KCM/BKP-16 and CMU/PY132) were completely affected by virus disease. Rest of the lines showed moderate incidence.

Advanced lines of chilli were evaluated during rainy season. Out of 60 lines, 7 lines (AHM-174/14, AHM-173/3, AHM-184/2, AHM-188-28, AHM-AMH-197/32, AHM-2002/41 and Haripur-1142) were free from diseases. These lines may be considered as potential source for breeding on disease resistance. Maximum incidence (18.75%) was observed in AHM-187/27. However, the chilli lines were relatively free from disease severity. In earlier stage, some of the lines (AHM-162/2, AHM-162/1 and AHM-171/11) showed wilt incidence but it was negligible (less than 3%).

At CHES, Godhra

I. 3 Studies on fungal and diseases of semi arid fruits (ber, pomegranate, aonla, anonna and phalsa)

Ber: Management of powdery mildew:

a) Fungicidal control:

The disease appeared in second week of September but its maximum progress was recorded in November month. The disease intensity was low due to occurrence of less rainfall during the rainy season. A control schedule involving only two spray application was tried which involved first spray with Bavistin (0.1 %) in third week of September (i.e. immediately after the first appearance of the disease, at flowering stage to jowar grain size fruit-stage) and the second spray in the first week of November (at marble size fruit stage). The schedule was quite effective in reducing the disease intensity and offered 88.3 to 94.1%disease control (PDC)

b) Management through foliar spray of resistance inducing chemicals, eco-friendly treatments and botanical formulations in alternation with fungicidal sprays.

First application of Sulfex (0.2%) in the last week of September followed by one spray at 20 days interval with either 0.1M KH_2PO_4(+KOH)(PDC=79.3 or salicylic acid (0.1 %) (PDC=82.21), $MgSO_4$ (0.1 %) (80.54), $KHCO_3$ (0.1 %)(72.70), $KMnO_4$ (0.1 %)(68.02) or phenol (0.1%)(66.66) provided good control of the disease under low- disease- pressure conditions in variety Umran.

One spray of Sulfex (0.2 %) followed by one foliar spray of an ecofriendly botanical formulation prepared by mixing 100g turmeric, 1g asafoetida and 1g.Sodium bicarbonate in 10 litre of water also recorded reduction in the disease intensity (PDI=8.17 as compared with 20.3 in untreated control) and offered 59.75 per cent disease control in var. Umran.

Two sprays with 50 % Panchamrut dairy milk also offered 51.1 % disease control in Cv. Gola.

c) Management through use of biocontrol agents (CIAH-isolates).

A combination of half dose of Karathane (0.05%) with 5% spore-suspension (liquid culture) of Trichoderma sp. or 5% bacterial-cell suspension of Pseudomonas fluorescens (liquid culture) recorded appreciable reduction in the disease intensity The experiment will be further repeated to confirm the results.

Disease management in Pomegranate:

The incidence of leaf anthracnose (Colletotrichum gloeosporioides) was observed during August and September months. The disease was found to be managed by single application of Blitox (0.3%), Bavistin (0.1%) and Kavach (0.2%) sprays, which offered 67.1,89.2 and 89.7 percent disease control, respectively.

1.4 Investigations on the fungal, Viral and Mycoplasma diseases of solanaceous, cruciferous and bulbous vegetables.

I. Integrated disease management In Tomato:

a) Early blight (alternaria leafspots) of tomato

The disease seriously affected the tomato crop during and immediately after monsoon season. Average disease intensity in control plots was quite high (PDI =38.6) which brought about severe defoliation in the plants and reduced the vigour of the crop. All the treatments were found to reduce the disease intensity (PDC ranging between 49.5 to 87.1) but two sprays with mancozeb (0.2%) or Kavach (0.2%) were superior over others. One spray of mancozeb (0.2%) followed by a combination of cultural, botanical and biological control also provided good disease control. An ecofriendly treatment called Ranode organic balls formulated by S.Gangopadhyay (1997) by mixing 2 kg fresh cow dung, 100g turmeric powder, 1g $ZnSO_4$ and 10g sodium tetra borate thoroughly and making 1 cm diam balls which were dried on concrete floor, was also applied. One ball was buried near the plant below soil surface and a few balls were powdered and dusted on foliage to prevent from all fungal, bacterial and viral attack. This treatment offered 80-90 percent freedom from major diseases.

Preinoculation of seedlings with VAM fungus and spray of Trichoderma spp. spores @2 x 10^5cfu on plant surface reduced the disease incidence by 49.1 percent.

b) Viral disease of tomato :

Incidence of tomato mosaic and leaf curl was found to be reduced by sprays with pure dairy milk (Panchamrut). This treatment, as also Ranode organic balls and foliar sprays with turmeric, hing and $NaHCO_3$ (in 100g: 1g: 1g ratio in 5 lt. Water) were very effective in reducing the incidence of leaf curl, mosaic and TSWV, and offered 56 to 80 percent disease control. The experiment will be repeated further.

II. Integrated disease management in chillies:

a) Alternaria leaf spots of chillies cv. Pusa Jwala.

The disease appeared in August but the disease incidence was very less. The results of control trials using sprays of fungicides, botanicals, host resistance inducing chemicals and cultural control showed that all the treatments were effective in reducing the disease intensity and offered PDC ranging between 56.32 to 93.72. One spray with fungicides (Chlorothalonil or mancozeb) was sufficient but its association with botanical, cultural and foliar sprays further improved its disease control efficacy. The experiment will be repeated further.

b) Management of powdery mildew of chillies cv G-4 using foliar sprays of resistance inducing chemicals:

Total 11 chemicals were tried which included methyl salicylate, K_2HPO_4 KH_2PO_4 , $KMnO_4$ $MgSO_4$,$KHCO_3$,$NaHCO_3$,$CaNO_3$ salicylic acid, Urea+ KH_2PO_4+ $MgSO_4$. Except the methyl salicylate, all were effective in reducing the disease intensity. Maximum disease intensity was recorded in control (34.11) and the minimum in K_2HPO_4(22.34). The Sulfex sprays (fungicidal check) recorded PDI= 14.54.

c) Effect of Rhizobacterial inoculation in rhizosphere of G-4 chilli on natural appearance of powdery mildew.

Out of 3 cultures of rhizobacteria (available fromGSFC) viz. Azospirillum, Azotobactar and PSB incorporation of Azotobactor recorded less disease incidence (PDI=15.91) as compared to Azospirillum(19.99), PSB (20.40) and control (34.11).

Control of insect pests of Horticultural Crops

FRUIT CROPS:

1.5 Pest management Ber, Pomegranate ,Aonla and Sapota.

[A] BER

1. Control of fruit fly,*Carpomyia* vesuviana costa and fruit borer, *Meridarchis scyrodes* in ber cvs.Gola and Umran.

Schedule involving two applications of either fenvalerate (0.005%), decamethrin (0.0015%), acephate (0.05%) or dimethoate. (0.05%) at 21 days interval commencing from second fortnight of September followed by two applications of NSKE (5.0%) at 10 days interval proved to be effective against fruit fly and fruit borer infesting ber cv., Gola and Umran. Even, the schedule involving two applications of NSKE (5.0%) at 10 days interval followed by insecticides and also combination of half dose of fenvalerate (0.0025%) with half dose of NSKE (2.5%) at 21 days interval were found to be equally effective in reducing the incidence of fruit fly and fruit borer. The average incidence ranged between 4% in treatment to that of 20% in control.

[B] POMEGRANATE

2.Control of thrips Scirtothrips dorsalis Hood and anar butterfly,Virachola isocrates in pomegranate cv. Ganesh.

Application of two sprays of either acephate (0.05%), dimethoate (0.05%), fenvalerate (0.05%) or decamethrin (0.0015%) at fortnightly interval followed by NSKE (5.0%) at 7 days interval proved effective and consistent in suppressing the population of thrips, Scirtothrips dorsalis Hood infesting pomegranate cv. Ganesh. The average population of thrips ranged from 10.0 thrips/plant in treatment to that of 28.0 thrips per plant in control. Incidence of fruit borer in pomegranate could be effectively checked by the above schedule of sprays.

[C] AONLA

Studies on control of borer in aonla.

Field trial laid out for the control of fruit borer in Aonla cv. NA- 7 revealed effectiveness of all treatments over control. The incidence varied between 8.0% in treatments to 30.0 % in control.

VEGETABLE CROPS:

1.6 Pest management in Chilli and Brinjal:

[A] CHILLI

1. Control of thrips, Scirtothrips dorsalis Hood in chilli cv.Pusa G- 4 and Pusa Jwala.

Chilli thrips, Scirtothrips dorsalis Hood a prominent pest causing leaf curl was effectively controlled by fortnightly sprays with Monocrotophos (0.05%), Dimethoate (0.05 %) or Phosphamidon (0.05 %) followed by weekly sprays with NSKE (5.0 %). Even half dose of Monocrtophos (0.025 %) with half dose of NSKE (2.5%) was found to be equally effective in reducing the incidence of leaf curl in both Pusa Jwala and G-4.

[B] BRINJAL

1. Control of Jassid Amrasca biguttula biguttula, Ishida and fruit borer Leucinodes orbonalis Guen in brinjal cv. Pusa Kranti

Brinjal jassid Amrasca biguttula biguttula Ishida was effectively controlled by fortnightly applications of Phosphamidon(0.05%),Monocrotophos(0.05%), Endosulfan (0.07%) or fenvalerate(0.05%) followed by weekly sprays with NSKE (5.0%). Even half dose of fenvalerate (0.0025%), with half dose of NSKE (2.5%), was equally good in suppressing the population of Jassid infesting brinjal Cv. Pusa Kranti. The incidence of fruit borer Leucinodes orbonalis Guen was effectively reduced by fortnightly application of Fenvalerate (0.05%), Endosulfan (0.07%) and Monocrotophos (0.05%), followed by weekly sprays with NSKE (5.0%). The incidence of fruit borer varied between 20.0% treatment to that of average 40.0% in control.

Plant production

Mission K: Production of planting materials

At CIAH, Bikaner

K 1. Establishment of Field Repository

Two-hectare area has been developed as "Field Repository" by planting different arid fruit types, which will also serve as conservatory for demonstration purpose of the fruit types suitable under arid ecosystem. So far, 60 varieties/strains of different fruit trees accommodating 21 genera have been collected from different places in India and abroad (Table-44).

Table 44: Status of arid crops in Nursery at CIAH, Bikaner

Fruit type	No. of collection	Place of collection
1. Ber	05	Jodhpur, Godhra
2. Aonla	07	Faizabad, Himanchal Pradesh, Tamil Nadu
3. Bael	10	Pant Nagar, Faizabad, Jodhpur
4. Guava	05	Hisar, Kaimganj, Aurangabad, Faizabad, Pant Nagar
5. Citrus	08	Godhra, Abohar, Aurangabad, Pant Nagar, Bharatpur
6. Phalsa	02	Faizabad, Godhra
7. Kronda	06	Faizabad, Godhra, Bharatpur, Udaipur, Pant Nagar, Baster
8. Lasoda	05	Bikaner, Bharatpur
9. Tamarind	03	Bikaner, Rahuri, Baster
10. Khejri	03	Bikaner
11. Carob	01	Israel
12. Marula nut	01	Israel
13. Chinese ber	01	Simala
14.Boardi	01	Saudi Arabia
15. Khirni	01	Godhra
16. Pomegranate	05	Jodhpur, Rahuri, Argentina
17. Ker	02	Bikaner
18. Fig	02	Rahuri and Bikaner
19. Mulberry	03	Bawal, Faizabad, Jodhpur
20. Jamun	02	Pratapgarh, Bikaner
21. Jangal jalebi	01	Jaunpur

K2. Introduction of plants

For better establishment of precious materials, proper acclimatization and hardening of new introductions are very essential. For the purpose, four growing structures have been developed. Fine nozzle sprinkler system has been installed for irrigation purpose. These structures are also being utilized for multiplication of fruits, vegetables and ornamental plants. As new introduction during 2002-2003, seeds of aonla has been collected from Himanchal Predesh and sown in the nursery. Some plants and seeds of bael have also been introduced in to nursery for further planting in bael block. The ker and Gonda were also introduced after extensive survey in Rajasthan and Gujarat.

K 3. Establishment of Mother Block

One ha area has been developed as apart of nursery for mother block during 2002. Three commercial fruit types namely ber, aonla and pomegranate have been accommodated in the mother block. This will serve as source of scion shoots for commercial multiplication of these fruit trees. Three rows of each fruit were planted at closer spacing. The fruit types, spacing and their promising varieties are given in table 45.

Table 45. Fruit types, spacing and their promising varieties planted in mother block

Fruit type	Spacing (m)	Promising variety
Ber (*Ziziphus mauritiana*)	6 x 4	Gola, Umran, Seb, Goma Kirti, Banarasi Karaka
Aonla (*Emblica officinalis*)	6 x 6	Neelam, Amrit, Chakaiya
Pomegranate (*Punica granatum*)	4 x 2	Jalore Seedless, Ganesh, G 137

K 4. Evaluation of fruit trees

The fruit plants maintained in nursery are also under evaluation to see their performance under irrigated hot arid ecosystem of northwestern Rajasthan. The management practices were similar for all the varieties of a particular fruit type. The irrigation, fertilization, intercultural operations, training and pruning etc. were based on the recommendations already available. The data on vegetative vigour and fruit yield have been presented in table 46.

Table 46. Vegetative vigour and fruit yield of some arid fruits planted in the nursery.

Fruit type/ Cultivar	Yr.of plantation	Vegetative vigour		Fruit yield (kg/tree)		
		Plant height (m)	Crown spread (m^2)	2000	2001	2002
Bael						
Pant Aparna	August, 1998	2.85	12.00	--	--	16.60
Pant Sujata	August, 1997	4.20	14.00	--	2.67	13.00
Pant Swarna	August, 1997	5.50	16.50	3.0	1.10	--
Pant Shivani	August, 1997	5.25	13.05	--	8.00	16.00
Pant Urvashi	August, 1997	5.26	18.00	--	15.50	16.20
NB 5	August, 1997	3.30	9.75	--	20.50	35.00
NB 7	August, 1997	5.35	10.25	--	--	2.00
NB 9	August, 1997	2.70	5.20	15.2	13.60	26.00
Dhara Road	Sept. 1999	2.90	7.50	--	--	--
Ber						
Kaithali	Sept., 1998	2.00	4.00	--	4.20	7.50
Umran	Sept., 1998	2.20	3.00	--	5.80	10.00
Seb	Sept., 1998	2.70	4.25	--	8.25	8.00
Gola	Sept., 1998	2.80	5.00	--	10.50	15.00
Goma Kirti	Aug., 1999	1.60	2.25	--	3.60	5.00
Citrus						
Sweetorange: Mosambi	August, 1997	2.75	9.00	2.0	4.00	5.50
Mandarin: Kinnow	August, 1997	2.85	8.20	--	--	--
Malta	August, 1997	1.85	4.00	--	--	--
Grapefruit:Marsh	August, 1997	2.80	7.50	--	--	--
Seedless Red Blush	August, 1997	2.60	6.00	--	--	--
Lemon: Pant 1	August, 1997	2.50	9.00	--	0.80	4.50
Guava						
Allahabad Safeda	Sept., 1997	3.00	7.50	--	4.20	3.50
L 49	Sept., 1997	1.90	3.00	2.5	8.50	6.50
Karonda						
KS 1	July, 1997	1.50	2.25	--	--	2.00
KS 2	July, 1997	1.85	2.00	--	1.10	4.60
KS 3	July, 1997	1.75	2.25	--	--	--
KS 4	July, 1997	1.45	2.45	--	1.13	3.50
KS 5	July, 1998	0.60	0.75	--	--	--
***Lasoda**						
LS 1	July, 1997	3.70	1.5	--	--	--
LS 2	July, 1997	5.50	45.00	4.5	75.40	130.00
LS 3	July, 1997	6.00	39.00	8.9	90.65	152.00
Pomegranate						
Ganesh	July, 1997	2.60	1.50	1.2	1.64	--**
G 137	July, 1997	2.80	1.00	1.7	2.75	--
Jalore Seedless		1.95	1.00	0.5	4.25	--
Mulberry	July, 1998	3.00	6.88	0.7	4.50	5.00

*Tender fruits for vegetable purpose ** Shoots were taken for multiplication

K 5. Multiplication of experimental materials

For experimental purpose, the plants were multiplied in nursery, maintained, hardened and handed over to the concern scientist for plantation at desired site (Table 47).

Table 47. Plants multiplied for experimental use

Plant type	Technique of multiplication	Quantity	Purpose
Ber	Budding	300	For ber germplasm block(30)* For plantation in mother block (250) For plant pathology experiment (20)
	By seeds	750	For commercial ber block(500) For agroforestry block (50) For aonla based cropping system block(50) For minor fruit block (150)
Aonla	Budding	60	For mother block(50) For gap filling in nursery (10)
	By seeds	410	Aonla block (100) Aonla based AFS (260) For mother block(50)
Pomegranate	By cutting	410	For mother block (300) For pomegranate block (80) For Pomegranate germplasm block(30)
	By seeds	100	For germplasm block(100)
Bael	By seeds	190	For bael block(190) For aonla based AFS(40)
Date palm	By seeds	2640	For datepalm block(2500) For nursery block (100) For farm complex(40)
Ker	By seeds	500	For underutilized block(500)
Gonda	By seeds	200	For minor fruit block(200)
Phalsa	By seeds	100	For minor fruit block(100)

* Materials collected by NBPGR, New Delhi and multiplied at CIAH Nursery

K 6. Multiplication of ornamental plants

The following ornamental plants were multiplied for beautification of campus, nursery area and farm complex (Table 48).

Table 48. Ornamental plants multiplied

Plant type	Propagation method	No. of plants
Bougainvillea	Cutting	100
Mehndi	Cutting	200
Clerodendran enormi	Cutting	100
Ticoma	Cutting	50
Chrysanthimum	Sucker/ cutting	150
Pot plants	Sucker	100

K 7. Commercial propagation

The fruit trees of commercial significance like; ber, aonla and pomegranate have been multiplied through vegetative means for distribution of true-to-type of planting materials among farmers and also for experimental purpose (Table 49). As a source of revenue generation, Rs. 15,055/- has been generated by on-spot selling of planting materials to the farmers.

Table 49. Production of planting materials (2002)

Fruit types	Variety	Propagation method	Plant material produced (No.)
Ber	Gola, Seb, Umran, Kaithali, Mundia, Others	Patch budding	1820
Aonla	NA 6, NA 7, Chakaiya	Patch budding	350
Pomegranate	Jalore Seedless, Ruby, G137, Ganesh,	Exotic material Cutting	650
Indian Aloe	Local Selection	Sucker	2045

At CHES, Godhra

K.5 C.H.E.S.,Nursery

In addition to the R.F.S., the C.H.E.S. Nursery produced more than 2000 budded /grafted fruit plants for distribution amongst the needy farmers and also to cater the need of scientists of the Station. Following planting material was generated at the nursery and sold / utilized for experimental purpose.

Sl. No.	Crop	Nos. Produced / Sold
1.	Aonla	592 + 127 *buddlings
2.	Mango	324 +56* grafts
3.	Pomegranate	52 +505* cuttings
4.	Ber (gola)	303 + 65 * buddlings
5.	Ber (Goma Kirti)	54 buddlings
6.	Guava	17 layers
7.	Custard apple	08 buddlings
8.	Lime	79 + 114 * gooties
9.	Bougainvillea	95 cuttings
10.	Gulmohar	200 saplings
11.	Ashoka	25 saplings
12.	Others	24
Total	Total	1453 +1187 *=2640

*Plant material utilized for experiment purpose/beautification of the building complex.

The CHES nursery realized revenue of Rs. 24,313/- from sales of various planting material.

Production of planting material in vegetable crops

During the rainy season about 63 kg of cluster bean and 35 kg of okra seeds were also produced for distribution to the farmers. Apart from this about 23,349 disease free seedlings of solanaceous vegetables (Chilli-6325, Brinjal-7687 and Tomato-9337) were produced and sold to the farmers.

Post Harvest Technology

Project:10. Post harvest handling and processing studies in arid zone horticultural crops

Sub projects 10.1Studies on processing techniques in *khejri* (*Prosopis cineraria*)

An experiment was carried out in order to standardize optimum stage and suitable condition for dehydration of *khejri* pods. Two different stages were selected namely, tender and matured stage. The pods were harvested, cleaned and sorted into two stages. The pods were subjected to following six treatments

T_1-Blanched in hot water (5min.)

T_2-Blanched in hot water (5min.)+0.1%KMS

T_3-Blanched in 2% salt solution (5min.)

T_4-Blanched in 2% salt solution (5min.)+0.1%KMS

T_5-Blanched in 2% salt solution (10min.)

T_6-Control

These were dried in three methods i.e., direct sun, under shade and in tray drier.

The experimental results reveals that the drying duration between the treatments are not varied. Among the different methods the pods dried in sun took lesser time i.e., 10 hour followed by tray drier and it took maximum under shade drying. The recovery percent of dehydrated tender pods ranged from 24.92-25.00 under sun drying (Table 50), followed by 24.91-25.14 in shade and 24.85-25.26 under tray drier. The recovery percent was higher in matured pod i.e., it ranged from 28.05-28.22 in Sun, 27.93-28.07 under shade and 28.02-28.21 in tray drying. The nitrogen content of tender pods (Table 51) ranged from 2.64-2.85 in Sun, 2.50-2.98 under shade and 3.11-3.32 in tray drier, whereas it was higher in matured pods 2.95-3.18 in Sun 3.02-3.28 under shade and 3.07-3.38 in tray drier. Among treatments the rehydration ratio (Fig.10) was maximum in T_1, followed by T_6 and the least was in T_4 in shade dried pods. T_6 scored maximum followed by T_5 and least in T_3 in case of pods dried in tray drier. T_6 was maximum followed by T_3 and least in T_1 in case of pods dried in Sun. Among different methods the rehydration was maximum in shade followed by Sun and the least in tray drier. In sun drying all the pods were brown black in clour, whereas in shade and tray dried the pods are light brown to brownish green in colour. The colour of rehydrated pods are light brown to green in case of pods dried in Sun where as in case of pods dried in shade and tray drier found to be green in colour.

The data on scoring for colour and appearance for dehydrated pods (Table 52) reveals that in Sun dried pod maximum score for colour was in T_3 and minimum in T_1, in case of shade dried T_3 scored maximum and the minimum was in T_6, whereas T_4 scored maximum and minimum in T_6 in tray dried pods. The mean value was maximum for the pods dried in tray drier followed by shade and the minimum was in case of Sun. The same trends follows for appearance among different methods, whereas the maximum score for appearance was in T_5 and minimum in T_6 in shade dried pods and maximum point for T_3 and minimum in T_6 for the pods dried in tray drier (Plate-2).

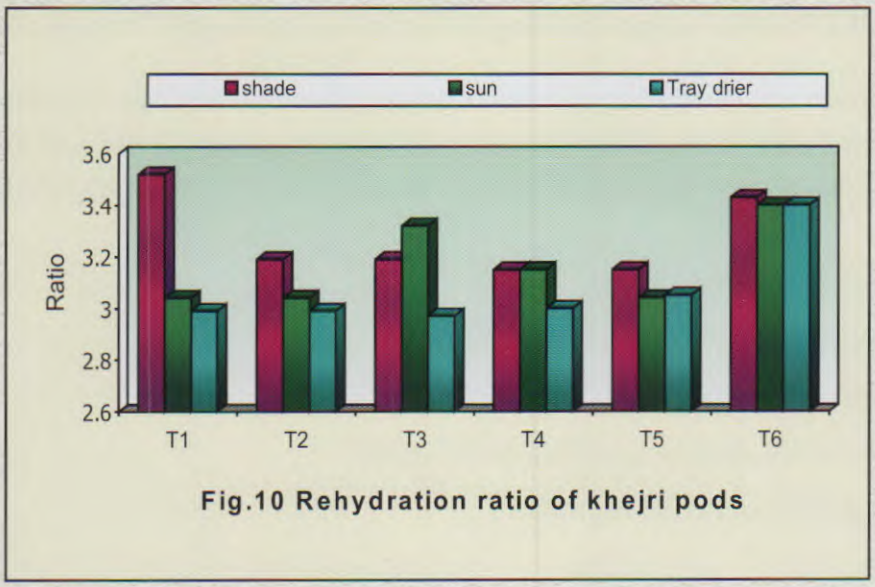


Fig.10 Rehydration ratio of khejri pods

Plate 2. Dehydrated khejri pods under shade

The data on rehydrated pods reveals that the scores for colour were maximum in T_3 and minimum in T_1 and for appearance follows the same trend in Sun dried pods. In shade-dried pods the score was maximum in T_2 for colour and appearance and minimum in T_6. In tray dried pods the maximum score was in T_3 and minimum in T_6 for colour and appearance.

Among the methods, the rehydrated pods dried in tray drier scored maximum followed by shade dried and the least in Sun. The overall acceptance score was maximum in T_3 in Sun, T_2 in shade and T_3 in tray dried pods. However, the pod dried in tray drier was scored maximum and minimum in Sun.

Table 50. Recovery percent of dehydrated khejri pods under different methods

Treatments	Methods of drying.					
	Sun		Shade		Tray Drier	
	1	2	1	2	1	2
T_1 Blanched in hot water (5min.)	24.92	28.05	25.13	28.07	24.85	28.18
T_2 Blanched in hot water (5min.)+0.1%KMS	25.00	28.06	24.91	28.01	25.12	28.08
T_3 Blanched in 2% salt solution (5min)	24.92	28.22	24.95	28.02	25.08	28.13
T_4 Blanched in 2% salt solution (5min)+0.1%KMS	24.99	28.07	24.99	27.99	25.07	28.02
T_5 Blanched in 2% salt solution (10min)	24.93	28.13	24.95	28.03	25.09	28.03
T_6 Control	24.94	28.07	25.14	27.93	25.26	28.21

Note:-1&2 Indicate tender and matured pods

Table 51. Nitrogen content (%) in Dehydrated Khejri pods

Treatments	Methods of drying.					
	Sun		Shade		Tray Drier	
	1	2	1	2	1	2
T_1 Blanched in hot water (5min.)	2.81	3.14	2.78	3.05	3.24	3.25
T_2 Blanched in hot water 5min.) +0.1% KMS	2.85	3.18	2.50	3.15	3.12	3.29
T_3 Blanched in 2% salt solution (5min)	2.72	3.09	2.52	3.28	3.11	3.11
T_4 Blanched in 2% salt solution (5min)+0.1%KMS	2.71	3.02	2.98	3.18	3.21	3.26
T_5 Blanched in 2% salt solution (10min	2.64	3.05	2.77	3.26	3.32	3.38
T_6 Control	2.85	2.95	2.77	3.02	3.18	3.07

Table 52. Physical properties of dehydrated and rehydrated khejri pods

Treatments	Colour of Khejri pods		Dehydrated pods		Rehydrated pods		Over all Acceptance
	Dehydrated	Rehydrated	Colour	Appearance	Colour	Appearance	
Sun							
T_1	Black	Brown	4.2	4.7	3.5	4.1	4.1
T_2	Black	Brownish green	4.9	5.2	4.4	4.8	4.8
T_3	Grey	Grenish yellow	6.5	5.8	7.1	6.7	6.5
T_4	Dark Brown	Light brown-grenish	4.3	4.4	5.7	6.0	5.2
T_5	Black	Light brown green	4.9	4.6	3.7	4.6	4.5
T_6	Ash	Reddish brown	4.9	5.0	5.1	5.1	5.0
Mean			**4.95**	**4.95**	**4.92**	**5.22**	**5.02**
Shade							
T_1	Light brown	Green	5.0	4.9	6.1	6.0	5.8
T_2	Light brown	Green	5.5	5.7	6.5	6.4	5.9
T_3	Light brown	Green	5.8	5.4	5.7	6.1	5.6
T_4	Light brown	Green	5.0	5.0	6:2	6.1	5.6
T_5	Light brown	Green	5.0	5.7	5.4	5.8	5.5
T_6	Light brown	Green	4.5	4.5	4.5	4.6	4.5
Mean			**5.13**	**5.20**	**5.73**	**5.83**	**5.48**
Tray drier							
T_1	Light brown	Green	5.4	5.7	6.4	6.3	6.2
T_2	Light brown	Green	5.7	5.1	6.3	6.3	5.7
T_3	Light brown	Green	5.6	6.8	6.9	6.4	6.3
T_4	Light brown	Green	5.8	5.4	6.0	6.3	5.9
T_5	Light brown	Green	4.9	5.0	5.7	5.0	5.1
T_6	Ash Light	Brown	4.9	4.7	5.0	4.9	4.9
Mean			**5.38**	**5.45**	**6.05**	**5.86**	**5.68**

Value added products from khejri pods-biscuits

An experiment was conducted in order to use the khejri flour to a biscuit formulation by replacing 15% of wheat flour, as constant and varying the ingredient as follows and baked in a commercial bakery at Bikaner. T_1 plain sweet, T_2 sweet+ egg, T_3 sweet + chocolate, T_4 - sweet + chocolate + egg, T_5 Salted + sweet + adjwain, T_6 salted + sweet + egg, T_7 control (pure maida). Organoleptic scoring was carried out for taste, appearance, flavour, crispness, softness and over all acceptability (Plate 3).

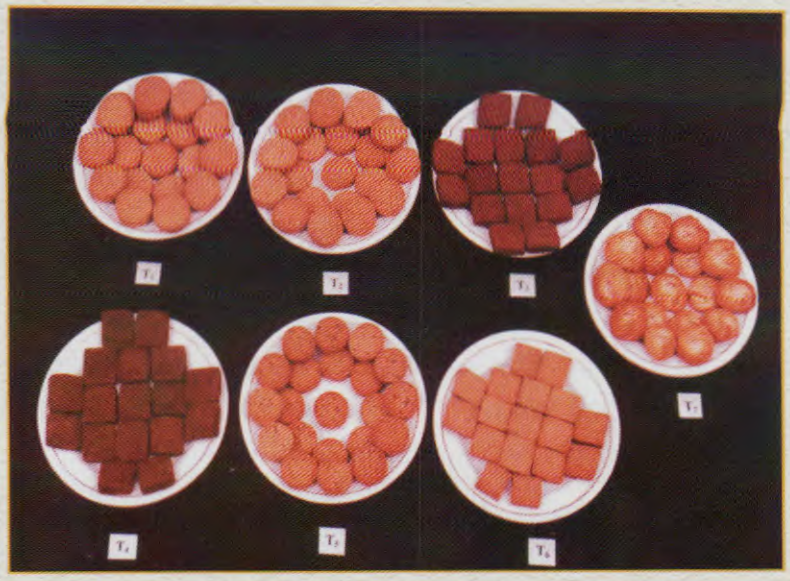


Plate 3. Khejri biscuits

The result (Table 53) reveals that the maximum score was in T_1 (6.8) for taste, T_2 (6.6) and the minimum was in T_6 (5.9) among khejri flour. However, T_7 control scored the highest (7.6). Similarly, the maximum score was in T_1 (6.9) followed T_3 (6.7) and minimum was in T_6 (5.8) for appearance. The score for flavour also topped in T_1 followed by T_3, the crispness was maximum in T_2 followed by T_1 and minimum in T_6 and the biscuits with plain sweet score highest (6.7) and least in T_6. The scores for overall acceptability was maximum in T_1 followed by T_2 and T_3 and minimum was in T_6. However for all character, control i.e. pure maida biscuits scored the highest points. The biscuits prepared with 15% khejri flour were found best. However, all biscuits were found acceptable for consumption.

Table 53. Organol eptic scoring of khejri biscuits

Treatments	Taste	Appearance	Flavour	Crispness	Softness	Over all acceptability
T_1 Plain Sweet	6.8	6.9	6.8	6.5	6.7	7.0
T_2 Sweet + egg	6.6	6.5	6.4	6.6	6.5	6. 7
T_3 Sweet +chocolate	6.4	6.7	6.6	6.2	6.6	6.7
T_4 -Sweet + chocolate+ egg	6.5	6.3	6.4	6.3	6.5	6.5
T_5 Salted +sweet +ajwain	6.2	6.2	6.3	6.1	6.1	6.2
T_6 Salted + sweet +egg	5.9	5.8	6.0	6.0	6.0	5.9
T_7 Control	7.6	7.8	7.0	7.4	7.3	7.5

II. An experiment was conducted in order to find the maximum levels of Khejri flour can replaced by wheat flour. The other ingredients are kept constants. The biscuits are baked in commercial bakery at Bikaner. The treatments are as follows: T_3 1-15% khejri flour with seed, T_2-20% khejri flour with seed, T_3

25% khejri flour, T_4-15% khejri flour without seed, T_5-20% khejri flour without seed, T_6-25% khejri flour without seed, T_7- control (pure maida). Nutritional analysis and organoleptic scoring were done.

Khejri biscuits are rich in protein contents. In table-54 treatment T_3 contains maximum protein (6.91) followed by T_6. The minimum was in control. Calcium % level increased as the concentration of khejri flour was increased. The biscuit with seeds contained higher amount of calcium compared to biscuits without seed. Similar trends followed in case of Na, K where as in case of N content was higher in biscuits without seed.

The organoleptic scores (Table-55) reveals that the biscuits with 15% khejri flour was found best in all character among the khejri flour followed T2. However, the biscuits from pure maida scored the maximum. However, all the treatments were found suitable for consumption.

Table 54. Nutrient content (%) of khejri biscuits

Treatments	Protien	Ca	Na	K	N
T_1-15 % Khejri flour with seed	4.85	0.79	1.43	0.14	1.08
T_2-20 % Khejri flour with seed	6.21	0.85	1.46	0.18	1.19
T_3-25 % Khejri flour with seed	6.91	1.03	1.51	0.25	1.21
T_4-15 % Khejri flour without seed	4.53	0.72	0.94	0.14	1.08
T_5-20 % Khejri flour without seed	5.17	0.77	1.25	0.15	1.20
T_6- 25 % Khejri flour without seed	6.19	0.85	1.27	0.23	1.32
T_7- Control	4.48	0.70	0.69	0.05	1.18

Table 55. Organoleptic scoring of Khejri biscuits

Treatments	Taste	Appearance	Flavour	Crispness	Softness	Over all Acceptability
T_1-15 % Khejri flour with seed	6.7	6.9	6.8	6.6	6.2	7.1
T_2-20 % Khejri flour with seed	6.3	6.0	5.8	6.0	5.6	6.4
T_3-25 % Khejri flour with seed	6.4	6.0	5.8	5.6	5.4	5.8
T_4-15 % Khejri flour without seed	6.4	6.7	5.9	5.8	5.7	6.4
T_5-20 % Khejri flour without seed	5.5	5.9	5.3	5.0	5.6	5.6
T_6- 25 % Khejri flour without seed	5.2	5.8	5.2	5.1	5.3	5.3
T_7- Control	8.4	8.3	7.1	7.0	7.0	7.9

Sub project 10.2: Dehydration of *Kachri* (*Cucumis calosus*)

An experiment was carried in order to standardize the dehydration techniques for *kachri*. Fully matured *kachri* cv. AHK-200 were selected and harvested at tight stage. The fruits were cleaned, sorted

out and subjected to two different treatments with three different drying methods. The fruits were made into thin slices 0.2-0.3cm thickness with peel and without peel. The sliced fruits were dried in Sun, tray drier and under shade. The drying duration was maximum in shade (36hr) and minimum in Sun (10hr). The recovery percent were maximum (Fig.11) in fruits dried in tray drier (12.45) and minimum in Sun (12.02) in case fruits with peel, whereas the recovery percent were maximum in the fruits dried without peel under shade (12.14) and lowest in tray drier (11.20). The results reveal that the powder prepared without peel was found good in colour and in appearance.

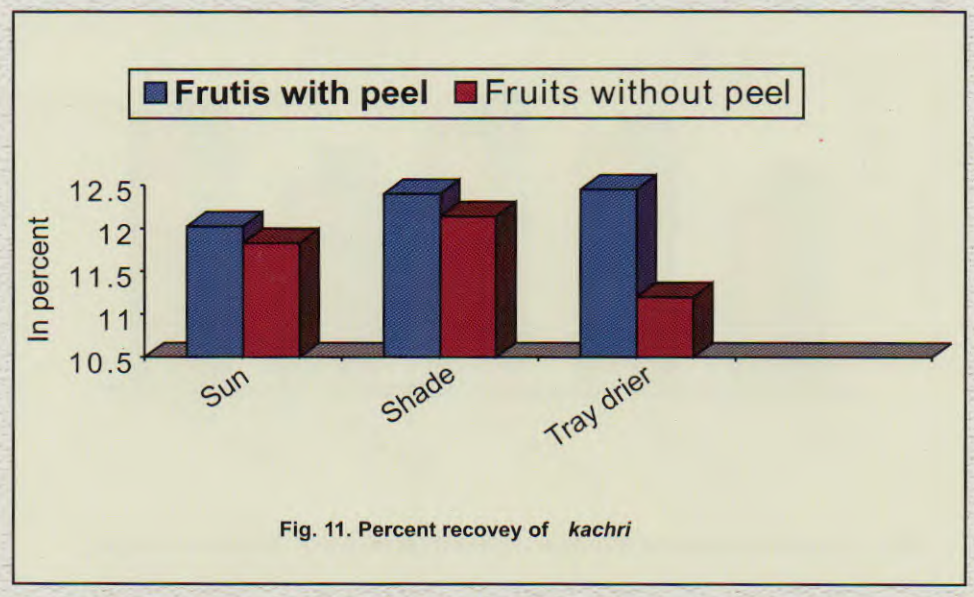


Fig. 11. Percent recovey of *kachri*

Preparation of value added products from *mateera*

Mateera is one of the important summer season crops, which are available in plenty, and no proper storage was done. An experiment was conducted to prepare value added beverages from *mateera.* Five varieties were selected and juices were prepared. The pulp recovery percent and juice recovery percent were also estimated. Organoleptic scoring was done in order to estimate its tastes and likeness of the colour. Absorbance was measured in order to find its colour intensity. The TSS was adjusted to 15 Bx. by adding required amount of sugar. The pulp recovery percent were maximum (Fig.12) in Durgapura and minimum in AHW-65, whereas the juice recovery percent was highest in AHW-19 and minimum in AHW-65.The score for colour (Table-56) were maximum in sugar baby (8.0) and minimum in AHW-19 (5.66), whereas for taste and overall acceptability it was maximum in AHW-65 (8.16) and (8.22) respectively. The absorbance value (Fig. 13) was maximum for sugar baby indicating the colour of the juice was dark red and minimum in Charleston indicating the colour intensity was light red.

Table 56. Organoleptic scoring of *mateera* and watermelon juice

Varieties	Colour	Taste	Over all acceptability
AHW-65	6.33	8.16	8.22
Sugar Baby	8.00	6.66	7.00
Durgapura	5.66	5.40	5.60
Charleston	6.33	6.80	6.80
AHW-19	5.66	6.00	5.88

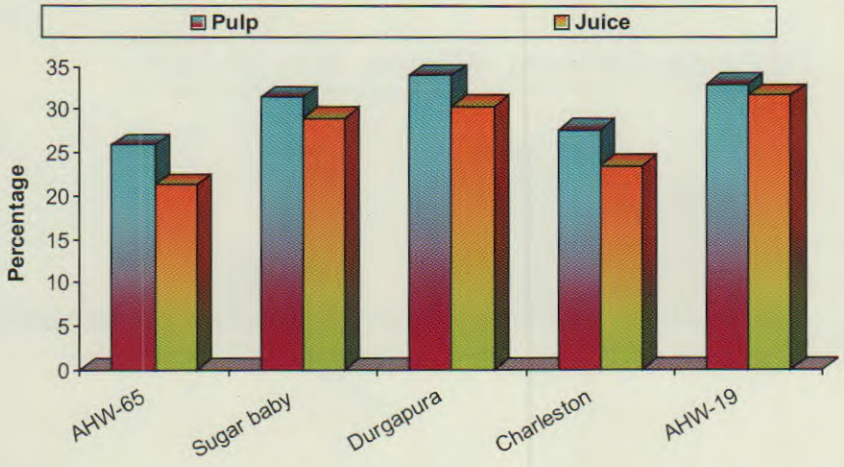


Fig. 12 Percent recovery of pulp and juice from *mateera* and watermelon

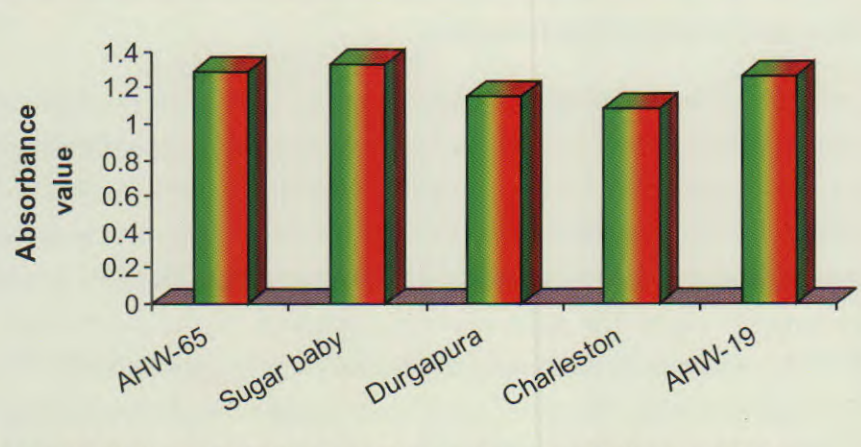


Fig. 13. Juice colour intensity in mateera and watermelon

Value added beverage from snapmelon

Snapmelon was used for preparing vegetables.The aroma of snapmelon and the acidic taste was good. Fruits are available in plenty in these regions, therefore an attempt was made to prepare value added beverage for the first time. The ripe snapmelon fruits were selected, the skins were peeled and seed along with placenta were removed. Care was taken to avoid bitter fruits. Snapmelon ready to serve was prepared by adding 1: 1 ratio of pulp and water and the TSS was adjusted to 15 Bx. Similarly, snapmelon were prepared by adding pulp, water and milk, in the ratio 1:1:1. TSS was adjusted to 15 Bx. Organoleptic scoring were made in order to see its acceptability, taste, appearance, sweetness and flavour. The results reveals that snapmelon shake were scored maximum (8.6) and RTS (8.4). The results show that snapmelon can be used for preparing both RTS and shake beverages.

Preparation of value added products from pomegranate

Pomegranate is one of the important fruits grown in arid areas, an experiment was carried to prepare value added beverages. The fruits were harvested and care was taken to avoid sand particles and dust. The arils were separated and juices were extracted in a juicer. These juices were subjected to different treatments viz., plain juice, juices+zinger extact, juice+lime, juice+ mosambi, juice+lime+ginger,juice+ginger+mosambi,juice +lime+mosambi,juice+lime+ mosambi+ginger. Among these treatments juice+ginger scored maximum point followed by pure juice. (Table 57) However all the treatments were acceptable for consumption. Besides these pomegranate squash were prepared and stored in bottles.

Table 57. Organoleptic scoring of pomegranate punch

Treatments/Attributes	Sweetness	Taste	Aroma	Colour	Over all acceptability
T_1-Pure juice	7.2	7.8	5.6	5.8	7.0
T_2- Pure juice+Zinger extract	7.2	7.4	5.4	6.8	7.2
T_3- Pure juice+lime	5.8	5.6	6.0	6.8	6.8
T_4- Pure juice+mosambi	6.6	6.6	6.6	8.0	7.0
T_5- Pure juice+zingerextract+lime	7.4	7.6	6.6	6.2	7.2
T_6- Pure juice+zingerextract +mosambi	6.0	6.2	6.0	5.6	5.8
T_7- Pure juice+ lime +mosambi	6.4	6.2	5.6	4.4	6.0
T_8- Pure juice+zingerextract +lime+mosambi	6.0	6.0	5.8	5.7	6.2

Preparation of value added products from bael

Desi bael fruits were collected and pulp were extracted .The pulp were prepared into ready to serve and squash. These were stored in sterilized bottles and packed air tight and kept in refrigerated condition. The squash was stored upto nine months and found organoleptically acceptable for drinking.

Preparation of by products from date palm

Date palm are very nutritious fruit grown in arid regions, it is normally being consumed as raw and in other processed form. An attempt was made to prepare date palm ready to serve and squash. The fruits at doka stage were harvested and the seeds are removed after proper cleaning of the fruits. The fruits are cut into small pieces and juices were extracted in a juicer. The TSS was adjusted to15 Bx for RTS and 60-65 for squash and filled in sterlised bottles. Both products were found organoleptically acceptable.

Preparation of value added products from aonla murabah

A new modified protocol was developed for preparation of murabah. Fully matured uniform big size fruits of NA-7, NA-6 were harvested, selected and cleaned. The fruits were pricked and kept in 2%salt solution for 24 hours, again the fruits were washed and subjected to 2% alum solution for 24 hours. The fruits were washed thoroughly, sugar syrup were prepared separately. The fruit are boiled for three minutes and allowed to boil in the syrup solution for another 5-6 minutes. In this methods when the fruits are boiled along with sugar syrub, the moisture inside were replaced by sugar. The fruits are packed in a container kept for three days the syrup solution were heated to remove excess moisture drained from fruits. The murabah are packed in container and stored for 8-9 months. The advantage over the earlier method was the repeated change of concentration daily could be avoided.

In another method dry murabah were prepared. The fully matured fruits are harvested, washed and boiled till it become soft. Seeds were removed and pulp was prepared in the mixie without adding water. Pulp was boiled along with sugar in the ratio1:0.8 or 1:0.7,as colour changes coconut powder were added and stirred carefully. Cinnamon and cardamom were added to taste. Cashew and raisin were added. Finally 50 gram of khus-khus and 5 gram of citric acid were added. It was packed in airtight container and stored for 8-9 months without sugar syrup.

Preparation of segmented aonla candy

Fully matured aonla fruits of NA-7 were selected. Fruits were kept in 2 % salt and alum solution for 24 hours respectively. The fruits are boiled for 8-10 minutes and seeds were removed. Fruits segments were dipped in hot syrup solution for 2 minutes. The products are cooled and kept in container for one week and again heating strengthens the syrub solution. The fruit segments were drained from syrub and dried in partial sun or in a tray drier at 50-52 C for 64 hours. The final products are packed in polythene bag and stored for six nine months.

Preparation of aonla shreds and chips

During the January 2003 an experiment was conducted to utilized cracked, spotted discarded/culled fruits of aonla by preparation of shreds with the use of six different treatment combinations. Based on organoleptic assessment it was found that T5 (Common salt+black

pepper+jeera) was more acceptable followed by T2 (common salt+Asafoetida), T6 (common salt+sauf+jeera) and T4 (common salt+black pepper) where as shreds prepared by using common salt was having least acceptance. Besides, aonla chips were also prepared by using the mixture of Common salt+Jeera+black pepper+sauf+Ilaichi.

Shelf life of ber CIAH Selection-1 and Hybrid-1

A Preliminary experiment was conducted to estimate the shelf life of ber selection and hybrid of CIAH along with Gola (check). Fully matured green fruits were harvested and kept in different material ie., polythene bag. Paper bag, gunny bag, corrugated fibreboard boxes and in open condition under room temperature during February. Observations were made on physiological loss in weight, no of days taken for colour change from green to yellow to red and pathological infection. The TSS was found to increase as the days increased. PLW was also increased; the maximum was noticed in Gola under gunny bag(13.14) while the minimum in polythene bag(2.8). The number of days taken for colour change was minimum (Table-58) in polythene bag (3.0) in all three varieties; maximum days took in hybrid and selection in paper bag (5.0)and corrugated fibre boxes.(5.0) Pathological infection was noticed in Gola kept in polythe bag. The ber selection and hybrid can be kept in room condition for four five days after harvest.

Table 58. Shelf life of CIAH ber Selection-1 and Hybrid-1

Treatments	PLW (%) at 4 th Day			Retention of fruits colour (days)			Pathological infection (%)		
	Gola	Selection-1	Hybrid-1	Gola	Selection-1	Hybrid-1	Gola	Selection-1	Hybrid-1
T_1 Polythene bag	2.80	3.08	2.38	3.0	3.0	3.0	5	-	-
T_1 Paper bag	10.16	6.84	7.34	4.0	5.0	5.0	-	-	-
T_3 Gunny bag	13.14	7.92	8.89	4.0	4.0	4.0	-	-	-
T_4 CFB-Boxes	9.93	6.30	6.49	4.0	5.0	5.0	-	-	-
T_5 Control (Open)	15.00	9.75	9.99	4.0	4.0	4.0	-	-	-

Preparation of value added products from ber CIAH Selection-1 and Hybrid-1

Fully matured fruits were harvested and peeled and ready to serve, squash, jam, murabah and chhukara were prepared. All the products were found organoleptically accepatable. Hybrid fruits are comparatively tastier than selection.

Assessment of post harvest losses of arid fruits and vegetables through local markets survey

A multidisciplinary team, which consists of fruit scientist, vegetable scientist and a plant pathologist, carried out survey during winter season. The fruits available are aonla, pomegranate, kinnow and ber. The cumulative analysis of data (Table 59) reveals that the maximum fruit losses were in ber

(16-23%)followed by aonla (14-22). However the lowest was in kinnow(10-12). The pathological losses were limited to 5% due to injury at the time of harvest and transit. The common post harvest pathogens in aonla were Penicillium and Aspergillus. The fruits are packed in gunny bag for aonla, ber and as such in truck in case of kinnow. Pomegranates were packed in CFB-boxes or wooden boxes.

Table 59. Post harvest losses of arid fruits under local market condition

Crops	Months	Average arrival/ day (Tones)	Kind of losses (%)				
			Handling	Transport	Retail shop	Pathological	Total
Aonla	Nov-Jan	3-5	6-8	4-5	2-4	4-5	14-22
Pomegranate	Nov-Jan	2-3	6-7	1-2	3-4	2-3	12-16
Kinnow	Nov-Jan	2-2.5	2-3	2-2.5	5-7.5	1-2	10-15
Ber	Jan-Mar.	2-3	6-8	3-4	4-6	3-5	16-23

Survey was carried during summer and winter season to assess the post harvest losses of vegetables. The losses of chillies and brinjal during winter were comparatively less. The cumulative analysis of data (Table 60) reveals that the maximum loss ranging from 8-20% in retail shop followed by transport (2-8%) and handling 2-5% irrespective of arid vegetables. The losses due to microbial invasion were limited up to 2.5% injured at the time of transit and handling. As far as individual vegetables are concerned, maximum total loss is in case of snapmelon ranging from 24-32%, followed by brinjal (20-25.5), *mateera* (14.5-19) and *kachri* (13-8). The minimum loss was observed in tinda (10.8-14.2). Among the methods the maximum handling losses was found in snapmelon and the transport losses in brinjal and in retail shop it was in snapmelon.

Table 60. Post harvest losses of arid vegetables produced in Bikaner district

Crops	Months	Average arrival/ day (Tones)	Kind of losses (%)				
			Handling	Transport	Retail shop	Pathological	Total
Mateera(Loiya)	May-June	1-1.2	2-3	2-3	10-12	0.5	14.5-19
Mateera	May-June	3-4	3-5	3-4	5-8	2-4	14-23
Snapmelon	July-Aug.	2-3	4-5	4-5	15-20	1-2	24-32
Kachri	July-Aug.	0.8-1.2	4-5	6-8	8-10	2-2.5	20-25.5
Tinda	May-July	0.8-1.3	2-3	3.5-4	4-5	0.5-1	10-13

At CHES, Godhra

A. Aonla:

1. Maturity standard in aonla cultivars.

The specific gravity showed increasing trend in all the cultivars during development. TSS, total and reducing sugar content increased as the fruits reached towards maturity. Titratable acidity increased

during initial period of fruit development then declined. In all the cultivars, vitamin C increased during development and became constant till the fruits attain physiological maturity. It may be concluded that fruits of NA-7 and Banarasi matured by the last week of October. Krishna and Francis matured by first week of November and that of Kanchan and Chakaiya by the last week of November under semi-arid ecosystem of Gujarat.

2 Effect of harvesting dates (tree storage) on fruit quality of Aonla cultivars:

Four cultivars of Aonla i.e. NA-7, Chakaiya, Francis and Banarasi were evaluated for their quality attributes while retaining on the tree itself after maturity. On the basis of one-year data, it was observed that fruits of NA-7 could be retained on the tree up to fifteen days from the date of maturity without causing economic loss due to pre harvest fruit drop. It was also noticed that NA-7 was more prone to pre-harvest fruit drop in comparison to Chakaiya, Banarasi and Francis.

3. Effect of size grading on fruit quality and shelf life of aonla cv. NA-7.

Due to heavy crop load, variability in fruit size of variety NA-7 was observed. Fruits were divided in to 3 grades i.e. A, B and C and accordingly fruit quality attributes and shelf life were assessed during storage. Physiological loss in weight and spoilage loss were less in A grade fruits when compared with B and C grade fruits. A grade fruits also recorded highest amount of vitamin C and it can fetch better price in the market due to better size, appearance and fruit quality.

4. Studies on storage behaviour of Aonla cultivars:

Increase in physiological loss in weight, spoilage percentage, TSS, Total sugar, reducing sugar and decrease in acidity, ascorbic acid with advanvancement of storage period were general phenomena in all the cultivars. Chakaiya and NA-7 were found most efficient in PLW during storage with least spoilage loss and exhibited 7 days storage life while, Banarasi and Francis could be stored up to 5 days at ambient temperature.

5. Effect of post harvest treatments on storage life of aonla:

Polythene wrapping, GA3 and calcium nitrate were used as post harvest treatments for enhancing shelf life of NA-7 Chakaiya, Banarasi and Francis cultivars of aonla during storage. Studies revealed that fruits treated with 1.5% Calcium nitrate and kept in perforated polythene bag had maximum shelf life (NA-7 and Chakaiya 11 days, Francis and Banarasi 9 days) during storage.

(B) Ber:

1. Studies on storage behaviour of ber cultivars:

An experiment on storage behaviour of five cultivars of ber i.e. Gola, Goma Kirti, Umran,Seb and

Mundia was conducted under ambient conditions. Umran recorded minimum PLW (23.00) on last day of storage (9th day), which was closely followed by Gomakirti (24.00%). Maximum PLW and spoilage loss were observed in variety Gola on 9th day of storage (29.00%), T.S.S. and total sugar content were found to be maximum in Umran during storage, it was at par with Goma Kirti. In view of PLW, spoilage loss and fruit quality attributes, Gola and Goma Kirti can be stored under ambient condition up to 3 and 5 days respectively without causing economic loss due to spoilage.

2. Effect of post harvest treatments on shelf life of ber cultivars:

Calcium nitrate and perforated polythene bag alone and in combinations were used for enhancing the shelf life of Gola and Goma Kirti cultivars of ber under ambient conditions. Goma Kirti and Gola fruits treated with calcium nitrate 1.5% and kept in perforated polythene bag showed least PLW and spoilage loss and retained maximum T.S.S., Sugars and Vitamin C content up to last day of storage in both the cultivars. In view of the spoilage loss and fruit quality attributes Gola and Goma Kirti can be stored up to 5 and 9 days respectively without causing economic loss due to spoilage.

Agricultural extension

At CIAH, Bikaner

A. Extension Research Activities

Extension research project entitled as (i) a study on horticultural development in IGNP area of Bikaner district, Rajasthan and (ii) Assessment of arid horticutlural status in Bikaner district of Rajsthan were initiated and the survey was conducted. The preliminary information/data of the survey so far conducted revealed that in irrigated area, 32% farmers grow mateera, snapmelon, kachari; 18% farmers grow brinjal, bottlegourd; 14% farmers grow ber and aonla on their fields as sole crops during the kharif season. In irrigated conditions, 26% farmers grow either clusterbean or mateera or snapmelon or kachari as intercrop in ber and aonla orchards during kharif season while during rabi season (irrigated conditions), cumin/pea/green fodder/mustard/cauliflower is grown by 9% farmers as intercrop in ber and aonla orchards. In mixed cropping system, pearl millet, clusterbean, mateera, snapmelon, kachari, seasemum, mothbean etc. are grwon in different combinations during the kharif season in rainfed conditions.

The farmers have adopted some of the improved varieties of ber (seo, gola, umran), aonla (Na-7, NA-6), mateera (AHW-65, AHW-19), snapmelon (AHS-10, AHS-82), kachari (AHK-119, AHK-200). Overall (both in irrigated and rainfed areas) 22, 12.5, 45, 56 and 30 percent farmer grow ber, aonla, mateera, snapmelon and kachari respecively, and 18 per cent farmers grow brinjal, bottlegourd, tinda during kharif season while 30 per cent farmers grow brinjal, cauliflower, cabbage, spinach, carrot, redish etc. at small scale during the rabi seson in irrigated conditions.

The poverty; low income; high cost of inputs; lack of credit and subsidy facilities, poor communication and transportation facilities; lack of reliable source of information, seeds, planting materials; poor linkage between research centres and farmers; lack of farmer's training; lack of location specific technologies; poor and erratic rainfall; water scarcity; high and low temperature; frequent drought; hot and high wind velocity; salty ground water etc. are the major constraint which hinder the development of arid horticulture.

B. Extension activities

(a) Farmer's visit to the institute farm

About 780 farmers from various villages of Bikaner district and other districts of Rajasthan were visited the institute's experimental blocks and farm. The major purpose to bring these farmers to the institute was to impart the knowledge amongst them about the new arid horticultural technologies developed/improved by the institute.

(b) Farmers's field visit

During the year, various visits were made to the farmer's field in different villages of Bikaner district. About 225 farmers, who grow or want to grow the horticultural crops were contacted personally. These farmers were interviewed to know about their felt need, desire, cropping system and problems faced by them in adopting horticultural technologies etc.

The technical guidances and solutions were provided to the farmers to remove the hurdles faced by them in growing horticultural crops.

(c) Popularization of the technologies available in the Institute

The arid horticultural technologies developed by the institute and other technologies available in the institute were popularized amongst the farmers through personal contact and mass media.

(d) Training programmes and group discussion

During the year, farmer's training programmes and group discussion were arranged on theam like, "Arid horticulture and water stress; arid vegetable production" etc. The various farmers from different locations of the Bikaner district participated in these programmes. They were benefited through these training and group discussion programmes with respect to arid horticultural technological knowledge gain.

(e) Kisan Diwas/Field Day

On 23rd December, 2003, a "Kisan Diwas" was organized on the eve of birth centenery of late Choudhary Charan Singh, former Prime Minister of India. About 250 farmers participated in this programme came from different districts of Rajasthan. A attractive exhibition related to arid horticultural technologies was arranged to increase the knowledge of the farmers about these technologies. The farmers were visited to the experimental blocks and laboratories of the istitute. Special lectures pertaining to arid horticultural technologies were delivered for the farmers. The questions related to the farmers problem were answered during question-answer session. The feed back of local leaders and farmers were viewed and recorded.

Ten farmers of the region were felicitated for promotion of arid horticulture in the locality. They were not only growing arid horticultural crops by adopting recent technologies but also set an example for the neighbouring farmers. All the ten farmers were felicitated by the chief guest by giving them a 'Sal' and a certificate in their honour. Besides them, three farmers were also awarded by presenting them as consolation prizes for their diversified farming practices and display of their produces in the exhibition.

(f) Organizing National Science Day

National science day was organized and celebrated in the institute on 28th February, 2003. Since the students are young educated farmers and they are good media for the disseminating the new

technologies to the users. Therefore, 58 students and teachers were brought to the institute from different schools of Bikaner city and they were exposed to different new technologies of arid horticulture on the occasion of National Science Day. They were visited to experimental blocks, research laboratories, exhibition and lession were also dilivered for them.

At CHES, Godhra

Communication Challenges of Horticultural Extension in India

The communication challenges in horticultural extension in India as perceived by the extension scientists of India were studied. Factors associated with their contribution like publication of research papers; research motivation by competent authority; access to communication channels; organizational support were quantified. The study was conducted in India during 2002 2003. Extension scientists of India were the respondents. The research design used was *ex-post facto.* The research tool was mailed questionnaire. A mailed questionnaire was designed and sent by post to the selected 200 extension scientists all over India during 18-29, May 2002. A time frame of six months was allotted to receive the filled in questionnaire. The researcher received 75 questionnaires by post. During screening, 15 questionnaires were rejected. Finally, 60 extension scientists were selected for analysis, which formed the sample of this study. Thus, the response to mailed questionnaire was 30 per cent. The data were analyzed in computer with MS excel and statistical package *Microsta*. The statistical tools used were frequency, per cent, mean, standard deviation, and multiple correlation.

Intensity of Communication Challenges in Horticultural Extension

The extension scientists perceived the challenge, 'after GATT agreement and formation of WTO, the market is thrown open to unrestricted import of horticultural produces from all over the world. ICTs have to be of international standard like instant messaging, teleconferencing, satellite extension, mobile phones, *etc.,* to compete with the competitive global market', as most important. The challenge, 'since most of the horticultural technologies require heavy capital investment and takes much time for break even and much more time to realize profits, it is essential to conduct a combination of extension methods like campaign, training, farm visits *etc.,* to adopt', ranked second. Further, the scientists felt, the challenge, 'completion of result demonstration will take at least 5 to 10 years because convincing the farmers to adopt horticultural technologies like yield performance of improved fruit crop varieties will take at least 5 to 8 years to get economic marketable yield', as the third important challenge.

Research Publication

Extension scientists of India published 1.77 research papers per year of extension experience in extension; 0.2116 research papers in horticultural extension; 0.45 research papers in communication; and 0.11 research papers in horticultural extension communication. Majority of the scientists (65 per

cent) published less than 2 research papers/year in extension. In horticultural extension, the publication was less than 0.2 research papers/year by majority of the scientists (68.33 per cent). In communication, majority of the scientists (46.67 per cent) published more than 0.4 research papers/year. Majority of the scientists (68.33 per cent) published less than 0.1 research paper/year in horticultural extension communication.

Research Motivation by Competent Authority

The competent authority is encouraging all activities pertaining to communication research *viz.* sanctioning of research projects, allotting facilities, approval to send research papers for publication in journals, permitting to participate in seminars, considering research papers for promotion, and providing financial support.

Access to Communication Channels

Majority of the extension scientists are having access to all communication channels. Majority of the scientists have access to only one journal each of international, national and state level. Regarding subscription, it is mostly institutional, whereas personal subscription was high in case of national and state level extension journals.

Technical Manpower

Majority of the scientists (60 per cent) do not have technical assistants. Among those who have, 37.50 per cent has only one technical assistant. Majority of the technical assistants (75 per cent) are postgraduates. Majority of the technical assistants have 6 to 10 years of experience. Majority of the extension scientists perceived that the technical assistants are good in survey, conducting result demonstration, operation & maintenance of extension aids (like projectors), organizing extension activities (like field day, exhibition, etc.), report preparation, extension publication and average in analysis. Among all the activities, competency level was highest in organizing extension activities like field day, exhibition *etc.* Survey and conducting result demonstration are ranked second and third respectively.

Availability of vehicles

Majority of the extension scientists have Jeep. However, 38.33 per cent of extension scientists do not have any vehicles.

Availability of Traveling Allowance / Dearness Allowance

Fifty per cent of extension scientists felt that funds allotted for traveling allowance / dearness allowance are inadequate. Majority of the extension scientists expressed that they do not get traveling allowance in advance; settlement of bills are delayed; and traveling allowance amount is not enough.

Extension aids

Majority of the extension scientists have extension aids like over head projector, slide projector, public address system, video cassette player, motion picture projector and desk top computer. However, availability of modern electronic aids like lap top computer, DVD/VCD/MP3 player, internet, and LCD (multimedia) projector, is low.

Time Spent on Non Extension Works

Majority of the extension scientists perform less than 25 per cent of time in each activity *viz.* administration, farm management, teaching, incharge of other divisions. On an average, each extension scientist is spending 63.72 per cent of time on non extension works. Every extension scientist is spending 32.30 per cent of time in teaching, 23.33 per cent of time in administration, 4.92 per cent of time in incharge of other divisions, and 3.17 per cent of time in farm management.

Personal & Communication Characteristics of Extension Scientists

Majority of the extension scientists belong to the age group of 40 to 50 years, holding position of senior scientist, possess Ph.D, posses telephone, and fax facilities. However, majority of the extension scientists do not have Internet and email ID.

Correlation matrix of selected variables

Communication challenge and access to communication channels are positively and significantly associated. Designation, extension experience, total experience, vehicle, age, and research motivation are positively and significantly associated with publication of research papers.

II. Adoption Constraints of *Aonla* Cultivation Technology

A study was conducted to assess the adoption constraints of *aonla* cultivation technology, (as perceived by the *aonla* growers) by interviewing thirty randomly selected *aonla* farmers of Panchmahals and Vadodara districts of Gujarat during January - March 2001. Response of the farmers was sought against the open ended question to list the constraints faced by him in adopting the *aonla* cultivation technology. The extension constraint, 'no technical guidance' was the most important constraint faced by the *aonla* growers. The resource constraint, 'no irrigation facility' was the second major constraint. The supply constraint, 'non availability of genuine budded plants' was the third important constraint. The production constraint, 'mortality of budded plants' was the fourth constraint. The social constraint, 'grazing of plants by animals' ranked fifth.

B. Frontline extension activities

Farm visit: During the period under report, 603 persons visited the station farm. Out of them, 428 were farmers, 103 farm women, 10 students, 60 officers, and 2 VIPs. Visitors were around the

station farm, explained the technologies generated, ongoing research projects, demonstrated propagation techniques of fruit crops and provided supplementary literature published by the station.

Training programme: Delivered a lecture on '*Aonla ki kheti*' (Cultivation of *Aonla)* to farm women trainees at Farmers' training Centre, Dahod, Govt. of Gujarat, for specialized training programme in horticulture on 24.07.2002.

Kisan diwas: Participated in '*Kisan diwas*' organized and held at C.I.A.H., Bikaner, Rajasthan on 23.12.2002. Exhibited the fruit samples, vegetables, seeds, photographs, charts, *etc.*

Exhibition: On 16.03.2003 attended the inauguration function of N.S.S. programme of G.A.U., at Goda village, Kalol taluka, Panchmahals district, Gujarat, as a participant. Exhibited the fruit samples, vegetables, seeds, photographs, charts, *etc.*

Village adoption programme: Ber demonstration trials at Dageria village, Jalod taluka, Dahod district, Gujarat yielded good crop. Regular follow up was made.

Externally funded projects

A. National Agricultural Technology Project

Project 1. Collection, evaluation and maintenance of arid horticultural crops under NATP on sustainable management of plant bio-diversity

(B.B.Vashishtha, D.K.Samadia and R.C. Aswani)

Objectives: To survey, collect, evaluate, multiply and maintain the plant bio-diversity of arid zone fruits and vegetables.

Lead centre	:	NBPGR, New Delhi
Cooperating centre	:	CIAH, Bikaner
Year of start	:	July 1999
Total budget allocation	:	Rs. 16,20,300/

Central Institute for arid Horticulture (CIAH), Bikaner is co-operating centre under NATP on plant bio-diversity for collection, evaluation and maintenance of arid horticultural crops and is also one of the identified National Active Germplasm Site (NAGS) for maintenance, multiplication and conservation of horticultural crops in arid region. Besides this, the institute mandate is to utilize genetic diversity in improvement programme and development of superior genotypes for high quality production under stressed environment. In Pre-NATP era (1994-99), under mission mode approach of NRCAH (now CIAH), this centre has made excellent growth in build up of plant genetic resources and its utilization particularly in arid zone fruits and vegetables. As a result of massive germplasm collection and augmentation programme (1994 to 99), this centre has developed *ex situ* field repository of *ber* (300), pomegranate (150), date palm (47), *aonla* (19), *bael* (5) and *lasora* (2) where as in vegetable a collection of 193 in watermelon (*mateera*), 558 of *kachri*, 90 of snapmelon and 132 of chilli and now this work is continuing under NATP.

During last three years (July 1999 March 2003), explorations were undertaken for survey, identification and collection of horticultural plant bio-diversity from parts of arid, semi-arid and sub humid regions of Rajasthan and Gujarat and resulted in identification of elite trees in arid fruits and a good number of collections have been made in *ber, Ziziphus mauritina* (19), *aonla, Emblica officinalis* (26), *bael, Aegle marmeolus* (7), *ker, Capparis* decidua (64), *lasora, Cordia myxa* (65), date palm, *Phoenix dactylifera* (46), muskmelon, *Cucumis melo* (55), bottlegourd, *Lagineria siceraria* (18), spongegourd, *Luffa cylindrica* (15), ridgegourd, *Luffa acutangula* (19) and chilli, *Capsicum annuum* (52). Beside, evaluation of a large number of germplasm in vegetable crops either collected by the CIAH

or received from co-operating centers of arid region under NATP on plant bio-diversity for characterization of germplasm and multiplication of seeds in sufficient quantities for the conservation in National Gene Bank at NBPGR, New Delhi (Table 61-63).

Table 61. Explorations for the survey and collection of germplasm under NATP

Crop	Areas explored	Collections	Associated scientist &++
Ber	i) Parts of Rajasthan and Gujarat	15	D.K. Samadia / Anil Shukla
	ii) Parts of Andaman	04	B.B. Vashishtha / D.B. Singh
Aonla	i) Parts of Rajasthan and Gujarat	05	D.K. Samadia / Anil Shukla
	ii) Parts of Himachal Pradesh	09	Arun Shukla
Ker	i) Arid and semi-arid areas of Rajasthan	64	D.K. Samadia
Lasora	i) Arid and semi-arid areas of Rajasthan	65	D.K. Samadia
Bael	i) Parts of Andamans	07	B.B.V ashishtha / D.B. Singh
Date palm	i) Kachchh region of Gujarat	46	R.S. Singh / D.K. Samadia
Muskmelon	Arid, semi-arid and sub-humid areas of Raj.asthan	55	D.K. Samadia
Chilli	Arid, semi-arid and sub-humid areas of Rajasthan and Gujarat	52	D.K. Samadia
Gourd cucurbits	Arid, semi-arid and sub-humid areas of Rajasthan and Gujarat	60	D.K. Samadia

++ Dr. R. C. Aswani. Research Associate of the project.

Table 62. Germplasm deposited for long-term conservation at NBPGR by CIAH

Crop	Year	Accessions	Status & Source Material
Kachri	2002	510	Re-evaluated Pre-NATP CIAH germplasm
Muskmelon	2001	55	Evaluated CIAH- NATP material
Chilli	2002	132	Evaluated Pre-NATP CIAH material
Indian bean	2002	10	Characterized CIAH material
Watermelon	2002	13	Characterized at CIAH (NATP material NBPGR, RS Jodhpur)
Roundmelon	2002	14	Characterized at CIAH (NATP material of NBPGR, RS Jodhpur)
Longmelon	2002	15	Characterized at CIAH (NATP material NBPGR, RS Jodhpur)
Chilli	2003	70	Characterized at CIAH (NATP material of CIAH & GAU)
Tomato	2003	14	Characterized at CIAH (NATP material of GAU, Vejapur)
Brinjal	2003	25	Characterized at CIAH (NATP material of CIAH & GAU)
Indian bean	2003	20	Characterized at CIAH (NATP material of GAU, Vejapur)

Table 63. Characterization and multiplication of germplasm under NATP at CIAH

Crops	Accessions	Source of material for Characterization
Minor cucurbits		
Cucumis callosus	33	NBPGR, Regional station; Jodhpur
C. melo var. *agrestis*	12	NBPGR, Regional station; Jodhpur
C. melo var. momordica	12	NBPGR, Regional station; Jodhpur
C. sativus	04	NBPGR, Regional station; Jodhpur
C. prophaterum	02	NBPGR, Regional station; Jodhpur
C. trigonus	01	NBPGR, Regional station; Jodhpur
C. hardwickii	11	NBPGR, Regional station; Jodhpur
Luffa hermophodita	01	NBPGR, Regional station; Jodhpur
Major cucurbits		
Cucumis melo	55	CIAH, Bikaner
C. melo var. *utilissimus*	15	NBPGR, Regional station; Jodhpur
Citrullus lanatus	13	NBPGR, Regional station; Jodhpur
Praecitrullus fistullosus	14	NBPGR, Regional station; Jodhpur
Solanaceous		
Capsicum annuum	52+18=70	CIAH, Bikaner and GAU, Vejapur
Lycopersicon esculentum	14	GAU, Vejapur
Solanum melongena	05+21=26	CIAH, Bikaner and GAU, Vejapur
Legumes		
Lablab purpureus (Sem)	18+20=38	CIAH, Bikaner and GAU, Vejapur

A: Explorations for the survey, identification and collection of germplasm

a) Collection of *aonla* from parts of Himachal Pradesh (Dr. Arun Kumar Shukla)

An exploration for the identification and collection of frost tolerate types in *aonla* was under taken during December 2001 and twelve promising genotypes were identified from parts of Shimla and Solan district in Himachal Pradesh. In this trip bud sticks of elite *aonla* trees were collected in August 2002 and top worked on existing seedlings in *aonla* field repository for evaluation and characterization at CIAH, Bikaner.

b) Exploration for the survey, identification and collection of *aonla* from parts of Rajasthan (Dr. Arun Kumar Shukla)

This exploration was undertaken during December 2002 in the semi arid areas of Rajasthan

covering Jaipur and Ajmer districts, where seedling *aonla* exist in natural form. A total of nine elite *aonla* seedling trees have been identified possessing desirable fruit quality and yield contributing characters (Table -64). Of these, one elite seedling in Pushkar valley bears big sized fruits in cluster and is heavy bearer. Further, bud-wood of identified trees will be collected during July 2003.

Table 64. Variability in identified seedling *aonla* germplasm under NATP.

Character	Range		Promising elite tree AKS/CIAH/EO 24
	Minimum	Maximum	
Fruit length (cm)	2.27	3.15	3.15
Fruit diameter (cm)	2.32	3.65	3.65
Fruit weight (g)	10.4	28.8	28.8
Stone weight (g)	1.12	2.27	2.19
Pulp weight (g)	9.28	26.61	26.61
Juice (%)	52.0	66.8	62.7
Acidity (%)	1.60	2.69	2.15
TSS (^{0}Brix)	17.1	27.0	18.3

c) Exploration for the survey and collection of gourd cucurbits from parts of Rajasthan and Gujarat (Dr. D. K. Samadia)

This exploration was undertaken during November 2002 for the collection of cucurbit vegetables in particular to the gourds from tribal areas of Rajasthan and Gujarat. Total 60 collections of various cucurbits were made from arid, semi arid and sub humid parts of Ajmer, Bhilwara, Chittorgarh, Banswara, Dungarpur, Udaipur, Sirohi, Rajsamand, Pali and Jodhpur in Rajasthan and Jalod, Dahod, Godhra, Baria, Piplod and Lunawada of Gujarat. The collections comprised of bottlegourd (18), ridgegourd (19), spongegourd (15), bittergourd (3), pumpkin (4) and cucumber (1). A wide spectrum of diversity was explored (Table-65) and collected in the form of composite seed samples. A number of observations were recorded for the crop growth behaviour, production aspects and fruit quality and seed parameters. Further, these collections will be evaluated in *kharif* season of 2003 at CIAH, Bikaner for the characterization and multiplication for conservation of germplasm.

Table 65. Agro-morphological characters observed in collected cucurbitaceous germplasm

CROP/CHARACTERS	Range value
Bottlegourd [*Lagenaria siceraria* (Molina) Standely]	
Fruit shape	Long, round, oblong, pyrifom, club shaped
Fruit colour	Light green, green, dark green, mottled green
Seed colour	White brown. brown. dark brown
Mature fruit length	46 - 85 cm
Seed length	1.15 - 1.92 cm
Seed width	0.445 - 0.815 cm
Test weight (100 seeds)	11.54 - 22.85 g
Number of seeds per fruit	165 - 683
Spongegourd [*Luffa cylindrica* Roem]	
Fruit shape	Straight long. Necked long, elliptical, oblong
Fruit colour	Dark green, light green, whitish green
Seed colour	Black, white, brown / dull, glossy
Mature fruit length	10.5 - 39.8 cm
Seed length	0.85 - 1.25 cm
Seed width	0.551 - 0.732 cm
Test weight (100 seeds)	7.754 - 12.124 g
Number of seeds per fruit	65 - 523
Ridgegourd [*Luffa acutangula* and *hermaphrodita*]	
Fruit shape	Long cylindrical, spindle, elliptical, club
Fruit colour	Light green, green, dark green
Seed colour	Black, brown black, dark black/ glossy, dull
Mature fruit length	6.0 - 95 cm
Seed length	0.75 - 1.25 cm
Seed width	0.41 - 0.85 cm
Test weight (100 seeds)	7.412 - 16.624 g
Number of seeds per fruit	29 - 299
Bittergourd [*Momordica charantia*]	
Fruit shape	Spindle, elliptical, long
Fruit colour	Dark green, green, whitish green,
Mature fruit length	11.45 - 28.54 cm
Seed length	1.02 - 1.35 cm
Seed width	0.51 - 0.92 cm
Test weight (100 seeds)	8.542 - 20.812 g
Pumpkin [*Cucurbita moschata / maxima*]	
Fruit shape	Globular, flattened, disk, oblong, pyriform
Mature fruit colour	Creamish, yellowish, greenish, saffron
Mature fruit weight	1.15 - 28.5 kg
Mature fruit length	15.5 - 55.8 cm
Seed length	1.62 - 2.11 cm
Seed width	0.74 - 1.25 cm
Test weight (100 seeds)	8.142 - 17.245 g

B: Characterization and multiplication of seeds for germplasm conservation

(Arid Vegetable Crops : Dr. D. K Samadia and R. C. Aswani)

a) Watermelon (*Citrullus lanatus*)

Thirteen watermelon accessions collected by NPBGR, RS, Jodhpur from parts of arid and semi arid areas of Rajasthan under NATP on plant bio-diversity were received at CIAH, Bikaner for the evaluation, characterization and multiplication of the collected material as a co-operating center. During the summer season 2002, these 13 accessions along with five checks were evaluated at CIAH, Bikaner and detailed observations were recorded on growth, flowering, fruiting, maturity, and fruit yield and quality components. Detailed observations were compiled to characterize and categorized the germplasm under hot arid climate. A set of multiplied seeds of 13 accession of watermelon has been deposited for the long-term conservation in the National Gene Bank at NBPGR, New Delhi.

The analysis of variance for 18 quantitative characters revealed that mean squares were highly significant for all the characters indicating enough variability in the material tested. Mean, range and genetic variability components are presented in the Table 66. Genotypic co-efficient of variation study reveals that there is ample scope for the improvement of this crop. Marketable fruits yield per plant exhibits a high GCV estimate followed by fruits/plant, seeds/fruit fruit weight and weight of 100 seeds. A close correspondence between GCV and PCV values in respect of all the characters indicate that environment has very little influence on the expression of the characters. Genetic advance as percentage of mean in the present study ranged from 23.22 to 175.53 percent.

b) Longmelon (*Cucumis melo* var. *utilissimus*)

Fifteen longmelon accessions collected by NPBGR, RS, Jodhpur from parts of semi arid areas of Rajasthan under NATP on plant bio-diversity were received at CIAH, Bikaner for the evaluation, characterization and multiplication of the collected material as a co-operating center. During the summer season 2002, these 15 accessions along with two checks were evaluated at CIAH, Bikaner and detailed observations were recorded on growth, flowering, fruiting, maturity, and fruit yield and quality components. Detailed observations were compiled to characterize and categorized the germplasm under hot arid climate. A set of multiplied seeds of 15 accession of longmelon has been deposited for the long-term conservation in the National Gene Bank at NBPGR, New Delhi.

The analysis of variance for the fourteen characters revealed that there is ample variability in respect to all the characters studies. The range, mean and components of genetic variability estimates are presented in Table 67. In general, PCV estimates were of high magnitude than the GCV but the differences were of low level for all the characters, which indicate that the minimal influence of environment on the expression of the characters. High estimates of GCV were recorded in fruits per plant followed by node to male flower appearance and fruit yield per plant.

Table 66. Genetic diversity component in *Citrullus lanatus* germplasm

Characters	Range		Mean	SE	SD	ECV (%)	GCV (%)	PCV (%)	GA as percent of mean (5 %SI) (%)
	Minimum	Maximum							
Days to male flower (DAS)	34.02	54.17	44.48	0.26	5.18	1.03	11.80	11.82	24.28
Node to male flower	3.12	10.21	5.53	0.06	1.47	2.11	26.95	26.98	55.47
Days to female flower (DAS)	43.77	67.23	52.90	0.37	5.95	1.21	11.36	11.38	23.37
Node to female flower	6.05	21.34	12.13	0.16	3.40	2.28	28.38	28.41	58.41
Days to first harvest (DAS)	76.02	114.65	88.87	0.40	9.88	0.78	11.28	11.29	23.22
Marketable fruits/plant	1.03	5.45	1.90	0.03	1.30	3.06	69.67	69.69	143.47
Fruit yield/plant	0.996	17.52	6.29	0.14	5.28	3.87	85.24	85.27	175.53
Fruit weight (kg)	0.786	6.81	3.10	0.03	1.46	1.98	47.89	47.91	98.64
Fruit length (cm)	16.11	44.50	26.69	0.26	6.69	1.73	25.43	25.45	52.35
Fruit girth (cm)	35.58	70.87	53.94	0.44	8.77	1.42	16.47	16.49	33.89
Edible flesh thickness (cm)	8.15	17.68	13.79	0.13	2.08	1.74	15.26	15.30	31.38
Non edible flesh thickness (cm)	0.74	2.78	1.75	0.02	0.49	2.55	28.61	28.65	58.87
TSS (°Brix)	5.14	10.92	8.32	0.09	1.46	1.99	17.77	17.81	36.55
Vine length	2.50	4.48	3.08	0.05	0.50	2.96	16.30	16.39	33.39
Branches/plant	4.05	6.27	5.05	0.06	0.69	2.12	13.77	13.83	28.27
Seeds/fruit	63.32	418.55	201.90	1.48	103.81	1.27	52.24	52.25	107.62
Weight of 100 seeds (g)	2.30	12.10	6.26	0.02	2.31	0.61	37.510	37.512	77.27
Seed length (cm)	0.72	1.35	1.04	0.01	0.17	1.66	17.26	17.29	35.51
Seed width (cm)	0.43	0.85	0.63	0.003	0.11	0.93	17.96	17.97	36.98

Table 67. Genetic diversity components in *kakdi* germplasm

Characters	Range		Mean	CD	GCV	PCV	Promising genotypes	
	Minimum	Maximum		(5%)	(%)	(%)	DPY-162	AHC-2
Days to male flower (DAS)	32.51	47.15	38.50	1.04	11.08	11.13	34.55	32.51
Node to male flower	2.23	6.25	3.50	0.07	31.49	31.51	2.41	2.40
Days to female flower (DAS)	40.70	54.80	46.89	0.81	7.80	7.82	42.33	40.70
Node to female flower	3.50	7.47	5.03	0.17	24.58	24.61	4.23	3.51
Days to first harvest (DAS)	53.17	66.18	59.82	1.01	7.12	7.14	55.18	53.17
Fruit weight (g)	129.65	271.76	185.50	4.14	27.43	27.44	138.78	271.76
Fruit length (cm)	22.66	39.55	27.31	0.92	15.89	15.93	26.69	27.86
Fruit diameter (cm)	1.93	3.53	2.95	0.20	15.98	16.16	2.41	3.20
Fruits/plant	5.25	17.91	10.83	0.65	37.60	37.75	17.91	11.97
Fruit yield/plant (kg)	1.16	3.27	1.83	0.12	31.07	31.16	2.53	3.26
Flesh thickness (cm)	0.61	1.28	0.89	0.05	26.13	26.22	0.65	1.13
Seed cavity (cm)	1.14	2.18	1.66	0.10	22.88	22.99	1.52	1.91
Vine length (m)	1.91	3.36	2.5	0.13	15.01	15.12	2.67	2.72
Branches/plant	4.41	6.47	5.78	0.25	10.23	10.34	6.27	6.20

c) Roundmelon, *Tinda* or Indian squash (*Praecitrullus fistulosus*)

Fourteen roundmelon accessions collected by NPBGR, RS, Jodhpur from parts of arid and semi arid areas of Rajasthan under NATP on plant bio-diversity were received at CIAH, Bikaner for the evaluation, characterization and multiplication of the collected material as a co-operating center. During the summer season 2002, these 14 accessions along with checks were evaluated at CIAH, Bikaner and detailed observations were recorded on growth, flowering, fruiting, maturity, and fruit yield and quality components. Detailed observations were compiled to characterize and categorized the germplasm under hot arid climate. A set of multiplied seeds of 14 accession of roundmelon has been deposited for the long-term conservation in the National Gene Bank at NBPGR, New Delhi.

The analysis of variance revealed significance mean squares estimates for all the thirteen quantitative characters indicating sufficient diversity among the genotypes. The range of variation and genetic parameters are presented along with means of two promising genotypes in Table 68. In general, PCV estimates were higher than the GCV for all the characters but the difference were of low magnitude, which indicate that the presence of genetic variability is because of non-interference of environmental factors. The high GCV estimates were recorded in fruits yield per plant and number of fruits per plant where as it is moderate for node to female flower appearance.

Table 68. Genetic diversity components in roundmelon germplasm

Characters	Range		Mean	CD	GCV	PCV	Promising genotypes	
	Minimum	Maximum		(5%)	(%)	(%)	KCM/BKP-1	AHRM-1
Days to male flower (DAS)	30.84	42.36	37.18	0.99	7.36	7.42	37.17	30.84
Node to male flower	2.24	4.08	3.10	0.11	15.32	15.38	2.72	3.16
Days to female flower (DAS)	38.22	48.11	45.22	1.02	5.21	5.27	44.20	38.22
Node to female flower	5.24	13.23	8.68	0.56	27.23	27.32	12.57	5.24
Days to first harvest (DAS)	47.84	64.81	56.45	1.08	6.48	6.51	61.13	47.84
Fruit weight (g)	71.42	137.55	97.31	3.92	20.02	20.07	76.59	99.04
Fruit length (cm)	4.18	6.14	5.16	0.13	13.03	13.06	5.06	6.14
Fruit girth (cm)	14.45	21.47	17.13	0.78	10.98	11.18	20.56	17.54
Fruits/plant	5.23	19.61	9.38	0.40	39.84	39.87	10.81	19.61
Fruit yield/plant (kg)	0.483	1.91	0.892	0.03	44.27	44.29	0.788	1.910
Vine length (m)	1.37	2.36	1.70	0.13	19.10	19.34	2.12	2.19
Branches/plant	4.25	8.15	6.33	0.11	18.73	18.74	7.40	6.51
Seeds/fruit	37.44	86.38	57.17	1.27	24.11	24.13	86.44	54.65

d) Chilli (*Capsicum annuum* L.)

Fifty two chilli accessions collected from parts of arid, semi arid and sub hunid areas of Rajasthan and Gujarat during December 2001 under NATP on plant bio-diversity by CIAH were evaluated along with three checks at Bikaner in the *kharif* season 2002. Like-wise, eighteen chilli accessions received from GAU, Vejapur (co-operating center, NATP on plant bio-diversity) collected from villages of Ahemdabad, Patan, Mehsana, Sabarkantha, Banaskantha, Rajkot, Panchmahal, Dahod, Vadodara and Kuchchh districts of Gujarat were also evaluated at this center for the characterization and multiplication of the germplasm. Therefore, a total of 73 chilli genotypes were evaluated under hot climatic conditions for recording observations on vegetative growth, flowering and fruiting behaviors, fruit yield and quality contributing components, seed characters, incidence of diseases and temperature affects. Detailed observations have been compiled to characterize and categorized the available chilli genetic diversity in arid, semi arid and sub humid parts of Rajasthan and Gujarat. A set of multiplied seed material of 70 accessions has been deposited in National Gene Bank at NBPGR, New Delhi for long-term conservation.

Evaluation of the germplasm revealed that, in general, there are well known pockets/areas where some typical types of landraces or local cultivars of chilli are still being cultivated and maintained by the growers owing to its peculiar quality and market demand (Table 69). Due to one or more production factors, the yield potential of these landraces is low and even then its cultivation is continue. These are, Mathania type chilli in Jodhpur, Nagour and Jalore; Mahaverji local in Karoli and Swaimadhopur; Patodi

and Reshmi in Tejara (Alwar) and Tonk local in Tonk districts of Rajasthan. Besides, there are very peculiar types or land races locally known as *desi* of the particular areas have distinct quality components and liked by a group of community. In tribal areas, still farmers are being maintaining the local landraces for their domestic purposes and possessing unique fruit quality, small sized and high in pungency. By considering fruit quality and market demand, the local land races/types of Mathania, Mahaveerji, Tejara (Alwar) and Tonk may be further exploited to develop uniform fruit producing genotypes with consistence yield potential. Besides, there is need for quality disease free seed of these types on regular basis irrespective of the areas of cultivation.

The analysis of variance for nine important quantitative characters revealed that the mean squares were highly significant for all the characters indicating considerable variability in the material. The estimates of mean, range and genetic variability are presented in the Table 70. Genotype coefficient of variation study revealed that the ample scope for the improvement in chilli. Fruit yield per plant exhibits a high GCV estimates followed by number of fruits/plant, fruit weight, number of seeds/fruit, fruit length and fruit diameter. A very close value of GCV and PCV estimates in respect of all characters indicate that environment has very little influence on the expression of the characters. Genetic advance as percentage of mean in the present study ranged from 13.47-185.64 percent.

e) Tomato (*Lycopersicon esculentum*)

Fourteen tomato accessions received from GAU, Vejapur (co-operating center, NATP on plant bio-diversity) collected from villages of Ahemdabad, Patan, Mehsana, Sabarkantha, Banaskantha, Rajkot, Panchmahal, Dahod, Vadodara and Kuchchh districts of Gujarat were evaluated at CIAH, Bikaner for the characterization and multiplication of the germplasm. Therefore, these 14 tomato accessions along with one check was evaluated at Bikaner as a *kharif* season crop of 2002-03 under hot climatic conditions for recording observations on vegetative growth, flowering and fruiting behaviors, fruit yield and quality contributing components, seed characters, incidence of diseases and temperature affects. Detailed observations have been compiled to characterize and categorized the land races of tomato available in arid, semi arid and sub humid parts of Gujarat. A set of multiplied seed material of 14 accessions of tomato has been deposited in National Gene Bank at NBPGR, New Delhi for long-term conservation.

Analysis of variance indicates that 15 land races of tomato differ significantly for all the quantitative characters under study. The estimates of mean, range, component of genetic variability and *per se* performance of two promising types are presented in Table 71. The PCV values, in general, were of high magnitude in correspondence to respective GCV estimates but the difference was very low magnitude indicating least influences of non-genetic factors on the expression of the characters. High GCV estimates were recorded for fruit weight followed by number of fruits/plant, fruit yield/plant and fruits/cluster. On the basis of fruit quality, earliness and yield, the genotypes KSB-29 and KSB-76 have been found promising under hot arid conditions.

Table 69. Average characteristics of some chilli land races/types available/grown in parts of Rajasthan and Gujarat.

Name of landraces/ types//Farmer's cultivar	Areas of cultivation	Plant Height (cm)	Fruit /plant	Fruit yield /plant (g)	Fruit weight (green) (g)	Fruit length (cm)	Fruit diameter (cm)	Seeds /furit	Fruit characters
Desi Type	Udaipur, Ajmer, Sikar	46.5	22.4	606.7	27.58	15.52	2.82	140.5	Fruit long, broad at upper and tapered at lower end, flestry thick wrinkled, dark-green, glossy and mild mild in pungency
Mathania Local	Jodhpur, Nagour, Jalore	68.2	45.8	968.8	21.53	18.34	1.98	122.8	Fruit very long, broad at upper, middle and tapered lower end, flestry, wrinkled, dark-green, glossy and mild in pungency
Haripur-Raipur Type	Jodhpur, Nagour Jalore, Ajmer	65.4	49.5	605.5	12.24	17.12	1.25	166.4	Fruit very long, slender, tapered, light green, glossy high in pungency
Mehsana Type	Jodhpur, Nagour Jalore	65.5	40.2	453.6	11.34	14.58	1.32	155.5	Fruit slender, tapered, green, dull and high in pungency
Mahaverji Local	Karoli, Sawai-Madhopur	62.8	40.5	620.4	15.51	13.53	1.68	95.8	Fruit long, broad at upper end and tapered downward, curved, fleshy, dark green, glossy and high in pungency
Tonk Local	Tonk	62.5	38.8	568.8	14.97	12.12	2.08	115.4	Fruit medium long, Broad base, straight, green, glossy. High in pungency
Desi of Khandar areas	Kota, Jhalawar Bundi	72.5	64.5	612.4	9.57	11.26	1.87	85.2	Fruit long, linear, thin., slender, green, dull, high in pungency
Patodi Type	Alwar (Tijara)	87.6	124.2	514.6	4.15	10.41	0.93	29.4	Fruit medium long, thin, linear, sender, straight, dark green, glossy, high in pungency
Nikhari Type	Alwar (Tijara)	72.5	95.2	631.7	6.65	10.62	1.12	86.6	Fruit medium long, thin, slender, tapered, straight. dark green, glossy, pungent
Kadeda Local	Ajmer	65.1	82.8	378.8	4.62	6.31	1.35	79.5	Fruit small, medium thick, blunt end, light green, dull, high in pungency
Desi of tribal areas (Rajasthan)	Banswara, Dungarpur, Sirohi, Udaipur	70.4	108.4	574.5	5.32	5.63	1.34	62.2	Fruit small, thick, slender, dark green, glossy, straight, high in pungency
Desi of Tribal areas (Gujarat)	Panchmahal, Dahod	65.9	95.5	530.1	5.58	6.21	1.04	56.8	Fruit small, slender, straight, tapered, green, glossy, high in pungency
Wild form	Tribal areas of Rajastha/Gujarat	75.5	155.0	370.0	2.11	2.91	1.15	47.5	Fruit very small, conical shape, yellowish green, dull, extremely pungent.

Table 70. Genetic diversity component in chilli germplasm

Characters	Range		Mean	SD	SE	CV (%)	GCV (%)	PCV (%)	GA as percent of mean (5 %SI) (%)
	Minimum	Maximum							
Days to 50 % flowering (DAT)	42.2	86.1	56.4	7.43	1.23	3.78	12.68	12.86	25.74
Days to green fruits harvest (DAT)	59.2	105.5	79.7	9.14	0.97	2.12	11.29	11.36	23.14
Days to red ripe fruits harvest (DAT)	87.2	130.1	104.1	7.23	1.27	2.11	6.65	6.76	13.47
Fruit weight (g)	2.64	27.82	12.1	6.31	0.10	1.49	52.52	52.53	108.18
Fruit length (cm)	3.19	18.95	9.71	3.82	0.07	1.32	39.47	39.48	81.31
Fruit diameter (cm)	0.64	3.41	1.63	0.52	0.04	4.83	31.81	31.94	65.29
Number of seeds/fruit	15.2	159.2	81.2	33.38	2.63	5.61	40.90	41.03	83.99
Number fruits/plant	3.25	165.2	42.97	28.15	1.19	4.82	65.60	65.66	135.03
Green fruit yield/plant (g)	11.11	2400.2	558.2	502.3	19.43	6.03	90.18	90.25	185.64

Table 71. Genetic diversity components in tomato landraces

Characters	Range		Mean	CD (5%)	GCV (%)	PCV (%)	Promising genotypes	
	Minimum	Maximum					KSB-29	KSB-76
Days to first flower (DAT)	39.7	52.7	45.7	1.65	9.22	9.30	45.37	42.65
Days to 50 % flower (DAT)	52.1	63.9	58.9	1.64	7.05	7.12	55.43	55.69
Days to first harvest (DAT)	102.2	114.8	109.6	3.87	3.09	3.32	111.01	111.76
Fruits/cluster	1.48	4.51	2.45	0.11	41.83	41.86	1.48	2.52
Fruits/plant	24.6	123.9	67.7	4.30	49.83	47.87	43.33	123.98
Fruit weight (g)	19.4	122.4	51.6	3.12	58.01	58.04	122.40	47.53
Fruit length (cm)	3.1	5.2	3.92	0.19	21.12	21.19	5.22	3.86
Fruit diameter (cm)	3.26	6.66	4.64	0.13	22.14	22.16	6.66	4.38
Seeds/fruit	81.9	262.8	172.3	8.86	35.13	35.18	165.79	152.75
Fruit yield/plant (kg)	1.47	5.82	2.85	0.18	48.21	48.25	5.14	5.82
Plant height	62.3	124.8	86.4	4.01	26.36	26.41	86.19	121.43
Branches/plant	5.3	9.4	7.75	0.32	15.51	15.58	8.43	8.26

f) Brinjal (*Solanum melongena*)

Twenty one brinjal accessions received from GAU, Vejapur (co-operating center, NATP on plant bio-diversity) collected from villages of Ahemdabad, Patan, Mehsana, Sabarkantha, Banaskantha, Rajkot, Panchmahal, Dahod, Vadodara and Kuchchh districts of Gujarat and four land races collected from parts of Rajasthan by the institute were evaluated at CIAH, Bikaner for the characterization and multiplication of the germplasm. Therefore, twenty five brinjal accessions along with five checks were evaluated at Bikaner as a *kharif* season crop of 2002-03 under hot climatic conditions for recording observations on vegetative growth, flowering and fruiting behaviors, fruit yield and quality contributing components, seed characters, incidence of diseases and temperature affects. Detailed observations have been compiled to characterize and categorized the land races of brinjal available in arid, semi arid and sub humid parts of Gujarat and also from Rajasthan. A set of multiplied seed material of 25 accessions of brinjal has been deposited in National Gene Bank at NBPGR, New Delhi for long-term conservation.

Analysis of variance indicates that 30 genotypes of brinjal differ significantly for all the characters under study. The estimates of mean, range, SD, GCV and PCV along with means of desirable promising types are presented in Table 72. High values of CV indicate wide range of variation for fruits/plant and fruit weight. The PCV estimates, in general, were higher than GCV but the differences were very low, indicating least influence of environment on the expression of the characters. High GCV estimates were recorded for fruits per plant where as it was moderate for fruit yield per plant, fruit weight and fruit length. On the basis of fruit quality and other desirable traits, the high yielding genotypes viz. AHB-2, KSB-52, KSB-33 and F_2 (AHB 04 x PPC) have been found promising under arid conditions.

Table 72. Genetic diversity components in brinjal germplasm

Characters	Range		Mean	SD	GCV	PCV	Promising genotypes			
	Min.	Maxi.					KSB 33	KSB 52	AHB 2	F_2(AHB 4 x PPC)
Days to harvest (DAT)	47.56	74.65	59.26	7.34	12.13	12.26	58.51	67.32	55.21	55.12
Fruits/plant	38.54	135.24	79.38	25.35	31.98	32.19	119.00	122.78	85.00	132.34
Fruit weight (g)	47.68	145.24	74.36	20.85	28.08	28.17	65.53	65.18	104.9	58.91
Fruit length (cm)	5.67	12.59	8.14	1.86	23.12	23.14	7.44	8.36	6.71	6.67
Fruit diameter (cm)	3.24	6.94	5.44	0.80	14.72	14.80	5.60	4.74	5.81	4.76
Plant height (cm)	48.64	82.24	63.23	6.19	9.17	9.42	79.34	65.35	63.40	62.48
Branches/plant	5.54	10.80	8.04	1.16	13.27	13.72	8.30	10.14	7.19	8.02
Fruit yield/plant (kg)	2.648	8.984	5.586	2.512	28.49	28.56	7.66	7.79	8.69	7.65

g) Indian bean, sem (*Lablab purpureus*)

Indian bean, *Dolichos* bean or *sem* (*Lablab purpureus*) is one of the important drought-tolerating legumes of Indian origin. Twenty five Indian bean accessions received from GAU, Vejapur (Co-operating center, NATP on plant bio-diversity) collected from villages of Ahemdabad, Patan, Mehsana, Sabarkantha, Banaskantha, Rajkot, Panchmahal, Dahod, Vadodara and Kuchchh districts of Gujarat were sown at CIAH, Bikaner for the characterization and multiplication of germplasm. Due to insect's infestation in five accessions resulting to no germination. Therefore, twenty accessions along with three advance lines were evaluated at Bikaner as a rainy-winter season crop of 2002-03 under extremes of temperatures for recording observations on vegetative growth, flowering and fruiting behaviors, fruit yield and quality contributing components, seed characters, incidence of diseases and temperature affects. Detailed observations have been compiled to characterize and categorized the land races of Indian bean available in arid, semi arid and sub humid parts of Gujarat. A set of multiplied seed material of 20 accessions of Indian bean has been deposited in National Gene Bank at NBPGR, New Delhi for long-term conservation.

The analysis of variance for ten characters indicates that there is considerable variation in respect to all the characters studies. The mean, range and genetic component estimates are presented in the Table 73. In general, the PCV estimates were higher than the GCV but the differences were of low magnitude for all the characters, which indicate that the minimum influence of environment in the expression of the characters. Yield per plant exhibits a high GCV followed by pod weight, pod length and pod per plant. Genetic advance as percentage of mean in the present study ranged from 15.02-131.10 percent.

Table 73. Genetic diversity components in Indian bean landraces.

Characters	Range		Mean	SD	ECV (%)	GCV (%)	PCV (%)	GA as percent of mean (5 %SI) (%)
	Minimum	Maximum						
Days to first flower (DAS)	80.25	105.30	92.87	6.72	0.81	7.30	7.32	15.02
Days to 50 % flower (DAS)	86.45	116.24	102.62	7.76	0.85	7.65	7.67	15.73
Days to first harvest (DAS)	94.35	136.25	118.53	10.10	0.73	8.63	8.64	17.77
Flowers/inflorescence	10.12	23.01	15.20	3.31	3.35	21.88	21.96	44.89
Pods/inflorescence	6.58	15.24	10.01	1.74	4.72	17.04	17.26	34.67
Pods/plant	65.28	265.24	136.21	47.22	1.72	35.22	35.24	72.53
Pod weight (g)	1.08	8.47	3.44	2.16	1.64	63.65	63.66	131.10
Pod length (cm)	4.12	14.61	8.23	3.28	1.45	40.57	40.58	83.56
Pod width (cm)	1.04	2.74	1.68	0.42	2.57	25.48	25.52	52.40
Pod yield/plant (g)	109.21	1436.25	455.37	310.40	0.66	69.34	69.35	142.85

h) Sword bean (*Canavalia gladiata*)

Sword bean (*Canavalia gladiata*) is an under exploited drought hardy perennial leguminous vegetable for nutritive tender pods. In tribal dominating areas of Southern Rajasthan and Northern Gujarat, the peasant tribal farmers are cultivating sword bean for domestic uses and also to earn some family contingencies by selling tender pods in near by localities. During the surveys it was observed that, hardly one to five plants are being maintained near by houses (trailed on trees) or open wells (trailed on live hedges/trees) for family needs. Owing to perennially growth characters (4-5 years) farmers usually not collecting the seeds regularly. Even then, the housewife for the perpetuation of the desired type is maintaining seeds of sword bean genotypes. Since, collection of this type of germplasm on large quantity is very difficult, therefore, few seeds (even 2-3 seeds) were collected by visiting farmer's houses during various explorations for surveying these areas in 2000-2002. Farmers were reluctant while supplying the seeds of sword beans and therefore efforts were for maximum seed collection over the period from these areas. At last, all the collected seeds were sown in 5 source population lines in relation to the five district boundaries of the states. Individual plants were observed for recording observation on growth, flowering and fruiting behaviour and pod yield and quality characters at CIAH, Bikaner during rainy-winter season (July 2002 to March 2003). After flowering, it was observed that all the source populations bear either white or purple colour flowers in the population. Therefore, two groups were made in each population for further observations on pod quality and yield components. Range value of growth, flowering, pod quality, pod yield and seed characters are presented in table 74. Besides characteristics of two high quality (tender stage) and higher pod yielding plants under extremes of arid conditions are also given in the table 74. Selfed seeds were harvested from the desired plants to generate individual plant progeny for further evaluation.

Project 2. Development of propagation techniques for *Capparis deciduas*

(R.Bhargava and P.L.Saroj)

Target 1: Standardization of vegetative propagation technique in *Capparis decidua*

Attempts were made to standardise vegetative propagation technique in *Capparis decidua*. The following experiments were conducted:

1. Effect of plant growth regulators on the sprouting of the cuttings

In order to ascertain the effect of PGRs on sprouting and establishment of cuttings, an experiment was conducted using IBA, NAA and Thymine. The treatments comprised of different concentrations of IBA and NAA along with 1000 ppm Thymine (as given in Table 75). The treatments were given either in aqueous medium or in organic medium (DMSO). For each treatment, 20 semi hardwood cuttings were

selected and given dip treatment. Subsequently cuttings were planted in nursery net house. Observations on per cent sprouting under various treatments were recorded at 15 days interval and final sprouting percentage at 45 days after planting are given in Table 75.

Table 74. Evaluation of sword bean population, rainy-winter season.

Characters	Population range		White flowered, early type plant	Purple flowered, late type plant
	Minimum	Maximum		
Number of flowers /raceme	4.2	15.8	10.5	13.5
Number of pods /raceme	0.5	4.5	2.9	3.2
Days to first flower (DAS)	70.2	115.8	70.5	90.2
Days to first harvest (DAS)	95.2	150.4	95.2	108.5
Tender pods /plant	5.2	30.2	26.8	28.5
Tender pod yield /plant (kg)	0.50	3.85	3.65	3.25
Pod length (cm)	9.2	25.8	24.2	22.1
Pod width (cm)	3.0	4.4	4.12	3.82
Pod thickness (cm)	0.84	2.10	1.74	1.85
Pod weight (g)	88.5	154.2	144.2	123.4
Number of seeds/pod	3.8	4.5	4.4	4.1
Test weight (100 seeds) (g)	120.5	225.4	220.1	125.4
Seed length (cm)	1.98	2.71	2.64	2.28
Seed width (cm)	1.25	1.84	1.65	1.54
Vine length (m)	3.0	5.4	3.5	4.2
Internodal length (cm)	8.5	14.2	12.6	8.9
Leaf length (cm)	5.8	7.2	6.5	7.2
Leaf width (cm)	7.6	8.8	8.5	8.6
Leaf colour	LG, G, DG		DG	DG
Flower colour	White & Purple		White	Purple
Pod colour	G,LG,DG,BG,YG,WG		LG-G	YG-G
Seed testa colour	LG,BG,DG,BB,WG		LGB	DWG
Seed coat colour	W,CW,BW,BW,DW,RP,CY		CW	RP mottled

Table 75: Effect of different plant growth regulators on sprouting of *Capparis decidua*

S. No.	Treatment	Per cent Sprouting (Nursery)											
		Apr 2002	May 2002	June 2002	July 2002	Aug. 2002	Sep. 2002	Oct. 2002	Nov. 2002	Dec. 2002	Jan. 2003	Feb. 2003	Mar. 2003
1	Control	-	-	-	-	-	-	-	-	-	-	-	10
2	IBA (5000 ppm) + 1000 ppm thymine (Aquous)	-	-	-	-	-	-	10	-	10	10	-	-
3	IBA (7500 ppm)+ 1000 ppm thymine (Aquous)	-	-	-	-	-	-	20	10	-	-	-	20
4	IBA (10000 ppm) + 1000 ppm thymine (Aquous)	-	-	-	-	-	-	-	10	10	-	-	-
5	IBA+NAA (7500 ppm) + 1000 ppm thymine (Aquous)	-	-	-	-	-	-	-	10	-	10	-	-
6	IBA+NAA (10000 ppm)+ 1000 ppm thymine (Aquous)	-	-	-	-	-	-	-	-	-	-	-	10
7	IBA (5000 ppm)+1000 ppm thymine (DMSO)	-	-	-	-	-	-	-	10	-	-	-	-
8	IBA (7500 ppm)+1000 ppm thymine (DMSO)	-	-	-	10	30	40	30	20	10	20	10	30
9	IBA (10000 ppm)+1000 ppm thymine (DMSO)	-	-	-	-	-	-	-	-	-	-	-	-
10	IBA+NAA (7500 ppm)+ 1000 ppm thymine (DMSO)	-	-	-	-	-	-	10	-	10	10	-	10
11	IBA+NAA (10000 ppm) +1000 ppm thymine (DMSO)	-	-	-	-	-	-	-	-	-	-	-	-

The data reveals that cutting taken during the month of July to September alone showed some response to the treatment with PGRs. In all other treatments, the sprouting and establishment was absent. Even in cuttings taken in July 2002 only 10% of the cuttings showed the sprouting. However, the cuttings taken during September showed about 40% sprouting and establishment. Our results demonstrate that the ideal time of taking the cuttings is in the month of September.

2. Effect of other chemicals on the sprouting of the cuttings:

Attempts were made to investigate the effect of other chemicals such as Ascorbic acid and citric acid in order to remove the inhibitory factors from the cuttings. In this regard, the cuttings were dipped in 100 ppm solution of ascorbic acid and citric acid separately for 1 and 2 hours. Along with this, a control (without water dip) and 2 hrs water dip treatment was also maintained. After the treatment, the cuttings were planted in plastic pots and kept in the nursery shade net house. The results demonstrates that the cuttings dipped in the solution of 100 ppm Ascorbic acid (for 1 or 2 hours) gave the best response giving a sprouting and establishment of 50% cuttings (Table 76).

Table 76: Effect of different chemicals on sprouting of *Capparis decidua*

S. No.	Treatment	Per cent Sprouting
1	2 hr. Distilled water	10
2	1 hr. Ascorbic Acid 100 ppm	50
3	2 hr. Ascorbic Acid 100 ppm	50
4	1 hr. Citric Acid 100 ppm	20
5	2 hr. Citric Acid 100 ppm	10
6	Control (without water dip)	-

Combined application of PGR and chemicals (Ascorbic acid and Citric Acid) was also tried on *Capparis decidua* to study the sprouting and rooting (Table 77). First the cuttings were given treatment with Citric or Ascorbic acid at the rate of 100 ppm for 2 hr. Subsequently the cuttings were given quick dip treatment in solution containing 7500 ppm IBA + 1000 ppm Thymine. The cuttings were planted in polytubes along with control. The data on percentage sprouting was recorded after 45 days. The results revealed that application of 100 ppm ascorbic acid gave best response giving an over all success of 60 per cent.

Table 77: Effect of different PGRs and chemicals on sprouting of C*apparis deciduas*

S.No	Treatment	Per cent Sprouting
1	Control	10
2	100 ppm Ascorbic Acid (2 hr dip) + 7500 ppm IBA + 500 ppm Thymine (quick dip)	60
3	100 ppm Citric Acid (2 hr dip) + 7500 ppm IBA + 500 ppm Thymine (quick dip)	40
4	Citric Acid @ 100 ppm	20
5	Ascorbic Acid @ 100 ppm	30

3. Levels of ABA and phenolics in the cuttings of *Capparis decidua*

Endogenous levels of ABA and Phenolics in the cuttings of the *Capparis decidua* were estimated at monthly interval. The data thus generated is presented in Table 78. Perusal of data reveals that ABA

level range from 11.96 to 12.06 ng/g fresh weight of the cuttings. Perusal of month-wise variation in ABA content in cuttings demonstrates that the magnitude of change is very low (Fig. 14). Thus, it is apparent that ABA is not the major participating factor in control of rooting in the cuttings.

Data on month-wise endogenous level of phenolics in the cuttings of *Capparis decidua* reveals that the phenolic content in the cuttings are low during February-March and September-October (Fig 14). They range from 80- 250 µg/g fresh weights of the cuttings. The variation in phenolics along with the variation with the sprouting / establishment of the cuttings reveals that the phenolics has definite role to play in control of establishment of cuttings.

Table 78. Endogenous levels of ABA and Phenolics in the cuttings of *Capparis decidua*

Month	ABA (ng/g fresh weight)	Phenolics (µg/g fresh weight)
January	11.97	116
February	11.96	80
March	12.06	84
April	11.99	120
May	12.05	230
June	12.12	220
July	12.15	220
August	12.01	160
September	11.95	115
October	12.00	120
November	11.98	220
December	11.98	250

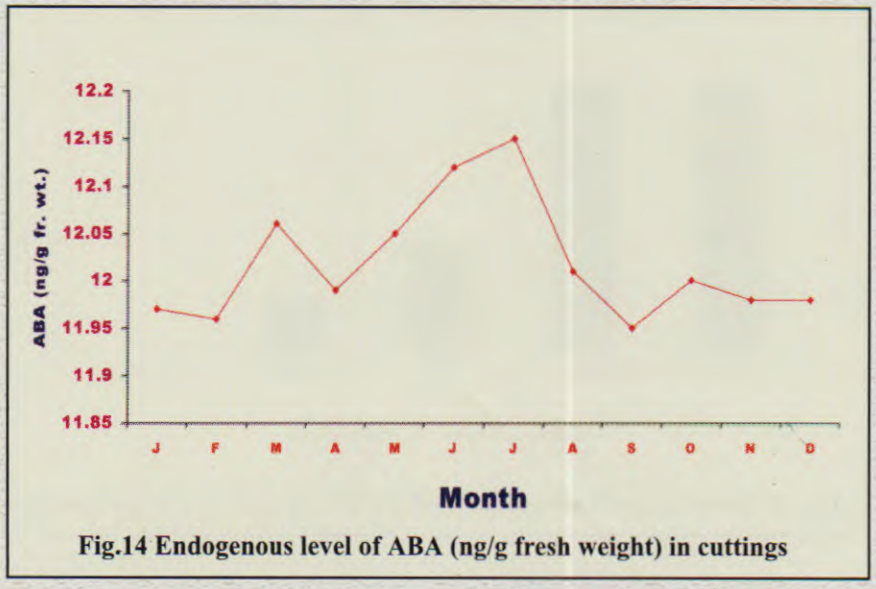


Fig.14 Endogenous level of ABA (ng/g fresh weight) in cuttings

4. Effect of Ascorbic acid and citric acid on the endogenous levels of Phenolics

The data on endogenous levels of phenolics in the cuttings of *Capparis decidua* due to treatment with Ascorbic acid and Citric acid was also undertaken. The data presented in Table 79 reveals that the levels of Phenolics declined from 115 µg/ g fresh weight to 50 µg/g fresh weight after treatment with 100 ppm Ascorbic acid solution for 1 hour. Similarly, the level of Phenolics in cuttings dipped for two hours was 55 µg/g fresh weight. However, the treatment with Citric acid could bring only very small decrease in the phenolic content. Since, the application of Ascorbic acid also improved the establishment of cuttings, it further proves that endogenous levels of phenolics have a definite role to play in controlling the establishment of cuttings of *Capparis decidua* (Fig. 15).

Table 79. Endogenous levels of Phenolics under the treatment with Ascorbic acid and Citric acid

Treatment	Phenolics (µg/g fresh weight)
Ascorbic acid (100 ppm)	
1 hr. dip	50.0
2 hrs dip	55.0
Citric acid (100 ppm)	
1 hr. dip	90
2 hrs dip	82
Control (without water dip)	115

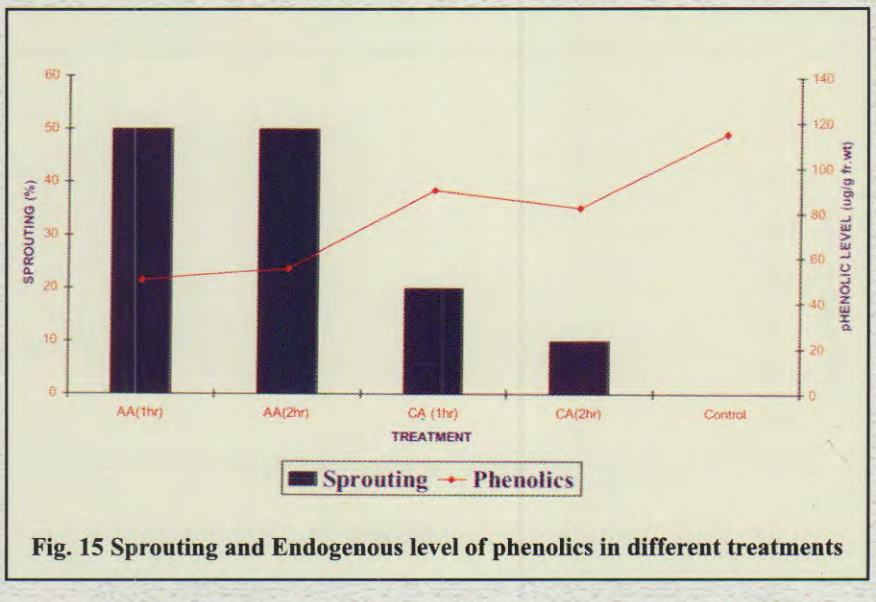


Fig. 15 Sprouting and Endogenous level of phenolics in different treatments

5. Standradisation of protocol for micropropagation of *Capparis decidua*

In order to standardize the protocol for micropropagation of *Capparis decidua* various treatment combinations were tried (Table 80). In all two experiments were conducted.

First the axillary buds/ nodal explants were kept for initiation of shoot in modified MS medium. The various combinations tried are presented in Table 80. The medium tried was solid MS medium containing different concentration of IAA, IBA, BAP and kinetin. The results demonstrated that both callus induction as well as shoot proliferation was best in the medium containing MS + 5 mg/l BAP + 1.5 mg/l IBA. However, the rooting was not found in this medium. Accordingly, the plantlets were sub cultured in modified MS medium. The various treatments tried comprised of full and half strength MS medium containing activated charcoal, IAA and IBA, NAA and different levels of Agar.

Table 80: Effect of different modified MS media on per cent callus induction and shoots proliferation in *Capparis deciduas*

S. No.	Treatment	% Shoot Proliferation	% Callus induction
1	MS + 1 mg/l BAP + 0.5 mg/l IBA	10	70
2	MS + 3 mg/l BAP + 1 mg/l IBA	25	47
3	MS + 3 mg/l BAP + 1.5 mg/l IBA	15	39
4	MS + 5 mg/l BAP + 1 mg/l IBA	20	42
5	MS + 5 mg/l BAP + 1.5 mg/l IBA	75	92
6	MS + 7 mg/l BAP + 1 mg/l IBA	0	00
7	MS + 1 mg/l BAP + 0.5 mg/l IAA	0	00
8	MS + 2 mg/l BAP + 1 mg/l IAA	5	18
9	MS + 5 mg/l BAP + 1.5 mg/l IAA	35	18
10	MS + 7 mg/l BAP + 2 mg/l IAA	0	55
11	MS + 100 mg/l NAA + 5 mg/50 ml Kinetin	10	00
12	MS + 3 mg/l BAP + 1.5 mg/l Kinetin	15	22
13	MS + 5 mg/l BAP + 2 mg/l Kinetin	20	29
14	MS + 0.1 mg/l NAA + 5.0 mg/l BAP + additives (50 mg/l ascorbic acid + 25 mg/l Adenine Sulphate + 25 mg/l Citric Acid + 100 mg/l PVP)	27	15

The shoots were sub cultured in the rooting media given in Table 81. Out of seven different concentrations of rooting media, the roots were produced in MS + 0.1 mg/l IAA + 1.0 mg/l BAP and 0.1 mg/l IAA + ½ strength MS liquid media only.

Table 81: Effect of different rooting media on root induction in *Capparis decidua*

S. No.	Rooting Media	Root Induction
1	MS + 0.1 mg/l IAA + 1.0 mg/l BAP	✓
2	MS + 0.3 mg/l IAA + 1.5 mg/l BAP	X
3	MS + 0.5 mg/l IAA + 1.5 mg/l BAP	X
4	MS + 1.0 mg/l IAA + 2.0 mg/l BAP	X
5	0.1 mg/l IAA + half strength MS liquid media	✓
6	Hormone free half strength agar gelled MS media	X
7	Half strength MS liquid media (Before pouring in this media shoots were treated with 1.0 mg/l IAA solution for 1 min)	X

Project 3. National Agricultural Technology Project under Competitive Grant Programme

Standardization of Fertigation Schedules and Water Requirement of Arid Fruit Crops under Micro-Irrigation Systems for Arid Ecosystems

The study was carried out with following objectives:

i) To evaluate the efficacy of drip and micro sprinkler *vis* a *vis* conventional method in terms of water and fertilizer economy in arid fruit crops.

ii) To standardize the fertigation technique and fertilizer and water requirement at different stages of crop growth under soil-climatic conditions of arid eco-region under micro-irrigation system.

iii) To compare growth, development, yield and fruit quality parameters under micro-irrigation and conventional methods.

iv) To standardized optimum wetting area for different growth stages of arid fruit crops.

Summary

The research project was undertaken on ber (*Ziziphus mauritiana* var. rotundifolia), pomegranate (*Punica granatum* L.) and kinnow (*Citrus reticulata*) arid fruit crops in sandy soils of western Rajasthan. The ber orchard was four years old and pruning was done in the month of May 2002. The watering was withhold upto June 2002 and new shoots were emerged in the month of July 2002. The irrigation and fertilizer schedules as per technical programme were deployed from the month of February 2003. The pomegranate orchard was five year old. The treatments of irrigation through different systems and fertilizer application (fertigation) could be deployed from the month February 2003.The initial plant height and tree volume of the plants in different treatments have been measured. The kinnow orchard was two year old. The gap filling in different treatments has been done in the month of October 2002 and

different systems of micro irrigation (drip, micro sprinkler and pipe system) were installed in the month of February 2003. The initial plant height and spread has been measured. The basal application of manure was done in the month of February 2003.

Achievements of the Project

Installation of drip, micro sprinkler and pipe irrigation system

Lay out as per technical programme was prepared for all three crops. In ber orchard, 0.25 ha area was covered under drip irrigation system. The 12mm lateral lines were taken from 63mm sub-main line and three drippers of 4lph capacity through 6mm micro tube have been provided to each plant. The 16mm lateral lines were taken from 63mm sub-main line and installed one micro sprinkler of 60lph capacity to each plant. From same sub main line a hydrant of 50mm was taken to apply the water through pipe. In 0.25ha area open channel system has been kept for flood system (control). The same layout has been laid out in pomegranate and kinnow orchards.

*For cleaning the impurities of irrigation water, a sand filter and screen filters were installed in eachcrop. For fertilizer application, venturi set was attached with sand/screen filter in kinnow block while in ber and pomegranate block, fertilizer tanks have been provided.

Collection of meteorological parameters

The data on evaporation, rainfall, maximum, minimum temperatures, relative humidity and wind speed were collected from Agricultural Research Station, Rajasthan Agricultural University, Bikaner. The data on above parameters are given in the below table 82.

Table 82. Meteorological parameters.

Month	Temperature		R.H. (%)		Total rainfall (mm)	No. of rainy days	Wind velocity (km/hr)	Evaporation (mm/day)
	Max.	Min.	Max.	Min.				
Jan.2002	24.7	5.8	68	24	0.0	0	5.2	3.2
Feb.	25.8	8.4	62	19	5.1	1	6.4	4.2
March	33.9	16.1	45	19	3.2	1	7.5	7.7
April	39.8	22.9	45	11	0.0	0	9.5	12.4
May	43.7	26.8	39	22	0.0	0	14.5	15.1
June	43.1	28.9	51	22	0.0	0	14.6	16.6
July	39.6	26.5	65	32	0.0	0	18.9	14.4
August	39.3	26.4	60	32	8.0	2	13.7	12.2
Sept.	37.8	23.3	65	29	46.5	1	8.7	9.9
Oct.	37.5	18.7	46	16	0.0	0	5.8	8.8
Nov	30.2	12.7	53	19	5.5	1	5.1	6.2
Dec.	25.9	7.6	63	26	9.0	1	3.5	3.5
Jan 2003	23.5	4.5	69	25	4.5	1	6.4	3.1
Feb.	24.5	8.3	68	26	6.5	2	5.0	3.8

Collection and analysis of soil samples

The soil samples of four depths i.e. 0-15, 15-30, 30-45 and 45-60cm have been collected from all three orchards for analyzing the initial soil fertility levels of respective orchard. The soil samples have been processed for physico-chemical analysis and analysis work is under progress.

Monitoring of irrigation water and fertilizer application.

The irrigation water requirement for ber, pomegranate and kinnow plant has been standardized. The planting distance, crop factor, pan factor, wetting zone and fraction of pan evaporation parameters has been considered for calculating the water requirement of the crop.

For ber crop, the crop factor 0.6, pan factor; 0.7; planting distance; 6 * 6 meter, percent area covered by foliage (wetted zone), 40 percent have been standardized on the basis of crop stage. The required amount of irrigation water would be calculated and applied through different methods of irrigation.

The pomegranate fruit crop is five year old and on the basis of crop stage, pan factor, 0.7; planting distance, 5 * 5 meter, crop factor, 0.55, and wetting area, 25 percent have standardized. Considering the efficiency of drippers, exact amount of water to be given to the crop has also been calculated and required amount of irrigation water has been applied through different irrigation method.

The kinnow plants are two year old and on the basis of crop age and their growth, pan factor, 0.7; crop factor, 0.5; planting distance, 6 * 6 meter; area to be wetted, 20 per cent have been standardized. On the basis of dripper efficiency and fraction of pan evaporation, the required amount of irrigation water would have been applied.

Standardization of fertigation schedules

On the basis of available information on recommended doses of nitrogen, phosphorus and potassium, the fertigation schedules have been evolved for each crop. In ber crop the fertilizer schedule will be started from the month of June and the end up in the month of November. In pomegranate, the fertigation schedule will be started from the month of May- June and end up in the month of December. In kinnow, the fertigation schedule will be beginning from the month of March and last in the month of December.

The amounts of the fertilizer have been standardized. During crop growth and flowering stage the nitrogen, phosphorus and potassium will be given in the ratio of 1:1:1 while during fruit set and maturity, the nitrogen and potassium will be applied in the ratio of 1:3 in all crops.

Observations on plant growth parameter

The initial plant height, spread and tree volume have been measured at the time irrigation system installation. These parameters will be used to observe the increment in plant growth parameter.

Project 4. Develop sustainable agri-silvi-horti production system for marginal lands under arid conditions

(S.S. Hiwale and P.L.Saroj).

Lead Centre : **CHES, Godhra**

Cooperative Centre : **CIAH, Bikaner**

At CHES, Godhra

Studies carried out on Agri-Horti production system on marginal lands with Aonla and Custard apple as main crop inter-cropped with six crops viz., Okra, Maize, Green gram, Til, Pigeon pea and Moth bean revealed that Aonla was more productive compared to Custard apple proving its adaptability to drought like conditions prevalent in the area. Whereas, in custard apple, there was drastic reduction in yield as fruit development was badly affected. Inter crop yield and biomass production of intercrops was higher in Custard apple compared to Aonla owing to timely sowing.

Economic analysis of the system carried out revealed that highest net income per ha. of Rs. 72,565/- was obtained from Aonla + Okra cropping system. Highest B: C. ratio of 1:8.17 was however obtained in Aonla + Til cropping system. Custard apple based cropping system though withstood drought resulted in less revenue generation of Rs. 22,687/- per ha. in Custard apple + Okra cropping system, with a B. C. ratio of 1: 1.42 only.

The experiment on leaf litter decomposition was initiated on 30/06/2001 by weighing 100 gm air-dried leaf litter fall of all the experimental tree species. They were put in nylon thread bag of 50cm x 50 cm size (average mesh size 2mm x2mm). The bags were buried at 15-30 cm depth. Periodical samples were taken to the laboratory for weighing and kept for oven drying at 70 C and then loss in weight was recorded. The data revealed that there were significant differences among the species in respect of leaf litter decomposition. Maximum decomposition was recorded in Subabool (17.00 %) and it was minimum in Aonla (8.44%) after two months of initiation. Similar trend was observed after four months interval.

Maximum leaf litter was produced in Aonla (7.06 Kg) per plant on the basis of chemical analysis of un-decomposed leaf litter samples. It is seen that during the year maximum nitrogen per plant (62.21 g) was recycled by Subabool. Whereas, maximum phosphorus per plant was recycled by Aonla (7.76 g). Maximum potassium was added to soil by Neem (35.89 g). Nutritional analysis of decomposed leaf litter (litter bag technique) reveled that % N,P content decreased in the first sampling after one month. Whereas there was increase in N and P content in the second sampling after 3 months of decomposition in all the four species viz., Aonla. Custard apple, Neem & Subabool. K content of leaf litter in case of Aonla & Custard apple remained static in first sampling and increased in second sampling, whereas in case of Neem and Subabool it showed declining trend in both the sampling.

Soil analysis carried out in different Agri-Horti as well as Agri-Silvi production systems under purely rainfed conditions revealed that in all the cropping system there was decline in pH values. Whereas organic carbon content increased significantly. P and K content in all the system showed increasing trend over control suggesting that there was overall improvement in soil health in different cropping systems.

Studies on allelopathic effect of tree species involved in various cropping system revealed that Custard apple leaf leachate had beneficial effect on seed germination, seedling growth and vigour of different intercrops. Where as Aonla and Neem had suppressing effect. Subabool leaf leachate had beneficial effect on Okra, Til, Fodder Jowar in respect of growth parameters and had suppressing effect in other intercrops tried in petridish experiment under laboratory condition. In case of pot culture studies the effect was non- significant. In four intercrops like Moth bean, Dolichos, Fodder Jowar, Okra and Til , there was beneficial effect on growth parameters in pot culture under ambient conditions in laboratory.

At CIAH, Bikaner

Ber based agri-horti system was initiated in September 2000 under irrigated arid conditions. The ber cultivar Gola was planted at 6 x 6 , 8 x 8 and 16 x 4 m spacing. The groundstorey crops were introduced from Kharif 2001 having crop combination of groundnut-wheat, cluster bean - mustard and Indian aloe. Before plantation, initial fertility status of experimental site was also analyzed, which indicated that the organic matter of the experimental site is very low and soil is highly sandy in nature.

Survival and growth of ber plants

In the third year of age, the plant survival is more than 90 per cent in all the treatments except sole plantation (88.63%). Data summarized in the table 83-87 for plant height, crown spread, stock diameter, scion diameter and scion: stock ratio, respectively, reveal that vigour parameters are positively influenced by different crop rotations, whereas, the spacing had no marked influence. Highest plant height (1.89m), crown spread (2.53m^2), stock diameter (3.23cm) and Scion diameter (2.88cm) was recorded under Indian aloe followed by Cluster bean Mustard, Groundnut-Wheat and minimum in sole plantation. It is evident that intercrops integrated into the system had no adverse effect on the establishment of ber orchard at initial stage; instead, intercropping has positive response on vigour of overstorey component as compared to sole plantation of ber.

Table 83. Plant height (m)

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2002	March 2003	Sept. 2002	March 2003	Sept. 2002	March 2003	March, 2003
Groundnut Wheat	1.41	1.72	1.39	1.67	1.43	1.78	1.72
Cluster bean Mustard	1.49	1.76	1.46	1.72	1.48	1.75	1.74
Indian Aloe	1.59	1.88	1.63	1.89	1.60	1.89	1.89
Sole plantation	1.46	1.67	1.49	1.64	1.52	1.71	1.67
Mean	**1.49**	**1.76**	**1.49**	**1.73**	**1.51**	**1.78**	

Table 84. Plant spread (m^2)

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2002	March 2003	Sept. 2002	March 2003	Sept. 2002	March 2003	March, 2003
Groundnut Wheat	2.08	2.24	1.98	2.32	2.04	2.20	2.25
Cluster bean Mustard	1.94	2.37	2.02	2.34	1.97	2.34	2.35
Indian Aloe	2.16	2.52	2.09	2.51	2.19	2.56	2.53
Sole plantation	1.87	2.10	1.89	2.14	1.93	2.22	2.15
Mean	**2.01**	**2.30**	**1.99**	**2.27**	**2.03**	**2.33**	

Table 85. Stock diameter (cm)

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2002	March 2003	Sept. 2002	March 2003	Sept. 2002	March 2003	March, 2003
Groundnut Wheat	2.79	3.05	2.81	3.07	2.86	3.11	3.08
Cluster bean Mustard	2.72	2.96	2.83	3.04	2.77	3.05	3.02
Indian Aloe	2.87	3.15	2.96	3.26	3.02	3.29	3.23
Sole plantation	2.64	2.85	2.70	2.93	2.68	2.97	2.92
Mean	**2.75**	**3.00**	**2.82**	**3.07**	**2.83**	**3.10**	

Table 86. Scion diameter (cm)

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2002	March 2003	Sept. 2002	March 2003	Sept. 2002	March 2003	March, 2003
Groundnut Wheat	2.43	2.65	2.38	2.59	2.41	2.63	2.62
Cluster bean Mustard	2.48	2.74	2.41	2.65	2.44	2.69	2.69
Indian Aloe	2.56	2.84	2.61	2.87	2.63	2.94	2.88
Sole plantation	2.39	2.58	2.32	2.55	2.36	2.60	2.57
Mean	**2.47**	**2.70**	**2.43**	**2.67**	**2.46**	**2.72**	

Table 87. Scion: Stock

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2002	March 2003	Sept. 2002	March 2003	Sept. 2002	March 2003	March, 2003
Groundnut Wheat	0.87	0.86	0.85	0.84	0.84	0.85	0.85
Cluster bean Mustard	0.91	0.92	0.85	0.87	0.88	0.88	0.89
Indian Aloe	0.89	0.90	0.88	0.88	0.87	0.89	0.89
Sole plantation	0.90	0.90	0.86	0.87	0.88	0.88	0.88
Mean	**0.89**	**0.90**	**0.86**	**0.87**	**0.87**	**0.88**	

Performance of groundstorey components

Since different components are integrated into the production system, multiple outputs were harvested from the field. From groundnut dried pods; from cluster bean green pods (for vegetable purpose); from wheat and mustard grain yield; from Indian aloe green leaf pad and suckers (as planting material) and from ber fruits, besides considerable amount of biomass from almost all the components were harvested in the second year of cropping.

Due to inadequate irrigation water during *Kharif* season, very low yield of groundnut (1.59 q/ha) and cluster bean (10.35 q/ha) was obtained. During *Rabi* season, the average yield of wheat was 16.93 q/ha while in mustard; it was recorded as 14.09 q/ha. The third cut of green leaf pad of Indian aloe yielded 23.91 q/ha, which is slightly higher than the second cut (23.39 q/ha). Indian aloe also yielded an average of 99396 and 125000 number of suckers/ha under Indian aloe+ber and sole Indian aloe, respectively (Table 88-90).

Table 88. Yield of groundstorey crops with ber based AFS (q/ha) during *Kharif* 2002

Spacing	Groundstorey crops		
	E. Kharif		Perennial Crop
	Groundnut*	Cluster bean**	Indian Aloe***
6 X 6 m	1.56	9.83	23.00
8 X 8 m	1.59	10.09	22.87
16 X 4 m	1.58	10.62	23.17
Sole	1.62	10.86	24.53
Mean	**1.59**	**10.35**	**23.39**

* Dry pod yield ** Green pod yield *** Green leaf pad yield in second harvest

Table 89. Yield of groundstorey crops with ber based AFS (q/ha) during *Rabi* 2002-2003) during *Kharif* 2002

Spacing	Groundstorey crops		
	E. Rabi		Perennial Crop
	Wheat	Mustard	Indian Aloe*
6 X 6 m	16.57	14.24	23.01
8 X 8 m	17.14	13.78	23.56
16 X 4 m	17.79	14.26	23.87
Sole	16.21	14.07	25.20
Mean	**16.93**	**14.09**	**23.91**

* Green leaf pad yield in third harvest

Table 90. Production of suckers of Indian aloe in ber based AFS (no. of suckers/ha)

Crop rotation	Spacing (m)			
	6 x 6	8 x 8	16 x 4	Mean
Indian Aloe + Ber	89666	98773	109749	99396
Sole Indian Aloe	119445	127778	127778	125000
Mean	**104556**	**113276**	**118764**	

Biomass yield

Biomass production from different groundstorey crops viz., groundnut, cluster bean, wheat and mustard was also recorded so as to incorporate it back to the field after decomposition in the same ratio from where they were harvested. Due to the diverse growing nature and specific root: shoot ratio of the

component crops, high variation was recorded in the aboveground and belowground biomass production in different groundstorey crops. In the *Kharif* season, the total biomass production was 9.99 and 5.06 q/ha from groundnut and cluster bean, respectively. Similarly, in *Rabi* season cropping, total biomass production was 50.66 and 25.46 q/ha from wheat and mustard, respectively (Table 91-92).

Table 91. Biomass production of *Kharif* crops (q/ha)*

Spacing	Groundstorey crops					
	Groundnut			Cluster bean		
	Above ground	Below ground	Total	Above ground	Below ground	Total
6 x 6 m	9.07	0.86	9.93	4.44	0.40	4.84
8 x 8 m	9.11	0.85	9.96	4.53	0.40	4.93
16 x 4 m	8.99	0.84	9.83	4.72	0.4	25.14
Sole crop	9.41	0.86	10.27	4.91	0.43	5.34
Mean	**9.14**	**0.85**	**9.99**	**4.65**	**0.41**	**5.06**

* - Dry weight basis

Table 92. Biomass production of *Rabi* crops *

Spacing	Groundstorey crops					
	Wheat			Mustard		
	Above ground	Below ground	Total	Above ground	Below ground	Total
6 x 6 m	33.45	14.80	48.25	21.08	3.08	24.16
8 x 8 m	36.69	15.96	52.65	23.24	2.67	25.91
16 x 4 m	38.10	16.60	54.70	25.48	3.45	28.93
Sole crop	32.87	14.16	47.03	19.87	2.94	22.81
Mean	**35.28**	**15.38**	**50.66**	**22.42**	**3.04**	**25.46**

* - Dry weight basis

Biomass recycling:

The nutrient content of the biomass produced (both above ground and below ground) was analyzed for groundnut and cluster bean, which is given in table 93. The biomass of *Kharif* and *Rabi* season crops will be incorporated in the plots in the same ratio from where they were harvested to recycle the nutrients in the field.

Table 93. Nutrient content in biomass of *Kharif*-2002

Crop	N (%)	P (%)	K (%)	Ca (%)	Na (%)	Zn (ppm)	Fe (ppm)
Groundnut							
Above ground	2.59	0.18	2.17	2.98	0.73	120	3926
Below ground	1.71	0.20	1.50	1.74	0.50	164	2612
Cluster bean							
Above ground	2.26	0.22	2.14	3.11	0.49	793	885
Below ground	1.82	0.25	1.81	2.34	0.30	115	982

Fruit yield:

At the age of three years, the overstorey component ber cv Gola came in flowering followed by good retention of quality fruits. An average yield of 14.44, 8.13 and 8.23 q/ha fruits were harvested from the plots of 6x6, 8x8 and 16x4m, respectively. The higher level of yield in the plot of 6x6m as against 8x8 and 16x4m plots is due to the presence of more number of plants per hectare. The average individual plant yield tells us that the spacing had no effect on the yield of ber cv Gola. On an average, ber cv Gola plants produced 5.20, 5.21 and 5.26 kg fruits / plant in 6x6, 8x8 and 16x4m plots, respectively. On the other hand, the different crop rotations applied in the experiment have remarkable influence on the yield of ber cv Gola fruits. The yield recorded from different crop rotations was 9.62, 9.80, 13.55 and 8.09 q/ha from groundnut-wheat, cluster bean-mustard, Indian aloe and sole plantation, respectively. Higher yields from groundnut-wheat, cluster bean-mustard and Indian aloe crop rotations as against sole plantation clearly showed that the input applied to the groundstorey crops in the form of nutrients and water cumulatively enhanced fruit yield of ber cv Gola in these treatments as compared to sole plantation of ber plants. The highest yield was recorded from Indian aloe plots whereas; the yield from groundnut-wheat and cluster bean-mustard plots was *at par*. In sole plantation, lowest fruit yield was recorded (Table 94).

Table 94. Fruit yield of ber cv Gola with ber based AFS (q/ha)

Crop rotation	Spacing (m)			
	6x6	8x8	16x4	Mean
Groundnut-Wheat	13.37 (4.81)*	7.64 (4.90)	7.86 (5.04)	**9.62**
Cluster bean-Mustard	13.81 (4.97)	7.83 (5.02)	7.77 (4.98)	**9.80**
Indian Aloe	19.13 (6.88)	10.76 (6.90)	10.76 (6.90)	**13.55**
Sole plantation	11.45 (4.12)	6.54 (4.03)	6.54 (4.19)	**8.09**
Mean	14.44 (5.20)	8.13 (5.21)	8.23 (5.26)	

* Figures in parenthesis are average yield of individual plants

Soil moisture depletion

The soil moisture depletion pattern under different treatment combinations was also analyzed. Data presented in table 95, 96 and 97 indicated that the depletion pattern under different combinations was directly proportionate to the requirement of the individual crop integrated into the system. In general, the depletion pattern was highest under Indian aloe and lowest sole plantation of ber. However, the depletion in the tree basin was more as compared to away from basin of the tree.

Table 95. Soil Moisture depletion during *Kharif* 2002 (cm/m)

Treatment	Spacing (m)		
	6x6	8x8	16x4
Sole Ber	11.50	11.50	10.52
Ber+Indian Aloe	16.50	16.00	15.80
Ber+Cluster bean	12.00	11.50	11.00
Ber+Groundnut	14.00	13.50	13.00

Table 96. Soil Moisture depletion during *Rabi* 2002-03 (cm/m)

Treatment	Spacing (m)		
	6x6	8x8	16x4
Sole Ber	8.50	9.50	9.50
Ber+Indian Aloe	12.50	13.50	13.00
Ber+Cluster bean	10.00	10.00	10.50
Ber+Groundnut	12.00	12.50	12.00

Table 97. Soil Moisture depletion during *Kharif* and *Rabi* 2002-03 (cm/m)

Treatment	Spacing (m)			
	Sole cropping	Indian Aloe	Cluster bean Mustard	Groundnut-Wheat
Inside basin	26.50	25.50	25.50	26.00
Away from basin	14.50	28.00	19.50	23.50

Performance of ber cv Gola in saline soils

The salinity in the arid zones is rapidly increasing as a result of indiscriminate use of canal water for irrigation purposes. Furthermore, the flood irrigation system generally adapted by the marginal farmers of this region is also helping in making field soil saline. Therefore, judicious use of irrigation water with proper irrigation system and integration of salinity tolerant/resistant fruit crops can help in developing viable production system for arid ecosystem. Ber cv Gola is said to be an important salinity tolerant fruit crop of this region, hence, it can be effectively integrated into different production systems

where salinity is a problem. In the present investigation, survival and performance of ber cv Gola was studied under different levels of salinity. A multi-location experiment was initiated on farmers' field to evaluate performance of ber cv Gola under different salinity levels, keeping non-saline arid situations as control.

Budded plants of ber cv Gola were planted in the field of two farmers selected in Lunkaransar tehsil of Bikaner for the study. Data presented in table 98 revealed that at initial stage, though not much difference was recorded in growth and survival of ber plants but now, effect on field survival and inhibition of growth is quite visible in the plants at higher salinity levels.

Table 98. Effect of different levels of salinity on survival and growth of ber cultivar *Gola*

Location	ECe (dSm^{-1})	Survival (%)		Plant height (cm)	
	Sept. 02	Sept. 02	March 03	Sept. 02	March 03
1.Beechwal, CIAH, Bikaner	0.64	95.20	95.20	58.50	80.50
2. Lunkaransar (289 RD - Veer Bal Ram)	6.45	96.15	96.15	55.25	73.25
3. Lunkaransar (277 RD -Mohd. Haneef)	12.25	90.50	80.25	52.45	67.45

Project 5. Horticulture and vegetable gardening for food and nutritional security

(JAY VIGYAN Household food and Nutritional Security)

1. 'Goma Kirti' a clonal selection from Umran performed exceedingly well over Gola and Umran in respect of vegetable parameters as well as yield.
2. Experiment on high density orcharding in pomegranate cv. Ganesh clearly indicated that the plant spaced at 5m x 5m recorded maximum plant height, plant spread and stem girth on compared to low spacing.
3. Adaptive trial on sweet orange var. Sathgudi showed the feasibility of growing sweet orange in dryland conditions of Panchmahals' provided need based irrigation are given at regular interval. Besides this even the plants of *Mosambi* are coming up very well in this region indicating feasibility of growing of *mosambi* in this region.
4. Experiment on performance of different varieties of pomegranate viz. Mridula, Ganesh, Ruby, Jalore seedless and Jyoti are in progress.
5. A large No. of plants of pomegranate and ber were made available to the farmers who are under frontline demonstration of NATP project. For this, a polyhouse has been constructed to meet the demand of the farmers.

C. Adhoc Scheme

Project : Studies on Powdery Mildew of Ber and Standardization of Techniques for Quick Screening

Total phenol in ber cultivars and powdery mildew reactions

Phenolics are constitutive in plant system conferring resistance and are often performed as inhibitory compounds. In order to ascertain the relative proportion of phenol in ber cultivars and its relationship with powdery mildew reactions, the susceptible cultivars viz., Gola, Umran, Seb Mundia; moderately susceptible cultivars viz., Kiathali, Jogia, Reshmi, Banarasi Karka ,Kathal, Chhuhara, Ponda, Nazuk, Sandhur, Laddu, Banarasi, Surti, Akhreta and Tsabtaso and the resistant cultivars viz., Rohtak Safeda, Chanchal, Govindgarh, Dandan, Narma, Saneur-1, Shamber, Badami, Safeda, Jhajjar Selection, Glory, Mirchia, KalaGola, BS-75-3-1, Narikela, Villaiti, Guli, ZG-2,Saferchandi, Illaichi, Kathapal, Seo, Sanuer-3, Kishmis and Chinese) were analyzed for total phenol. Total phenol content in young, maturing and matured leaves, tender and matured fruits of these genotypes was estimated and results are presented.

Ber leaves are richer in total phenol content than fruits samples from irrespective of genotypes. Tender leaves of ber cultivars contained high phenol content followed by maturing and matured or old leaves. Similarly in case of fruits, tender or young fruits are having more phenol than matured fruits. Comparison of phenol content among cultivars revealed that the constitutive phenol is varied between cultivars. Susceptible and moderately susceptible cultivars are weak in phenol content as compared to resistant cultivars. Maximum quantity of phenol was estimated from young leaves of cv. Saneur-1 (2.4530 mg/g), cv. Banarasi (2.0554mg/g) and cv. Surti (2.0025mg/g). The former cultivar has been reported as resistant and later two are moderately susceptible under field conditions against powdery mildew incidence. However, some of the resistant cultivars are also having less in phenol compare to susceptible genotypes. These may be attributed with the higher constituent of other biochemical like calcium ion and total protein and which are also conferring to powdery mildew resistance.

Average phenol content in different groups of genotypes against powdery mildew reactions revealed that susceptible cultivars expressed low level followed by moderately susceptible genotypes. Resistant genotypes showed higher phenol (Fig.16). Fruit samples are poor in phenol content and therefore, such fruits are infected easily and rapidly colonized by powdery mildew pathogen. It also evidenced that young leaves of susceptible cultivars are easily infected and along with tender fruits. Both of these parts of ber are having less phenol, may act as reservoir of powdery inoculums once exposed to successful colonization.

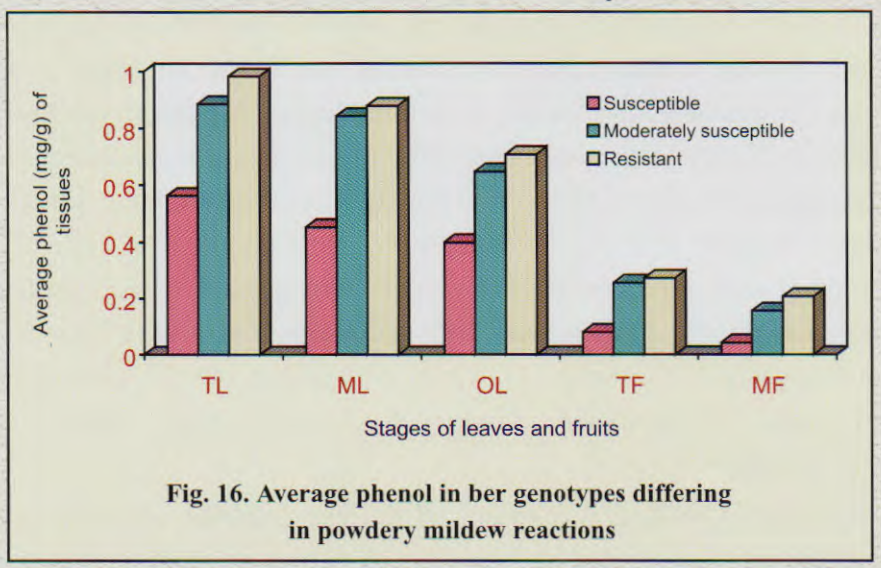


Fig. 16. Average phenol in ber genotypes differing in powdery mildew reactions

Oxidative enzymes in relation to powdery mildew reactions

Ber genetic stocks enriched with defence chemical or anti fungal molecules in their cellular compartments are potential source of powdery mildew resistance. Basically, oxidative enzymes play key role in defence reaction in response to powdery mildew infection or any other biotic and abiotic stresses. Therefore, it was imperative to quantify the major oxidative enzymes and to workout their relationship towards powdery mildew reactions. Two key enzymes viz., peroxidase and polyphenol oxidase are involved in phenol metabolism. Presently these key enzymes were estimated in resistant, moderately susceptible and susceptible cultivars of ber. In the initial stage cvs. Gola, Umran and Seb (susceptible), cv. Kiathali (moderately susceptible) and Illaichi, SaferChandi and *Z.nummularia* (resistant) were taken up for the estimation of enzymes. Young, maturing and matured leaves, tender and matured fruits of these genotypes were estimated and results on peroxidase activity are presented in table (Table 99).

Table 99. Peroxidase activity in ber cultivars differing powdery mildew reactions

Ber cultivars	Peroxidase activity (units/min/g)					
	Reactions	TL	ML	OL	TF	MF
Gola	S	180.07	107.14	99.40	72.50	65.05
Umran	S	125.9	109.34	76.64	101.25	89.62
Seb	MS	314.84	226.63	151.59	98.63	75.50
Kaithali	MS	311.0	293.16	142.50	120.80	88.95
Illaichi	R	70.03	49.26	38.32	35.08	43.43
Saferchanid	R	545.48	320.50	172.43	153.85	112.50
Z.nummularia	R	574.80	412.63	300.05	160.20	108.8

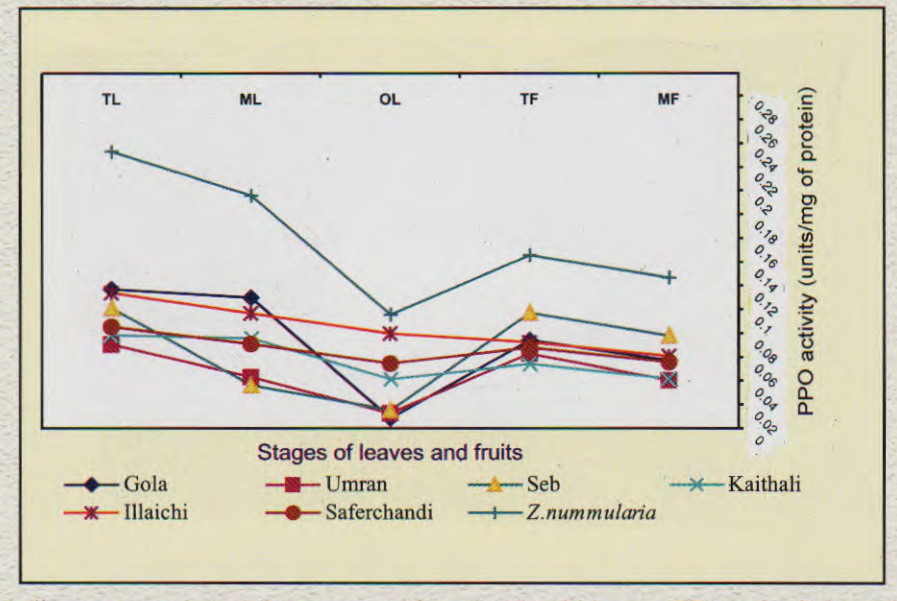
Values are means of 4 replicates

TL: Tender Leaves ML: Maturing Leaves; OL: Old leaves;

TF: Tender fruits MF: Matured fruits

Peroxidase activity was high in resistant cultivars followed by moderately susceptible and susceptible cultivars. Among different stages of leaves and fruits, the enzyme activity is highly pronounced in young leaves and fruits compare to matured leaves. Maximum enzyme activity of 574.8 units/min/g was recorded in tender leaves of the wild species i.e., *Z.nummularia* followed by Safer Chandi (545.48 units/min/g) which are resistant to powdery mildew incidence. Under field conditions, the wild species are comparatively very less susceptible than commercial cultivars. Perhaps, these oxidative enzymes along with other biochemical constituents may act as resistant factors. The tender leaves of moderately susceptible cultivars viz., Seb and Kaithali also have shown better activity of peroxidase compare to susceptible cultivars. However, peroxidase activity is less in case of cv. Illaichi leaves and fruits. Perhaps, this particular genotype may synthesis other oxidative enzymes in more quantity other than peroxidase.

Similarly, polyphenol oxidase is also one of the key enzymes involved in disease resistant reactions. In most of the genotypes tested, the activity is less than peroxidase. It is not varied in tender fruits while in leaves, some variation was observed. Young leaves of wild species recorded higher polyphenol oxidase activity than commercial cultivars. Among cultivars, Illaichi was found to have more PPO followed by Seb and susceptible cultivars (Fig.17). These oxidative enzymes are key proteins involved in biosynthesis of disease resistant chemicals or anti fungal compounds.. However, in obligate parasitism like is case of ber powdery mildew, this phenomenon is not well understood so far. Presently the results clearly demonstrate that the oxidative enzymes and total phenol content of particular genotype are important consideration to categorize powdery mildew reactions on the basis of biochemical indices.



YL Indicates young leaves, ML: matured leaves, OL: old leaves, TF: tender fruits and MF: matured fruits. The figure reveals that the wild species has more activity than commercial cultivars. Ber leaves are enriched with high PPO and therefore, the powdery mildew incidence is very low compare to fruits.

Fig. 17. Polyphenol oxidase activity in relation to ber cultivars differing powdery mildew reactions

Calcium ion in ber cultivars and powdery mildew reactions

In earlier investigations, it was found that calcium ion content is variable between the genotypes which are already under commercial cultivation. Such cultivars are also differ in powdery mildew resistance reactions. It can be considered as a biochemical marker for screening ber genotypes. Therefore, the ber cultivars viz., Gola, Umran, Seb Mundia; moderately susceptible cultivars viz., Kiathali, Jogia, Reshmi, Banarasi Karka ,Kathal, Chhuhara, Ponda, Nazuk, Sandhur, Laddu, Banarasi, Surti, Akhreta and Tsabtaso and the resistant cultivars viz., Rohtak Safeda, Chanchal, Govindgarh, Dandan, Narma, Saneur-1, Shamber, Badami, Safeda, Jhajjar Selection, Glory, Mirchia, KalaGola, BS-75-3-1, Narikela, Villaiti, Guli, ZG-2,Saferchandi, Illaichi, Kathapal, Seo, Sanuer-3, Kishmis and Chinese) were subjected to estimation of calcium content. Different stages of leaves (tender/young, maturing and matured/old) and fruits (tender/young and matured) were assessed. Cumulative analysis of data showed that, susceptible cultivars contain less calcium ion ranging between 0.47 and 0.61 in tender leaves 0.54 and 0.68 in maturing leaves, 0.68 and 0.72 in matured leaves and 0.17 and 0.23 in tender fruits and 0.19 and 0.28 in matured fruits of susceptible cultivars. In case of moderately susceptible genotypes, obviously, high calcium content was observed. Among 45 genotypes analyzed, maximum level of 0.95% was recorded in matured leaves of cv. Kathapal and Sanuer-3 followed by 0.90% in Seo. The maturing and tender leaves of these genotypes were also enriched with high calcium content. Similarly, fruits of wild species (*Z.nummularia*) were observed with more calcium than commercial cultivars. The pooled analysis of data on average calcium content in different categories of ber genotypes revealed that fruits samples are least in calcium content followed by tender/ young leaves (Fig 18). Since tender fruits are less in disease resistant molecules like calcium, powdery mildew infection and rapid colonization occur under favorable conditions. Therefore, this particular chemical could serve an important factor as biochemical basis in screening of ber genotypes.

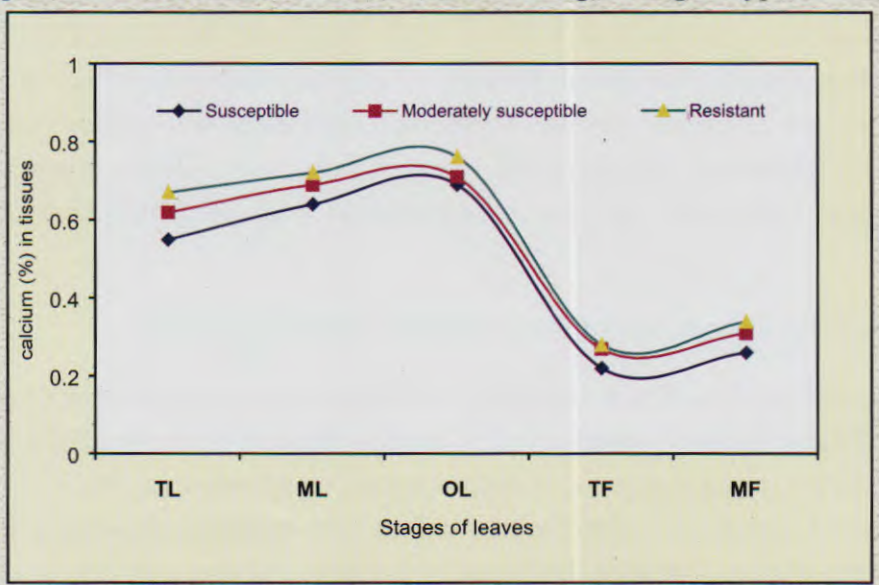


Fig. 18. Average calcium ion (%) in ber genotypes differing in Resistance

Standardization and electrophoration of protein fractions of ber powdery mildew isolates

Powdery mildew incidence in ber is influenced by the environmental factors along with the relative genetic resistance level of the respective host. Percent incidence is varied with the stages of plant canopy. Differences in pathogenecity may exist within ber powdery mildew isolates and practically, it is intricate to study the rate of virulence in obligate parasitism because lot of variations occur through asexual reproduction. Investigation on biochemicals or in other words, chemo taxonomic characters of such tough organism will be feasible. Considerable attention has been made in majority of the plant pathogens The nature and intensity of the protein bands in gels may get varied between isolates. Therefore, quantification and subsequent fractionation of constitutive protein of powdery mildew isolates are important part to differentiate isolates.

Total protein content in powdery mildew isolates

Powdery mildew isolates from different locations viz., Rahuri (Maharastra), Detia (Madhya Pradesh), Jhansi and Faizabad (Uttar Pradesh) were subjected to electrophoration (SDS-PAGE). Isolates viz., Gola (J), Seb(J), Banarasi Karaka (J), Local (J), Gola (D), Seb (D), Umran (D), Amarawathi (D), Local (D), Gola (KG), Umran (KG), Kaithali (KG), Gola (H), Umran (H), Seb(H), Kaithali (H), Goal (G) and Umran (G) were used for electrophoration of protein profile. The conidial mass from fresh colonies was scrapped gently and suspended in ice cold Tris-HCL buffer and stored under freezer conditions. Total protein of these isolates was estimated as in case of host protein and the results are presented in table 100. The overall results revealed that the total protein content among ber powdery mildew isolates was not consistent. However, maximum of 30.20 microgram per milligram of protein was estimated from isolate collected from c.v. Gola (Faizabad). Samples from Jhansi showed less than 10 microgram except in case isolate from local cultivar. Similarly, protein content from other local cultivars was also inconsistent. Powdery mildew isolates from Detia (Maharastra) showed more than 25 microgram of protein. The possible reasons for such variations would be the influence of intrinsic factors either by respective host or isolate; mixing of epidermal cells along with conidia while processing for sample preparation. Therefore, this particular piece of work needs further attempts with advent of molecular biological techniques for price estimation not only of protein and other biochemical molecules.

Total protein content in ber cultivars differ in powdery mildew reactions

It is well established fact that the protein is an important constituent required for the growth and colonization of obligate parasites like powdery mildew fungus. In most of the host plants, such compounds are exist in varying proportion in different parts. Constitutive nature of protein may serve as source of nutrient and perhaps, powdery mildew pathogen may prefer accordingly for it infection. In earlier studies, it was clearly indicated that protein content in varying cultivars to cultivars and even within the cultivar, quantity vary inn stages of leaves and fruits. Therefore, ber genotypes viz., Gola,

Umran, Seb Mundia; moderately susceptible cultivars viz., Kiathali, Jogia, Reshmi, Banarasi Karka ,Kathal, Chhuhara, Ponda, Nazuk, Sandhur, Laddu, Banarasi, Surti, Akhreta and Tsabtaso and the resistant cultivars viz., Rohtak Safeda, Chanchal, Govindgarh, Dandan, Narma, Sanuar-1, Shamber, Badami, Safeda, Jhajjar Selection, Glory, Mirchia, KalaGola, BS-75-3-1, Narikela, Villaiti, Guli, ZG-2,Saferchandi, Illaichi, Kathapal, Seo, Sanuer-3, Kishmis and Chinese) were analyzed for total protein.

Results revealed that resistant genotypes are rich in protein followed by moderately susceptible. However, maximum content of 55 mg/g has been estimated in tender leaves of cv. Surit which is moderately susceptible. In contrast to calcium ion, matured leaves and fruits of ber cultivars are weak in total protein and therefore, it may be one of the reasons for the pathogen to fail in infection and colonization. Results presented in figure 19 revealed that tender leaves and fruits are having more protein compare to maturing leaves. matured leaves and fruits. However, within different groups of reaction categories, protein levels differ. In some genotypes, this particular nutrient was found inconsistent in different stages of leaves. Under such conditions, the qualitative assessment with advent of molecular biological technique is essential and hence these genotypes were subjected to fractionation of total protein through PAGE and the detailed results are presented separately.

Table 100. Total protein content of ber powdery mildew isolates from different locations

Locations	Source of ber powdery mildew isolates					
	Gola	Umran	Seb	Kaithali	Others	
Rahuri (MH)	12.0	-	-	7.4	Popular Gola	9.8
					Illaichi	7.0
					Illaichi Jhajjar	9.0
					Saferchadi	7.8
					Karaka	12.0
					Chuhhara	14.8
Detia (MP)	26.0	26.2	24.4	-	Amarawati	16.6
					Local	11.2
Jhansi (UP)	6.4		6.8	-	B.karaka	7.0
					Local	11.8
Faizabad (UP)	30.2	28.8	-	8.8	Selection-I	11.8
					Selection-II	24.9

Figures are total protein in micro gram per milligram of conidia

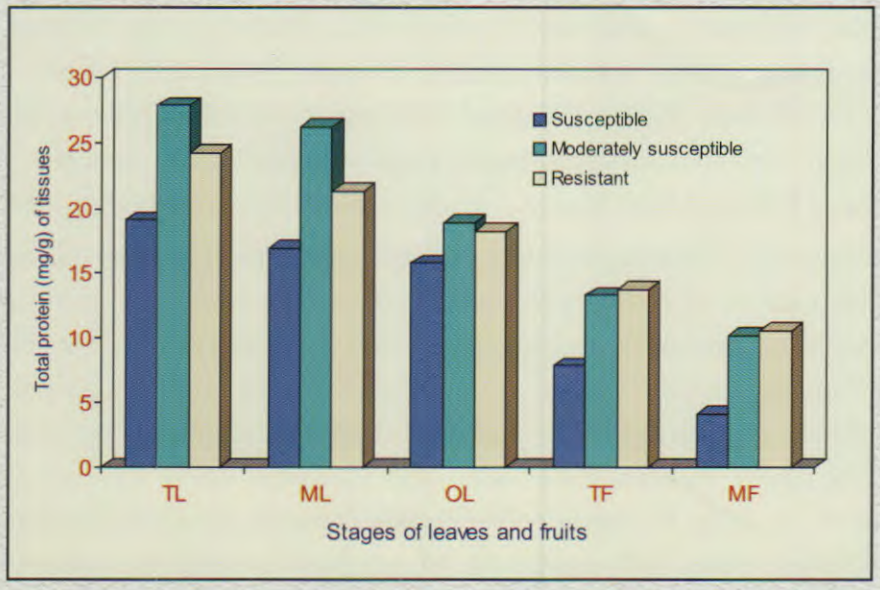


Fig. 19. Average total protein in ber genotypes differ in PM resistance

Standardization of electrophoration of total protein from powdery mildew isolates and *Ber* cultivars

Protein profile of ber powdery mildew isolates

Considerable attention has been made in majority of the plant pathogens and it is used to determine variability. Protein profile pattern of that particular isolate can help in maintenance and purification from the natural population. At the time of electrophoration, conidia were ground thoroughly and the concentrated protein has been subjected to electrophoresis. Protein bands were visualized after sequence of processing and the results revealed that the protein bands were very faint and inconsistent. Perhaps, the quantity of protein applied in each well might have denatured due to environmental induced variability. Therefore, this particular piece of work has to repeated with fresh samples from different locations.

Protein profile of ber leaves from different genotypes in relation with powdery mildew resistance

Since majority of the highly susceptible *ber* cultivars are varying in total protein content and hence, electrophoration was carried out in *ber* cultivars to assess the qualitative nature in relation to powdery mildew reactions. The protein fractions bands were visualized only in bottom of the gels. There were few bands above the intensive bands. All genotypes showed similar kind of protein bands with varying intensity between genotypes. It indicated that the concentration of protein could have been responsible for such variability and therefore, subsequently, the susceptible cultivars viz., Gola, Umran, Seb Mundia; moderately susceptible cultivars viz., Kiathali, Jogia, Reshmi, Banarasi, Karka ,Kathal, Chhuhara, Ponda, Nazuk, Sandhur, Laddu, Banarasi, Surti, Akhreta and Tsabtaso and the resistant

cultivars viz., Rohtak Safeda, Chanchal, Govindgarh, Dandan, Narma, Saneur-1, Shamber, Badami, Safeda, Jhajjar Selection, Glory, Mirchia, KalaGola, BS-75-3-1, Narikela, Villaiti, Guli ZG-2,Saferchandi, Illaichi, Kathapal, Seo, Sanuer-3, Kishmis and Chinese) were used for electrophoration. Powdery mildew intensity is varied in different plant parts of ber and hence, young fruits, matured fruits, young leaves, maturing leaves and matured leaves were subjected to protein extraction separately. Proteins was extracted from all these genotypes and concentrated in phosphate buffer in the form of powder and loaded in each wells after dissolving in buffer. Since the protein has different fractions having different molecular weight, the relative mobility of bands was calculated. Each genotypes yielded different pattern of protein fractions and the mobility in terms of R_f values of individual bands was calculated and compared with genotypes resistance reactions.

Results presented in table 101 revealed that leaf samples of cv. Gola, Seb, Umran, Kaithali, Mundia and Jogiya expressed a total of 30 fractions having the R_f values ranging from 0.11 to 0.82. Among these genotypes, susceptible cultivars viz., Gola and Seb were having similar type of bands of R_f 0.57, 0.65, 0.8 and 0.82 except in case of Mundia having two bands of R_f 0.46 and 0.53. Moderately susceptible cultivars Kaithali and Jogiya were also having similar kind of protein bands of R_f 0.57 and 0.46 . However, these genotypes could be resolved with additional fractions of R_f 0.11,0.56, 0.61 and 0.76. The tender and matured leaves did not vary much in fractions but the intensity was different indicating the nature of protein. Perhaps, the concentration or intensity of such protein fraction may be related with level of powdery mildew infection. In addition, different quality of protein bands found in moderately susceptible cultivars may also be related with powdery mildew infection level and which would serve as molecular marker for identification of genotypes in varietal improvement programme.

Leaf samples from Mundia, Laddu, Rhotak Safeda, Chanchal, Govidgargh and Reshmi were studied under protein profile. Under field conditions, these genotypes are varied in powdery mildew reactions. There were a total of 4 bands having R_f values ranging from 0.07 to 0.97 and a common fraction at 0.55 could be seen almost in all the genotypes. In case of resistant cultivars, additional band at R_f 0.30 was observed. In addition, two distinct and intensive bands also could be visualized at R_f 0.66 and 0.94 in cv. Govindgarh which is reported to be resistant to powdery mildew incidence (Table 102).

In another set of samples, moderately susceptible genotypes were taken up for investigation of protein profile. In this study, tender and matured leaves from cultivars viz.,Banarasi karak, katha,Chhuhara, Ponda and Sandur were analyzed. The over all results presented in table 103) revealed protein bands were faint or not clear in irrespective of the genotypes except in few cases. In all these moderately susceptible cultivars, fractions of protein at R_f 0.49,68 and 0.88 were observed. However, in case of Banarasi karaka the fractions were different. The former had the protein bands at R_f 0.27,0.39 and 0.63 which are distinct. In case of cv. sandhur also, an intensive and different kind of protein band was noticed. Tender and matured leaves of all these genotypes did not vary in protein bands but tender or young leaves of Banarasi karaka and Ponda had more number of protein fractions than matured leaves.

Table 101. Electrophoretic protein fractions of different genotypes of ber

R_f/ Stages	Gola (S)		Seb (S)		Umran (S)		Kaithali (MS)		Mundia (S)		Jogiya (MS)	
of leaves	T	M	T	M	T	M	T	M	T	M	T	M
0.11												
0.46									+	+	+	+
0.53									+			
0.57			+	+	+		+					
0.61								+			+	+
0.65	+	+	+		+	+						
0.69							+					
0.76						+	+	+		+	+	+
0.80	+	+	+	+	+							
0.82					+							
0.84												

T: Tender leaves M: Matured leaves

Table 102. Electrophoretic protein fractions of different genotypes of ber

R_f/ Stages of leaves	Mundia (S)		Laddu (MS)		Rohatak Safeda (R)		Chanchal (R)		Govindgargh		Reshmi (MS)	
	T	M	T	M	T	M	T	M	T	M	T	M
0.07	+											
0.11	+											
0.30				+	+		+		+			
0.40					+		+		+			
0.44		+		+								
0.47												
0.51	+											+
0.55	+	+		+	+		+	+	+	+		
0.59	+											
0.66										+		
0.94										+		
0.97												

T: Tender leaves M: Matured leaves

Table 103. Electrophoretic protein fractions of moderately susceptible genotypes of ber

R_f/ Stages of leaves	Banarasi Karaka (MS)		Katha (MS)		Chhuhara (MS)		Ponda (MS)		Sandur (MS)	
	T	M	T	M	T	M	T	M	T	M
0.27	+									
0.39	+	+								
0.49			+	+		+	+		+	
0.53				+						
0.57		+								
0.63	+									
0.68						+	+		+	+
0.80										
0.88						+	+		+	+
0.90										

T: Tender leaves M: Matured leaves

In spite of repeated run on PAGE with various combinations of samples and buffers, it was observed that the protein fractions are noticeably resolved from tender leaves than matured leaves. In order to get reliability and consistency in results, it was experienced that leaves must have uniformity in size and stage of growth. Moreover, it was also experienced that protein extraction from ber leaves is very tough due to the presence of mucilaginous nature of tissues compare with rest of the crops. Therefore, tender leaves in apical meristem portion of ber plants were collected in subsequent experiments. Tender leaves from cultivars viz., Gola, Umran, Kathapal, Sanur-3, Tsabtsto, Seo, Reshmi, Kaithali, Mundia, Chinese , Illaichi, Chhuhara, BS-75-3-1, Akherto, Chanchal and Jogiya were analyzed for protein profile (Plate 4 and 5). The resolution observed in plate.18 indicated a total of 36 bands with R_f values ranging from 0.07 to 0.96 (Table 104). Protein band having 0.50, 0.64 and 0.85 were observed in Umran, Kathapal, Kishmis, Sanur-3, Seo. In case of Tsabtso and Reshmi the fractions were different. Qualitative nature of such protein bands in response powdery mildew incidence would be important in screening of genotypes. Similarly from table 105, variability in protein profile can be seen. The moderately susceptible cultivars except Chhuhara, (Kaithali, Jogiya, Illaichi and Chanchal) were having more number of bands than susceptible genotypes like Mundia. Protein fraction at R_f 0.52 and 0.62 were observed in majority of test genotypes. In case of Illaichi, protein bands at R_f 0.67 and 0.68 were prominent than rest of the genotypes investigated. Additionally, fractions at 0.87 and 0.92 were also observed in this genotype.

In another set of ber genotypes viz., Sandur, Saferchandi, Akheta and Surti as moderately susceptible and Jhajjar selection, Glory, Govind Gargh and Safeda as resistant cultivars were subjected to electrophoration. The results presented in table 106. indicated that a fraction of R_f 0.98 could be observed in irrespective of the genotypes. However, cv. Glory which is resistant to powdery mildew had protein bands of R_f 0.65 and 0.71 where as in case of moderately susceptible cultivars, the protein fractions were resolved at R_f 0.92 and 0.94 indicating the difference between the resistant and moderately susceptible cultivars.

Table 104. Electrophoretic protein fractions of tender leaves from ber cultivars

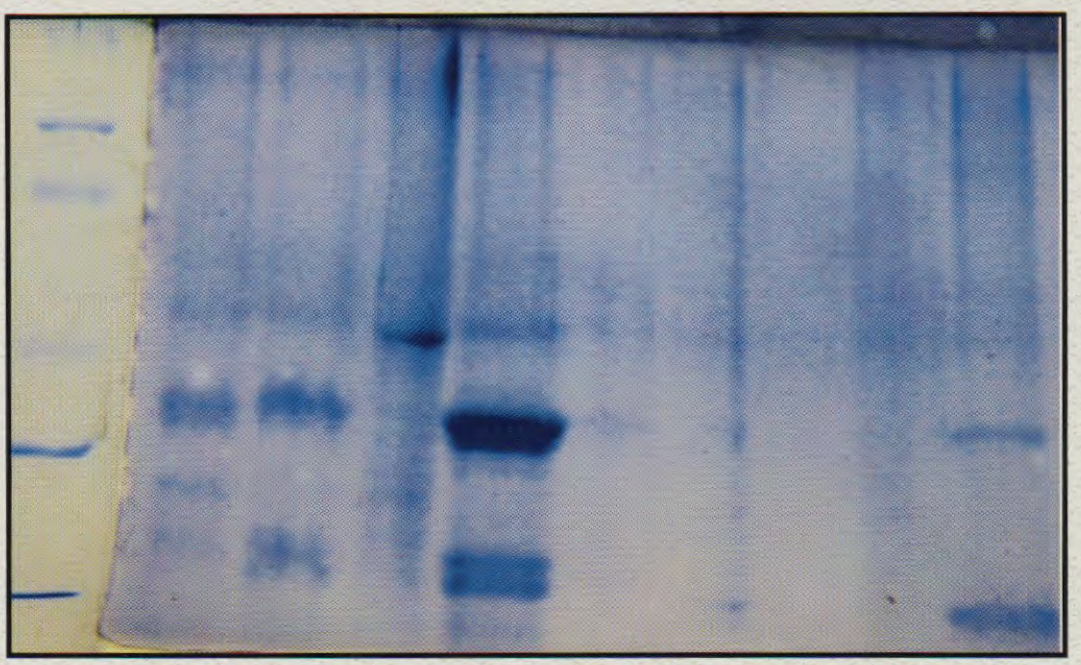
R_f / Genotypes	Marker	Gola (S)	Umran (S)	Seb (S)	Kathapal (R)	Kishmis (R)	Sanuer-3 (R)	Seo (R)	Tsabsto (MS)	Reshmi (MS)
0.07										
0.17	+	+								
0.28	+									
0.42		+								
0.46									+	
0.50			+		+	+	+	+		
0.54	+									
0.60		+	+				+	+		
0.62										+
0.64		+	+		+	+				
0.65					+	+				
0.67										
0.72	+									
0.75		+								
0.77			+							
0.78							+			
0.84			+		+	+				
0.85			+		+	+			+	
0.87								+	+	
0.89			+				+	+		
0.96	+									

Table 105. Electrophoretic protein fractions of tender leaves from ber cultivars

R_f values	Marker	Kaithli (MS)	Mundia (S)	Chinese (R)	llaichi (R)	Chhuhara (MS)	BS-75-3-1 (R)	Chanchal (MS)	Jogiya ((MS)
0.06									
0.17	+								
0.27	+								
0.45		+	+					+	
0.48								+	
0.52	+		+	+	+	+	+		+
0.60		+							
0.62		+	+	+	+				
0.65		+	+			+			
0.67					+				
0.68	+	+			+		+		+
0.74		+							
0.82		+		+			+		
0.87					+				
0.92					+				+

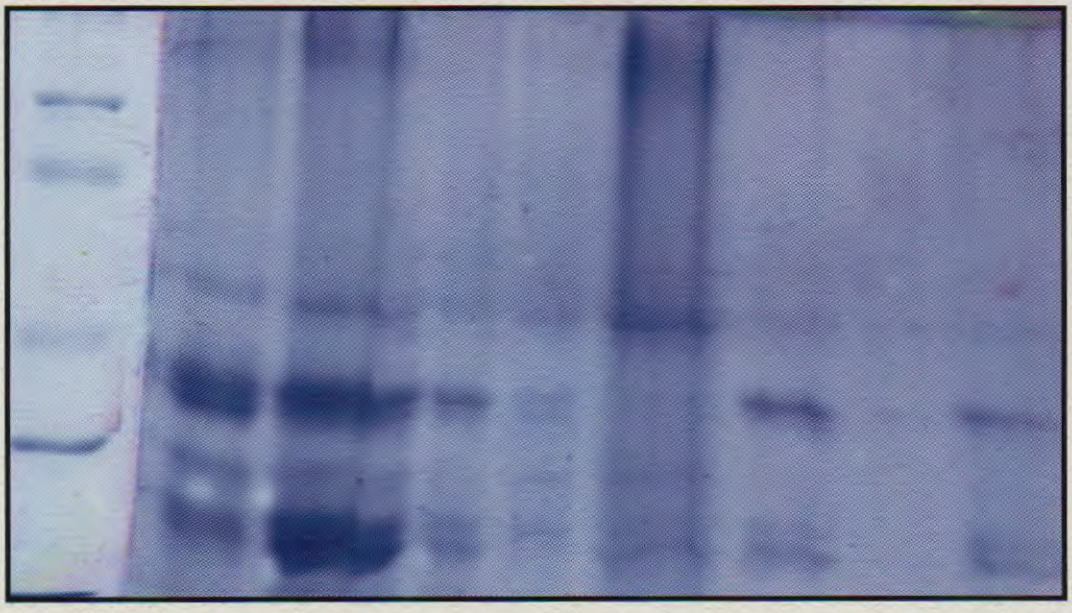
Table 106. Electrophoretic protein fractions of tender leaves from ber cultivars

R_f values	Govindgargh	Sandur	Surit	Safeda	Jhjjar selection	Glory	Akherta	Saferchandi
0.57								
0.61								
0.65						+	+	
0.69		+	+	+	+			
0.70	+							
0.71						+		
0.85							+	+
0.86	+				+			
0.92		+	+	+				
0.94							+	+
0.98	+	+	+	+	+			



Marker Gola Umaran Seb Kathapal Kishmis Sanuer-3 Seo Tsabsto Reshmi

Plate 4. Protein profile of tender and matured leaves of ber cultivars



Marker Kaithali Mundia Chinese Illaichi Chhuhara BS-75-3-1 Chanchal Jogia

Plate 5. Protein profile of tender and matured leaves of ber cultivars

Ber genotype Ponda, Laddu, Banarasi as moderately susceptible and Badami, Narikela, Dharaki, Saferchandi, Kathapal, ZG-2, Guli, Kishmis, and Chinese as resistant were also subjected to elucidation of protein profile and their relationship with powdery mildew reactions. A total of 36 bands with variable intensity and relative mobility were observed. The R_f values of these bands were ranging from 0.30 to 0.95. In Ponda and Laddu, the R_f values were different being 0.46; 0.30 and 0.36 respectively (Table 107). These bands were not found in other genotypes. However, protein bands at R_f 0.60,0.69,0.92 and 0.93 were observed in irrespective of the genotypes. Resistant genotypes like Badami and Nazuk were resulted in two separate bands at R_f 0.64. Similarly, Nazuk and Saferchandi were also resulted with a protein fraction at R_f 0.8 and 0.84 respectively. In addition, a separate band of R_f 0.86 was noticed in case of Badami, Narikela and Dharaki. Therefore, these distinct protein quality exists in such resistant cultivars may play critical role in powdery mildew incidence in addition to other biochemical constituents.

Electrophoration of protein from ber fruits in relation with powdery mildew resistance

Ber powdery mildew incidence could be observed at very early stage of fruits initiation and the rapid colonization occurs in tender fruits than matured fruits. In order to find out the qualitative nature of protein and their relationship towards the variability. Tender and matured fruits of cultivars Gola, Umran and Seb which are susceptible and Kaithali, Jogiya and Reshmi as moderately susceptible were subjected to electrophoration. There were a total of 34 bands having R_f ranging from 0.22 to 0.95 (Table 108). The

intensive and major fractions (0.22, 0.27,0.63 and 0.86) could be resolved in Umran, Seb, and Kaithali. However, bands were very faint or less intensive in Jogiya, Reshmi and Gola (Plate 6). In moderately susceptible genotypes (Kaithali, Jogiya and Reshmi), the protein bands ar R_f 0.43,0.50 and 0.90 could be observed which were not appeared in susceptible cultivars.

Similarly, young and matured fruits from ber cultivars viz., Sandur, Nazuk, Dandan, Naram and Sanuer-1 were tried. Proteins extracts from these genotypes were quantitatively measured and equal amount of proteins were loaded in each well of polyacralamide gel. The results (Plate 7) revealed that a total of 35 bands in these genotypes which are bound with common fractions of protein having R_f ranging between 0.05 to 0.81 except cv. Ponda and Nazuk were lacking a band at 0.59 in matured fruits and tender fruits of respective genotypes (Table. 109).

Protein profile was also investigated only in tender fruits of some of the cultivars like Jogiya (MS), Mundia (S), Seedless (R), Villaithi (R), ZG-2 (R) and Tsabtso (MS). It was found that the protein profile is different in each of the genotypes. A common fraction of R_f 0.90 was shared by Jogiya, ZG-2 and Tsabtso. All the resistant types possessed more number of protein bands than moderately susceptible and susceptible genotypes (Table 110). The results suggest that the tender and matured fruits are constituted with different mobility of fractions having different molecular weight and such proteins may be involved in the powdery mildew resistance.

Table. 107. Electrophoretic protein fractions of tender leaves from ber cultivars

R_f values	Ponda (MS)	Laddu (MS)	B.karaka (MS)	Badami (R)	Narikela (R)	Dharaki (R)	Villati (R)	S.Chandi (R)	ZG-2 (R)	Guli (R)	Nazuk (MS)
0.30		+									
0.36		+									
0.46	+	+									
0.49											
0.53											
0.58					+	+					
0.60			+								+
0.61											
0.64				+			+	+	+		+
0.67		+									
0.69				+	+	+					
0.76	+	+	+		+						
0.80											+
0.83			+								
0.84			+								
0.86				+	+	+					
0.90	+	+	+								
0.92	+								+	+	
0.93											+
0.95	+		+								

Table. 108. Electrophoretic protein fractions of tender and matured fruits from ber cultivars

R_f values	Gola (S)		Umran (S)		Seb (S)		Kaithali (MS)		Jogiya (MS)		Reshmi (MS)	
	T	M	T	M	T	M	T	M	T	M	T	M
0.22			+	+	+	+	+					
0.27			+	+	+	+	+					
0.36						+	+					
0.43									+			
0.50						+	+		+			
0.63		+	+	+	+	+	+	+				+
0.86		+	+	+	+	+	+	+				+
0.90												+
0.95												

Table. 109. Electrophoretic protein fractions of tender and matured fruits from ber cultivars

R_f values	Sandur (MS)		Ponda (MS)		Nazuk (MS)		Dandan (R)		Narma (R)		Sanuer-1 (R)	
	T	M	T	M	T	M	T	M	T	M	T	M
0.09		+										
0.13	+											
0.18		+	+			+				+	+	
0.22	+						+					
0.31		+										
0.34												
0.36				+								
0.45		+										
0.54												+
0.59	+	+	+			+	+	+	+	+	+	
0.61				+	+							
0.81	+	+	+	+	+	+	+		+	+	+	+

Table 110. Electrophoretic protein fractions of tender fruits from ber cultivars

Rf Values	Katha (MS)	Mundia (S)	Seedless (R)	Villaiti (R)	ZG-2 (R)	
0.43						
0.45						+
0.47	+			+		
0.52						
0.65					+	
0.67				+		
0.71	+	+				
0.74						
0.79	+		+			
0.81					+	
0.83	+			+		
0.85						
0.89	+		+			
0.90					+	+
0.92				+	+	+

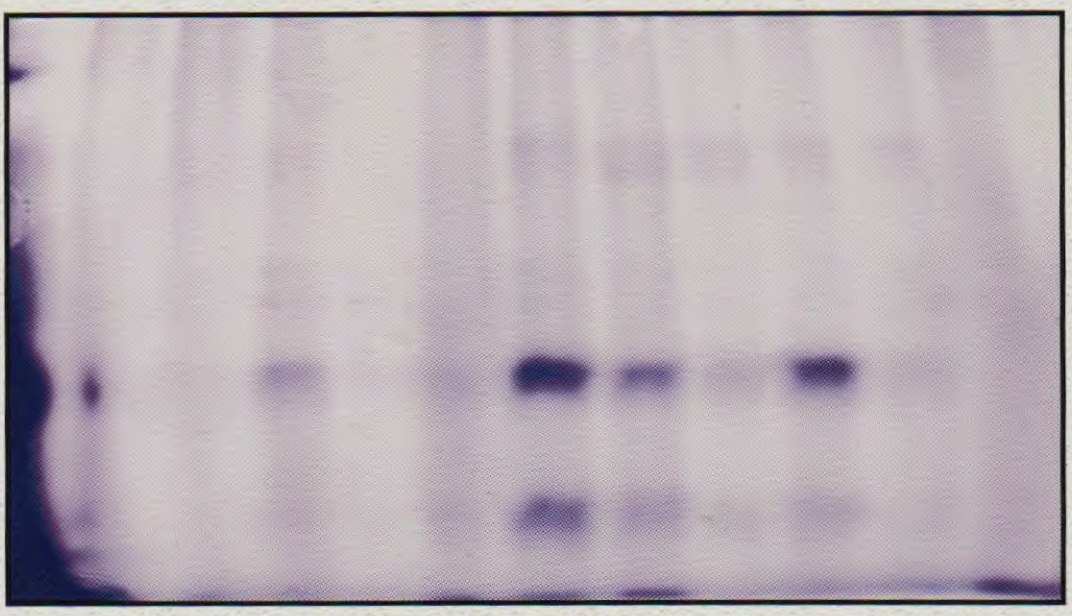
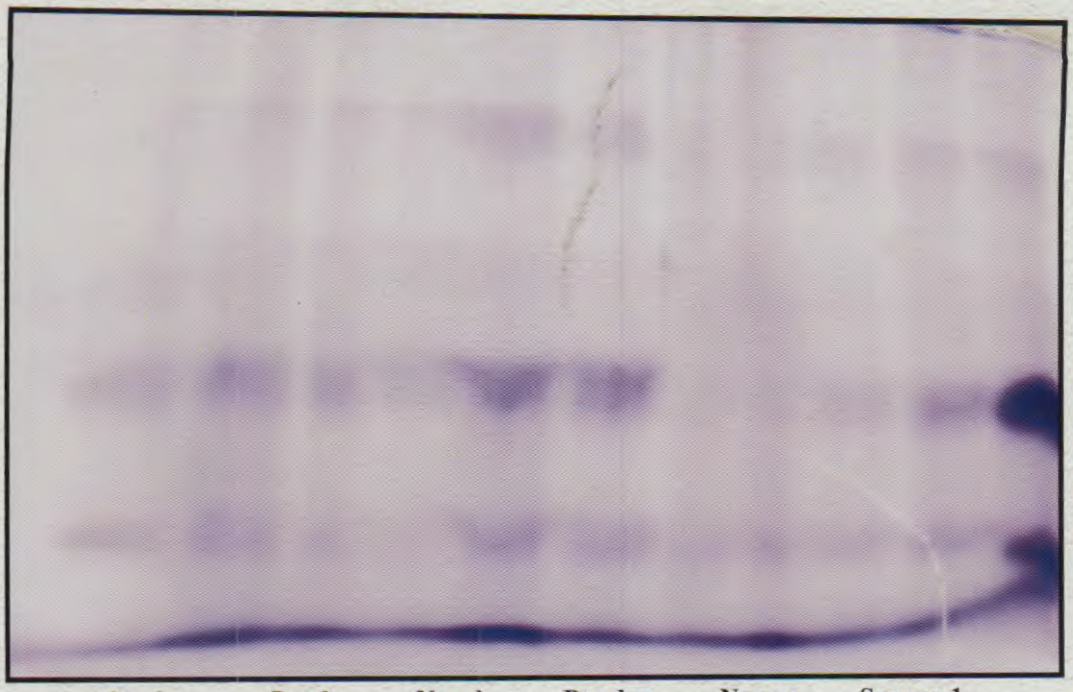


Plate. 6. Protein profile of tender and matured fruits of ber cultivars



Sandur Ponda Nazuk Dandan Narma Sanuer-1

Plate. 7. Protein profile of tender and matured fruits of ber cultivars

D. Revolving fund scheme on commercial propagation of fruit crop.

Location: CHES, Godhra

During the period, following quantity of plant material was propagated and sold:

1. Mango - 3143 Nos.
2. Aonla - 4658 Nos.
3. Sapota - 1264 Nos.
4. Ber - 822 Nos.
5. Guava - 1135 Nos.
6. Pomegranate - 171 Nos.
7. Custard apple - 956 Nos.
8. Kagzi lime - 492 Nos.

Farm development

At CIAH, Bikaner

1. Development and Management of CIAH farm

In addition to the existing area under cultivation, additional 7 ha was leveled for taking up new experiments. During the period under report 6 hectare area was brought under cultivation *i.e. bael* (1ha), minor fruits (1ha), mother block (2ha), aonla based cropping system (2 ha), stress physiology experimental block (1ha). Besides land development farm section is involved in maintenance of orchards for germplasm conservation, production-based crop experiments and seed production blocks covering *ber* (12), pomegranate (4), date palm (3), *aonla* (4), progeny block (4), vegetables (3), underutilized fruits (2), *bael* (1), cropping system, *aonla* (2), *ber* (1), kinnow, *khejri,* Pl.pathology, Pl.physiology- one each. Windbreak planted around the fenced area is also being maintained through the farm section.

2. Revenue generation

Through sale of vegetable seeds, auction of *khejri* leave, *guar* seed, sale of fresh fruits, planting material etc., revenue of about Rs. 1,00, 000 (Rupees one lac) was generated during the period under report.

3. Irrigation system

Water requirement in different blocks is mainly met through (i) IGNP water supply (ii) tube well (iii) overhead tank (5 lakh litre capacity) (iii) water reservoir of 25 lakh litre capacity which is mainly used for irrigation during the lean period through 4" main pipe line laid out in 3 Km area covering 50 hectares area either through open channel, controlled hose pipe, sprinklers (4 set), drip system (14ha). In the recent past a new water reservoir of 10 lakh litre capacity has been constructed. To fill this water reservoir efforts were made to bring water from IGNP channel through 1 BKM. With this facility live saving irrigation can be met out during periods of extreme crisis.

Pipeline for drinking water from electric sub station to farm complex was laid out in approximately 2 Km area to facilitate drinking water at certain points in field, farm complex, nursery and prisoners quarters.

At CHES, Godhra

So far, about 116 ha. land area has been put under cultivation. During the year, 5 ha. new area was

brought under cultivation of crop like *Jamun,* Tamarind and *Aonla*. Thus, the farm development was continued despite severe drought for the third consecutive year. Besides, two-hactare area in Block-II was planted with diverse species of fruit crops. Action has been initiated for beautification of premises in Block-II by planting *Gul Mohar, Ashoka* and Bouganvillea.

Construction work: One more underground water reservoir was constructed to facilitate watering to juenile plants and spraying operations. A submersible pump has been installed on the bore-well constructed in Block-III.

Work has been initiated for construction of second phase of compound wall. Six residential quarters and an overhead tank of 1 lakh litre capacity is nearly ready to be handed over to the Station by CPWD.

Staff position

Cadre Strength of the Institute as on 31.03.2003:

Category	Present strength
Research Management Position	01
Scientific	35
Administrative	28
Technical	43
Supporting	39
Total	**146**

Staff under A and B as on 31.03.2003

A. Headquarter

S.No.	Name	Designation/Discipline
I.	**Research Management Position**	
1.	Dr. D.G.Dhandar	Director
II.	**Scientific**	
1.	Dr. B.B.Vashishtha	Principal Scientist (Hort.)
2.	Dr. B.D.Sharma	Sr. Scientist (Soil. Sci.)
3.	Dr. P.L. Saroj	Sr. Scientist (Hort.)
4.	Dr. R. Bhargava	Sr. Scientist (Plant Physiology)
5.	Dr. O.P.Awasthi	Sr. Scietnist (Hort.)
6.	Dr. Dhurendra Singh	Sr. Scientist (Bio-tech.)
6.	Dr. R.S. Singh	Scientist Sel. Grade (Hort.)
7.	Dr. D.B. Singh	Scientist Sr. Scale (Hort.)
8.	Dr. D.K. Samadia	Scientist Sr. Scale (Hort.)
9.	Dr. P. Nallathambi	Scientist Sr. Scale (Plant Pathology)
10.	Smt. C. Umamaheswari	Scientist (Plant Pathology)
11.	Dr. Anil Kumar Shukla	Scientist (Hort.)
12.	Sh. Sumer Singh Meena	Scientist Hort. (Vegetable crop)
13.	Dr. Arun Kumar Shukla	Scientist Hort. (Fruit crop)
14.	Sh. A. Nagaraja	Scientist Hort. (Fruit crop)
15.	Dr. S.R. Meena	Scientist (Agril. Extension)
16.	Dr. I.S. Singh	Scientist (Soil Phy.-SWC)

III.	**Administrative**	
1.	Sh. R.P. Singh	Administrative Officer (upto 31.01.2003)
2.	Sh. S.C. Sharma	Asstt. Fin. and Accounts Officer (w.e.f. 29.04.2002)
3.	Sh. V.K. Pandey	Asstt. Admn. Officer
IV.	**Technical**	
1.	Sh. S.K.Pandey	T-5 (Technical Officer) Farm
2.	Sh. M.K.Jain	T-4 (Sr. Computer)
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)

B. Regional Station (CHES, Vejalpur)

S.No.	Name	Designation/Discipline
I.	**Scientific**	
1.	Dr. B.G. Bagle	Principal Scientist (Ento.) & I/c 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. Appa Rao	Scientist (Soil Science)
6.	Sh. V. Lenin	Scientist (Agril.Extension)
7.	Dr. A.K. Singh	Scientist (Hort.)
8.	Sh. Raja Shankar	Scientist (Hort.)
9.	Sh. D.T. Meshram	Scientist (Soil and Water Conservation & Engineering)
II.	**Administrative**	
1.	Sh. J.B. Saxena	Asstt. Admn. Officer
III.	**Technical**	
1.	Sh. D.K. Saraswat	T-8 (Technical Officer) Farm
2.	Sh. Nihal Singh	T-6 (Technical Officer) Farm
3.	Sh. G.U. Trivedi	T-5 (Librarian)
4.	Sh. A.V. Dhobi	T-4 (Overseer)
5.	Sh. M.N.Makwana	T-4 (Hindi Translator)

Finances

Budget allocation and expenditure incurred during 2002-03 are given in table below.

Budget allocation and expenditure incurred during 2002-03

S.No.	Head	Plan		Non-Plan	
		Allocation	Expenditure	Allocation	Expenditure
1.	Establishment Charges	-	-	159.47	159.47
2.	Wages (Temp. status)	-	-	34.63	34.62
3.	T.A.	4.00	4.00	1.20	1.20
4.	O.T.A.	-	-	-	-
5.	Works	34.09	34.09	1.00	1.00
6.	Other Charges	63.91	63.91	34.80	34.80
7.	One time catchup grant	-	-	-	-
	Total	**102.00**	**102.00**	**231.10**	**231.09**

Publications

A. Research papers

Awasthi, O.P., D.G. Dhandar and I.S. Singh (2003). Land use diversification through multistrata cropping system in arid region. *Paper presented in poster session of 6th Agricultural Science Congress,* organized by National Academy of Agricultural Sciences from February 13-15, 2003 at Bhopal.

Bhargava, R., R.S.Singh, B.B.Vashishtha and D.G.Dhandar (2003). Photosynthetic parameters in Tissue culture and sucker plants of date palm cultivars. 2nd International Congress of Plant Physiology on Sustainable Plant Productivity under changing environment held at New Delhi, India from Jan 8-12, 2003.

Dhandar, D.G. and B. D. Sharma (2002) Micro irrigation for fruit crops in India. In: National Symposium on Soil and Water Conservation Measures and Sustainable Land Use Systems with Special Reference to the Western Ghats Region held at ICAR Research Complex for Goa from November 16-17, 2002. pp: 95-106.

Dhandar, D. G., B. B. Vashishtha, D. K. Samadia and R. S. Singh (2002) Conservation of horticultural bio-diversity in hot arid region of India (Lead paper) In: Workshop on Bio- diversity Conservation, National Institute of Rural Development: Hyderabad, 12-15 August 2002.

Hiwale, S.S. & S.P.Singh (2002). Prolonging shelf life of guava (*Psidium guajava* L.). Indian J. Hort., March, 2003-Ph. D. Work)

Hiwale, S.S. (2002). Multipurpose Agroforestry species for the dry lands of Western India. Ber (*Zizyphus mauritian*). Indian Farming (Accepted for publication)

Hiwale, S.S.& S.P.Singh (2002). Value addition through prolonging shelf life of Ber (*Zizyphus mauritiana* Lamk.).(part of Ph.D. work).

Hiwale, S.S., S.P.Singh & M.Parmeshwaram (2002). Prolonging shelf life of Custard apple(*Annona squamosa* L.).(part of Ph.D. work).

Nallathambi, P., C. Umamaheshwari and D.K. Samadia, (2002). Arid cucurbit germplasm as potential source of disease resistance. Abstracts of contributed papers In: International Conference on Vegetables, Banglore: India, 10-14 November 2002, I 20P : 20.

Nallathambi, P. and B.B.L.Thakore.2002. Biocontrol potential of *Pseudomonas fluorescens* against fruit rot pathogen of ber, Proceeding on National Seminar on Role of Antimicrobials for Sustainable Horticulture, held at Indira Gandhi University, Raipur, p 30-31.

P.Nallathambi and B.B.L.Thakore.2002. Efficacy of *Trichoderma* isolates against fruit rot pathogen of ber. *Proceedings on National Seminar on Role of Antimicrobials for Sustainable Horticulture, Antimicrobials for Sustainable Horticulture*, held at Indira Gandhi Agricultural University, Raipur. p 30

Pareek, O. P. and D. K. Samadia (2002). Promising Indigenous Cucurbit Varieties. Indian Horticulture 47 (2): 15-18.

Samadia, D. K. (2003). Snapmelon production technology for arid and semi arid areas. Intensive Agriculture 40 (1-2): 27-29.

Samadia, D. K. and R. C. Khandelwal (2002). Combining ability in bottlegourd. Indian J. Hort., 59 (4): 402-405.

Samadia, D. K. (2002). Performance of bottlegourd genotypes under hot arid environment. Indian Journal of Horticulture 59 (2) : 167-170

Samadia, D. K., A. K. Purohit and O. P. Pareek (2002). Genetic diversity in vegetable type *khejri*. Indian J. Agroforestry 4(2): 132-134.

Samadia, D. K., B. B. Vashishtha and D. G. Dhandar (2002). Evaluation, characterization and utilization of Indian bean germplasm under hot arid environment. Abstracts of contributed papers In: International Conference on Vegetables, Banglore: India, 10-14 November 2002, I-14P: 18-19.

Samadia, D. K., B. B. Vashishtha and D. G. Dhandar (2003) Arid vegetables for nutritional security in Indian desert. In: IX Asian Congress of Nutrition, New Delhi, February 23-27, 2003. Abstract of paper PFC2-94 : 168.

Samadia, D. K., D. B. Singh and B. B. Vashishtha (2002) Genetic diversity in *ker* : A traditional fruit plant of Indian desert. Indian Horticulture (Accepted).

Samadia, D. K., P. Nallathambi, B. B. Vashishtha and D. G. Dhandar (2002). Quality improvement in drought *mateera* (*Citrullus lanatus*) under hot arid conditions. Abstracts of contributed papers In: International Conference on Vegetables, Banglore: India, 10-14 November 2002, II-86P : 84-85.

Samadia, D. K., R. C. Ashwani and B. B. Vashishtha (2003) Genetic diversity in Indian bean. Vegetable Sciences (Communicated).

Samadia, D. K. and O. P. Pareek (2001). AHW 19 and AHW 65: New *mateera* varieties. Indian Horticulture 46 (2) : 8-9 & 21

Samadia, D.K.,P.Nallathambi.,B.B.Vashishtha, and D.G.Dhandar (2002). Quality improvement drought *mateera (Citrullus lanatus)* under hot arid conditions. Abstracts of contributed papaers In: International Conference on Vegetables, Bangalore, India, 10-14 November, 2002, I-14p: 18-19.

Saroj P.L, D.G. Dhandar, B.D. Sharma and R. Bhargava (2003). Evaluation of ber based cropping system for hot arid ecosystem of north-western Rajasthan. Paper presented in Agriculture Science Congress, at IISS, Bhopal from 13-15, February 2003.

Saroj, P.L. and R. K.Tiwari (2000). Ways and means to utilize degraded lands through horticulture in central and peninsular India. *Advances in Plant Science Research*, 12: 39-46.

Saroj, P.L., B.D. Sharma, R. Bhargava and C.K. Purohit (2002). Allelopathic influence of aqueous leaf extracts of ber (*Ziziphus mauritiana* L.) on germination, seedling growth and phytomass of groundstorey crops. *Indian. J. of Agroforestry*, 4(1): 57-61.

Saroj, P.L., D.S. Tomar and Y.K. Arora (2000). Peach based agroforestry systems in degraded foothills of north-western Himalayan region. *J. Appl. Hort.*, 2(1): 21-24.

Sharma, B.D. (2002) Scope and Importance of fertigation in arid ecosystem. In: Compendium on management of arid horticulture. (Eds. Atul Chandra), Director of Extension, RAU, Bikaner.pp: 111-120.

Sharma, B.D., B. B. Vashishtha, D. G. Dhandar and R. S. Singh (2003) Review and refinement of fertilizer recommendations for arid fruit crops in Rajasthan. In: PPIC, Gurgaon held at MPAU, Udaipur, February 21, 2003.

Sharma, B.D., D.G. Dhandar and B.B.Vashishtha (2002). Response of ber (*Ziziphus mauritiana* var. rotundifolia Lamk) to drip fertigation in aridisols of western Rajasthan. In: National seminar on sustainable management of water resources for enhanced agricultural production held at BSKVV, Dapoli from October 26-28, 2002, p: 59-60.

Sharma, B.D., D.G.Dhandar, B.B.Vashishtha and R.Bhargava (2002) Effect of moisture regimes and N-fertigation through drip on growth and yield of pomegranate (*Punica granatum* L.). In: National seminar on sustainable management of water resources for enhanced agricultural production held at BSKVV, Dapoli from October 26-28, 2002, p: 59.

Sharma, B.D., D. G. Dhandar, B. B. Vashishtha and R. Bhargava (2003) Impact of integrated nutrient management on soil fertility, growth and yield of pomegranate under arid agro-ecosystem. In: 6th Agricultural Science Congress on Multi-Enterprises System for viable Agriculture at IISS, Bhopal. 13-15 February 2003.

Sharma, B.D.; B.B.Vashishtha; D.G.Dhandar and R.S.Singh (2003). Review and Refinement of fertilizer recommendation for arid fruits in Rajasthan. In Seminar on uses of Potash and organized by PPIC, Gurgaon and held at M.P.A.U., Udaipur on 20.2.2003.

Sharma, R.R., S.K. Saxena, A.M. Goswami and A.K. Shukla (2002). Effect of foliar application of calcium chloride on fruit cracking yield and quality of Kagzi Kalan lemon. *Indian J. Hort.* 59 (2): 145-149.

Shukla Arun Kumar, Anil Kumar Shukla, B.P. Singh and A.K. Singh (2002). Effect of plant spacing and level of nitrogen on flowering and yield of Papaya (*Carica papaya*) var. Pusa Delecious. 26th International Horticultural Congress Toranto Canada. 11-17 August.

Shukla, A.K., R.K. Pathak and R.P. Tewari (2002). Response of drip irrigation and mulching in relation

to plant growth and leaf nutrient status of Indian goose berry in sodic soil. 26th International Horticultural Congress Toranto Canada. 11-17 August.

Shukla, Anil Kumar, Shukla, Arun Kumar, Sharma, R.R. and Goswami, A.M. (2002) Response of nutrition on chlorophyll content and carbon assimilation rate of Kinnow under high density planting. 26th International Horticultural Congress Toranto Canada. 11-17 August.

Singh D.B.; O.P.Awasthi and R.S.Singh (2003). Effect of pruning heights on growth, fruit yield and quality in *Phalsa*. The Hort. J. (Communicated).

Singh, D.B.; R.S.Singh, O.P.Awasthi, D.G.Dhandar, B.B.Vashishtha (2003). Role of unexploited fruits of arid zone for nutritional ecological and social security. IXth Asian Congress of Nutrition, Feb. 23-27, 2003, New Delhi, India.

Singh, D.B., R.S. Singh, O.P. Awasthi, D.G. Dhandar and B.B. Vashishtha (2003). Role of unexploited fruits of Arid Zone for nutritional ecological and social security. *Paper presented in IX Asian congress of Nutrition* held at Delhi from February 23-27, 2003, by the first author.

Singh, R.S.; D.K.Samadia and B.B.Vashishtha (2002). Genetic diversity in date palm. Indian Horticutlure (Communicated).

Umamaheswari, C., P.Nallathambi and B.S.Nathawat. 2002. Fungicide resistance in *Tirchoderma* isolates of arid conditions. *Proceedings on Asian Congress of Mycology and Plant Pathology*: Plant Health for Food Security, held at University of Mysore,p.184.

B. Popular/Technical Extension Articles

Bagle, B.G., A.K. Singh, Trivedi, Meena and D.K. Sharma (2003). Mosambi, Special issue on fruit crops. *Krishi Go-vidya,* pp: 167-168.

Singh, R.S. and D.G.Dhandar (2002). Shushka Shektra mein khajoor utpadan (in hindi),Unnat Krishi (Communicated).

Samadia, D. K. (2002) *Bahu-upayogi kachari* (Hindi) *Unnat Krishi* 41 (3) : 30-31.

विशाल नाथ एवं आर.एस.सिंह (2002). लाभप्रद व्यवसाय है–ग्वारपाठा की खेती। राजस्थानी खेती; 3(5): 28–29.

शुक्ल अरूण कुमार, शुक्ल अनिल कुमार, अवस्थी ओ.पी. एवं वशिष्ठ बी.बी. (2002). शुष्क क्षेत्रा में आंवला उत्पादन (१) कृषि चयनिका, जुलाई–सितम्बर, पेज 20–22.

शुक्ल अरूण कुमार, शुक्ल अनिल कुमार, अवस्थी ओ.पी. एवं वशिष्ठ बी.बी. (2002). शुष्क क्षेत्रा में आंवला उत्पादन (प्स) कृषि चयनिका, अक्टूबर–दिसम्बर, पेज 32–34.

Saroj P.L. (2002). Genetic diversity of khejri (*Prosopis cineraria*) in Thar Desert. *SAIC News Letter*, 12(3): 11.

Saroj, P.L. (2001). Bagwani mein mulvrinto ka prayog (Hindi). *Unnat Krishi*, May-June, 2001, pp. 6-10.

C. Book Chapters/ Bulletins

B. D. Sharma (2002) Integrated management of micronutrients for sustainable crop production. In: Training Programme for State level officer on Integrated Nutrient Management for sustainable crop Production. Held at Director of Extension, RAU, Bikaner pp: 34-40.

Shukla, Arun Kumar, Anil Kumar Shukla, J. Singh and I.S. Singh (2002). Damask Rose. Medicinal and Aromatic crops Vol. II Pub. By University Press, Hyderabad .

Shukla, Anil Kumar, Arun Kumar Shukla and A.K. Singh (2002) Dill seed. Medicinal and Aromatic crops Vol.II Pub. University Press, Hyderabad.

Dhandar, D.G., B.B. Vashishtha and P.L. Saroj (2002). CIAH, Programmes and Progress.

D. Lecture delivered

Dr. R.S.Singh

- Participated in Kisan Diwas programme of CAZRI, RRS, Bikaner held at Lakhusar village, Bikaner on 20.12.2002 and delivered a talk on "Importance of fruit plants cultivation in arid region".
- A lecture on "Fruit cultivation in arid region" delivered in "Farmers Training Programme at CIAH, Bikaner on 07.09.2002.

Dr. D. K. Samadia

- Vegetable production in arid region. In: One-day Farmers Training, organized on September 7, 2002 at CIAH, Bikaner.
- Technology for vegetable production in arid regions. In: Farmer's Day, organized on December 23, 2002 at CIAH, Bikaner.

Dr. P.L. Saroj

- Delivered a lecture on "Nursery Management" in a farmers training at CIAH, Bikaner dated 07.09.2002.
- Delivered a lecture on "Fruit cultivation and marketing" (Hindi) in a farmers training at RAU, Bikaner dated 07.8.2002.

Dr. B.G. Bagle

- **'IPM in horticultural crops'** at Vasad, on 03.09.2002
- **'Pest management in fruit crops'**organized by N.M.Satguru watershed management foundation, at Ajwa village, Halol taluka

Dr.S.S.Hiwale

- 'Role of horticulture in water shed development project' organized by Gujarat State Rural

Development Corporation, at Vadodara on 24/9/2002.

- 'Cultivation of Mango, Aonla, Lime' talk arranged by N.M. Sadguru water and development foundation, dahod on 17 & 26 April, 2002.
- `Cultivation of fruit trees under dry land condition' in the office of Deputy Conservation of forest (Social Forestry), Godhra on 27/2 /2003.
- 'Development of fruit tree culture in Narmada river catchment area' to the subject matter special of Gujarat State Land Development Corporation.
- 'Transfer of Horticultural Technology to Watershed areas of Waghodia' taluka organised by Central Soil and water Conservation Research and Training Institute , Vasad centre on 03/09/2002

Dr.H.K.Joshi

- 'IDM in horticultural crops' at Vasad, on 03.09.2002
- 'Disease management in fruit crops' at Jambudi village, Halol taluka, on 24/10/2002.

Mr. V.Lenin

- ***'Aonla ni kheti'*** **(Cultivation of *Aonla)*** to farm women trainees at Farmers' training Centre, Govt. of Gujarat, Dahod, Gujarat for specialized training programme in horticulture on 24.07.2002.

Mr. S.Raja

- **'Vegetable cultivation in central Gujarat'** to farm women trainees at Farmers' training Centre, Govt. of Gujarat, Dahod, Gujarat for specialized training programme in horticulture on 24.07.2002.

E. Radio Talk

- **Dr. Arun Kumar Shukla**
- Delivered **radio talk** on **Ber vergiya poudhon me kiye jane wale krishi karya** AIR Bikaner, 30.3.2003.

F. TV Telecast

Dr. P.L. Saroj

- Demonstrated the 'budding technique in ber' (Hindi) which was telecasted by E-TV dt. 05.08.2002

Dr. Anil Kumar Shukla

- Pest Management in ber at E-TV Rajasthan on 22nd December, 2002.

Human Resource Development

A. Training programme attended

Dr. Anil Kumar Shukla

Attended 21 days **Summer School** on "Production, protection and post harvest management of subtropical fruits" from 3rd June to 23rd June 2002, organized by CISH Lucknow.

Dr. D.K.Samadia

Attended short training course " *Ex situ* Conservation of Plant Genetic Resources, under Human Resource Development in Plant Genetic Resources Conservation and Management under Team of Excellence Mode of National Agricultural Technology Project at National Bureau of Plant Genetic Resources (ICAR): New Delhi, September 17 to October 11, 2002 (25 days).

Attended National Training Programme on "Protected Cultivation of Horticultural Crops, at Department of Horticulture, Centre for advance studies in Horticulture, MPKV, Rahuri (Maharastra), March 10-30 March, 2003.

Dr. P.L. Saroj

Attended a summer course on "Recent Advances in Production, Protection and Management of Sub-tropical Fruits" at CISH, Lucknow from 3-23 June, 2002.

Sh. S. Raja

Attended a winter school at IIVR, Varanasi from 03.12.2002 to 23.12.2002 on "Recent Advances in Vegetable Production Technology".

Dr. B.D. Sharma

Attended a training programme of Biodynamic and Organic farming at CISH, Lucknow on 18-20 April 2002.

B. Teaching

Dr. Anil Kumar Shukla, Scientist (Hort.) as a faculty member/course leader for the teaching of "Post harvest technology of horticultural crops" to the Post Graduate Student of RAU, Bikaner.

Dr. O.P.Awasthi taught a PG. Course entitle, "Production of Tropical and Temperate Fruits" (Horts. 613) to M.Sc Ag. (Hort.).

C. Foreign Visit

Dr. B.B.Vashishtha, Principal Scientist (Hort.) attended the establishment meeting of Date Palm Global Network (DPGN) at Al-Ain UAE (Abu Dhabi) from April 7-9, 2002.

Meeting /Seminars/Symposium/Workshop

Scientiest participated	Name of Meeting/Seminar/Symposium
Dr. D.K. Samadia, Sci. S.S. (Hort.)	Attended two day Group Meeting cum Orientation Training of Arid zone co-operating centres under NATP on sustainable management of plant bio-diversity, at NBPGR, RS Jodhpur, September 9-10, 2002.
	Attended the IX Asian Congress of Nutrition, New Delhi, February 23-27, 2003 and presented paper entitled "Arid vegetables for nutritional security in Indian desert. Abstract of the paper PFC2-94 : 168.
	Participated "Brain storming session on production potential, diversification and marketing of *ker*, *sangari* and *kumat*. Organized at Arid Forest Research Institute, Jodhpur, February 18, 2003.
	Attended One-day zonal workshop of working partners of Arid zone co-operating centres under NATP on sustainable management of plant bio-diversity, at NBPGR, RS Jodhpur, March 4, 2003.
Dr. B.D. Sharma, Sr. Sci. (Soil Sci.)	Research Advisory Committee, RAU, Bikaner as member nominee of Director, CIAH, Bikaner, held at Pant Krishi Bhawan, Jaipur, June 26, 2002.
	Extension Advisory Committee, RAU, Bikaner as member nominee of Director, CIAH, Bikaner, held at Pant Krishi Bhawan, Jaipur, June 27, 2002.
	Farmers Advisory Committee, KVK, RAU, Bikaner as member nominee of Director, CIAH, Bikaner, held at Pant Krishi Bhawan, Jaipur, June 26, 2002.
	Research Advisory Committee, CIAH, Bikaner, August, 2002 as member
Dr. R.S.Singh, Sci. S.G. (Hort.)	Visited Tissue Culture Lab., Mundra,(Kachhch) Gujarat on 5.12.2002 with Director, CIAH and Chairman of the committee and prepared a report of the same for compilation of Tissue Culture Lab. Visit Report of Rajasthan and Gujarat State.

Dr. P.L. Saroj, Sr. Sci. (Hort.) Dr. A. Nagraja, Sci. (PHT) Dr. O.P. Awasthi, Sr. Sci. (Hort.) Dr. S.R. Meena, Sci. (Agril. Exten.) Dr. I.S. Singh, Sci. (SWC)	Participated in 6th Agricultural Science Congress on "Multi-enterprise systems for viable agriculture" at IISS, Bhopal from 13-15th February, 2003.
Dr. R. Bhargava, Sr. Sci.	Participated in 2nd International Congress of Plant Physiology on Sustainable Plant Productivity under changing environment held at New Delhi, 8-12 Jan., 2003.

Joining

- Shri S.C.Sharma joined as Assistant Finance and Accounts Officer on 29.04.2002 from NRCOG, Pune on transfer.
- Dr. Dhurendra Singh, Sr. Scientist (Bio-Technology) joined on 22nd March, 2003.

Transfer

Following staff transferred from CHES, Godhra to CIAH, Bikaner as below:

- Sh. R.K. Solanki, P.A. w.e.f. 03rd Oct., 2002
- Sh. R.R. Baria, T-4 (Field Tech.) w.e.f. 09th Aug., 2002
- Sh. H.B. Patel, T-2 (Driver) w.e.f. 31st Aug., 2002.

Superannuation

- Sh. R.P. Singh, A.O., CIAH, Bikaner retired from Council's service on 31.01.2003.

Visitors

At CIAH, Bikaner

- **Shri Sompal Shastri**, Member of Planning Commission, Govt. of India has visited the Institute on 29th September, 2002.

At CHES, Godhra

- **Dr. G. Kalloo**, Dy. Director General (Hort.), ICAR, New Delhi on dated 24.11.2002.
- **Dr. C.R. Ramesh**, Principal Scientist (Pl. Patho.) & Head, IGFRI (Regional Station), UAS Campus, Dharwad (Karnataka) on dated 05.03.2003.

Dr. D. G. Dhandar, Director, CIAH, addressing the farmers during Kisan Diwas on 23rd Dec., 2002

A view of farmers participating Kisan Diwas

Dr. D. G. Dhandar, Director, CIAH, addressing the participants during National Science Day on 28th Feb., 2003

CIAH, Newsletter released by Dr. M.P. Sahu, Director Research, RAU, Bikaner during Aonla Diwas.

Scientists - Farmers interaction at CIAH, Bikaner

Hon'ble Sh. Sompal ji, Member Planning Commission, Govt. of India, New Delhi discussing scope of arid horticulture with the Scientists on 29-9-02