वार्षिक प्रतिवेदन
ANNUAL REPORT
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केन्द्रीय शुष्क बागवानी संस्थान
बीछवाल, बीकानेर-334 006

Central Institute for Arid Horticulture
Beechwal, Bikaner-334 006 (Raj.), India

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(भारतीय कृषि अनुसंधान परिषद)
बीछवाल, बीकानेर–334006, राजस्थान

Central Institute for Arid Horticulture
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Cover

Front: Top Left : A bearing tree of date palm
Top Right : A fruit bunch of date palm cv. Khuneij
Bottom Left : A fruit bunch of date palm cv. Medjool
Bottom Right : A fruit bunch of date palm cv. Shamran
Back: Top Left : A flowering twig of *Capparis decidua*
Top Right : A vegetatively propagated plantlet of *C. decidua*
Middle Left : Multiple shoot under tissue culture
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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. Despite this, the region harbours a rich biodiversity of horticultural crops whose optimum utilization is still a dream. However, the agroclimatic strengths of this region can be fruitfully harvested provided adequate technologies are developed. The region has great potential to produce quality fruits and vegetables.

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 on 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, one Network 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 very 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 including Growth Chambers, Culture racks, Autoclave, LCD, Automatic nitrogen analyzer, BOD, Net houses, Hitech nursery, etc. The Institute has strengthened the ARIS Cell by incorporation of 6 computer systems, VSAT and establishment of Local Area Network. The phase II of Laboratory cum Office Building was completed during this period and is ready for inauguration.

I am please to publish this Annual Report for the year 2001-2002 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

Executive Summary

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 2001-2002:

Germplasm conservation

During the period under report budwood of 18 frost resistant genotypes of aonla were identified from Himachal Pradesh. 2 anardana type pomegranate from H.P. and IIHR, Bangalore, 7 genotypes of bael from A & N Island, 3 genotypes of phalsa from Rajasthan and Gujarat and 4 genotypes of karonda were collected. With this, a total of 318 germplasm of ber, 150 of pomegranate, 22 of aonla, 107 of cactus pear, 52 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. In addition to this, 32 genotypes of Cordia myxa, 3 of phalsa, 4 of karonda and several exotics were collected and are being maintained in germpalsm block at CIAH, Bikaner. At CHES, Godhra, germplasm of ber, aonla, sapota, jamun, tamarind and moringa were collected and are being maintained.

Studies on frost resistance in ber revealed that cvs. Chhuhara, Tikadi, Kathaphal, Kharki No.1, Badami, Glori, Safeda Rohtak were unaffected by frost.

Application of boron to reduce the cracking in pomegranate was tried. It was observed that 0.2% solution of boron was effective in reducing the cracking.

An exploration to Kachchh region (Gujarat) was undertaken during July, 2001 and 46 collections/fruit samples of date palm were collected. Considerable variability in fruit characteristics was recorded. Studies on photosynthetic parameters revealed that maximum net photosynthetic rate was at spathe emergence stage in different cultivars of date palm.

Genetic improvement

Organoleptic taste evaluation of *ber* CIAH-Hybl (H1) and CIAH-selection 1 germplasm (sel 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 H-1 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-5 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 have revealed that seed germination was better in bigger size (25x15cm) polybags. The vigour of seedlings was better when either pond soil or manures were used as filling mixture.

Studies on propagation in tamarind conducted at Bikaner revealed that maximum bud sprout was obtained when budding was done between 15th July to 15th August.

In lasoda, it was observed that budding around 15th August gave best performance. Similarly in pomegranate, use of semi-hardwood cutting gave better performance when planted during Jan.- Feb. and July-August.

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 thymine gave best sprouting and rooting.

Growth and development

Studies on growth and development under water stress revealed that when water stress is imposed in mateera its dry matter allocation does not get affected whereas in watermelon, reduction of even 2 irrigations hampered the dry matter distribution.

Studies on photosynthetic parameters revealed that imposition of water stress in mateera reduced the photosynthetic rate marginally whereas in watermelon it reduced by 50%. It was further observed that mateera is able to check transpiration with imposition of stress.

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 Management

The recommended doses of N, P and K were applied through sheep manure, cattle manure, vermicompost and inorganic fertilizers to the pomegranate fruit crop. The nutrient requirements were given through either 100% of 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 parameter such as high total soluble solids and low juice acidity. Application of sheep manure, cattle manure and vermicompost increased the water retention capacity and make the mosture available to the crop for a longer period.

This study was carried out under the network project sponsored by Indian Council of Agricultural Research, New Delhi. The research programme was conducted on pomegranate and *ber* fruit crops. In this study irrigation was given on the basis of crop evapotranspiration and N fertigation through drip irrigation system.

In pomegranate fruit crop, the results revealed that irrigation at 0.75CPE level gave the maximum plant height and spread. The fruit yield was also maximum (25.0 q/ha) in 0.75 CPE irrigation level. The maximum water use effciency (2.61 gm/lit.) was also recorded in the same irrigation level. The N fertigation at 75% of recommended dose increased the plant growth and fruit yield.

In ber fruit crop, the maximum plant height, spread and fruit yield was observed in 0.75 CPE irrigation level and maximum water use efficiency (21.05 gm/lit) in the same irrigation level followed in 0.50 CPE irrigation level. The N fertigation with 50% of recommended dose of N gave the better results with regards to plant growth, fruit yield and fruit quality parameters.

The 0.75 CPE irrigation level maintained the relative water content to the maximum level in both the crops.

Plant protection

Desert isolates of *Trichoderma* spp. were evaluated under various growth factors. Majority of the isolates varied in growth and coindiegenesis. Isolate CIAH-175 shows resistance to higher concentrations of mancozeb and metalaxyl + mancozeb. Similarly, isolate CIAH-186 was also resistant to higher concentrations of wettable sulphur. Bacterial antogonist *P. fluorescens* isolates were also evaluated. On ber laboratory studies, isolate CIAH-186 was grown better in manure with finger millet followed by vermicompost supplemented with wheat. Some of the *Trichoderma* isolates were grown better even under high pH (7 to 8) and temperature (upto 35°C).

The toxic metabolites of ber fruit rot pathogen *Alternaria alternata* is being tested for screening of ber germplasm against fruit rot, which is a major problem under arid region. The arid cucurbits (*mateera, kachari* and snapmelon) lines were evaluated against diseases and most of the lines were found free from diseases under field conditions.

In an Ad-hoc scheme on ber powdery mildew, morphological variations in ber powdery mildew isolates from various locations viz. Rahuri (Maharashtra), Detia (MP), Faizabad, Jhansi (UP), Hisar (Haryana) and Udaipur (Rajasthan) were found. Artificial inoculation and establishment of ber powdery mildew was also tried. 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

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. At CHES, Godhra 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.

Studies carried out on Agri-Horti production system on marginal lands revealed that at Godhra highest B:C ratio was 1:8.17 with Aonla+Til cropping system. At Bikaner, similar studies were conducted using ber cultivars Gola planted at different spacings. It was observed that there was not much variation in yield of crops grown at different spacings.

Post harvest technology

During the period under report, RTS and squash of bael, ber, pomegranate were prepared. In addition to these, other value added products such as chhuhara from date fruits, dehydrated kachari powder, aonla shreds and aonla candy were prepared.

Agricultural extension

The Institute participated in the State level Krishi Vigyan Mela organised by RAU, Bikaner on March 24, 2002. The technologies developed by the Institute were displayed and seed/planting material and technical literature were distributed to farmers. The Institute was awarded first prize for best exhibition, stall arrangement and popularising *Moringa* amongst all Government and Non-Government Organization/Institute.

Preliminary data related to existing cropping pattern, adoption 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.

At CHES, Godhra, it was found that the level of knowledge of aonla cultivation as a whole was high at 65 per cent. The farmers had high knowledge in practices like season, intercropping, varieties, spacing, flowering, etc. They had less knowledge about pest management, self incompatability and diseases.

Finance and staff position

The total fund allocation of CIAH, Bikaner was Rs. 391.43 lakh. Out of this the fund allocated under Plan was Rs. 206.10 lakh and under Non-Plan Rs. 185.33. The Institute was able to spend 99.71% of allocated funds under Plan and 99.78% Non-Plan.

The cadre strength of CIAH was 146 as on 31.03.2002. This includes 36 scientists, 28 administrative, 43 technical and 39 supporting staff.

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 have 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. Accordingly, NRCAH was established at Bikaner, which later got upgraded to Central Institute for Arid Horticulture in October, 2000.

Mandate

To conduct mission oriented research for improvement in productivity of horticultural crops and development of horticulture based cropping system under arid environment; and to act as a repository of information related to 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 2001-2002 were:

1. During the period under report budwood of 18 frost resistant genotypes of aonla were identified from Himachal Pradesh. 2 anardana type pomegranate from H.P. and IIHR, Bangalore, 7 genotypes of bael from A & N Island, 3 genotypes of phalsa from Rajasthan and Gujarat and 4 genotypes of karonda were collected. With this, a total of 318 germplasm of ber, 150 of pomegranate, 22 of aonla, 107 of cactus pear, 52 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 (Table 38.) 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. Application of boron to reduce the cracking in pomegranate was tried. It was observed that 0.2% solution of boron was effective in reducing the cracking.

5. Studies on photosynthetic parameters in date palm revealed that maximum net photosynthesis rate was at spathe emergence stage.

6. Organoleptic taste evaluation of *ber* CIAH-Hyb1 germplasm (H1) (and CIAH-selection 1 (sel 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 H-1 scored highest.

7. In a persuit to incorporate drought hardy characters of mateera in water melon, F-5 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.

8. 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.

9. 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.

10. In lasoda, the time of budding was standardised. It was observed that budding around 15th August gave best performance.

11. Studies on photosynthesis in mateera and watermelon reveals that depression in photosynthetic rate was very less, under water stress, in mateera whereas in watermelon it reduced to 50%.

12. 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.

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. In order to evaluate the efficacy of carbohydrate on growth and colonisation of *Trichoderma*. Carbohydrate in the form of finger millet or wheat was supplemented to vermicompost, FYM and sheep manure. It was observed that addition of carbohydrate source to the manure/vermicompost could increase the colonies tremendously.

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.

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

***Ber* Germplasm**

At present 318 genotype/strains of ber have been maintained since 1995 in the National Repository at CIAH, Bikaner. Out of these 69 genotypes/strains were collected through survey from Rajasthan (Chirana, Jobner, Bhusawar, Udaipurvati, Banar, Sirohi etc.), Gujarat (Patan, Mehsana, Anand, Panchmahal, and Sabarkata) and Andaman. Likewise 244 cultivars/genotypes and 05 exotics species/cultivars were collected from different institute.

Floral biology of *ber*

Observations with regards to period of bloom , time of anthesis, time of separation of petals from the stamens, number of flower per cymes, colour of calyx, petal size of 15 genotypes i.e. NRCAHB1 to NRCAHB15 of ber were recorded .The time of anthesis of NRCAHB1, NRCAHB2, NRCAHB3, NRCAHB4, NRCAHB5 NRCAHB6, NRCAHB9, and NRCAHB15 was between 7.30 AM to 8.00 AM whereas the time of anthesis of NRCAHB10,NRCAHB11, NRCAHB 12, NRCAHB 13 & NRCAHB 14 was between 12.15PM to 2.00 PM.There was no flowering in NRCAHB8. Besides anthesis, conformity observation were recorded with respect to number of flowers on primary, secondary and tertiary shoots in Gola, Umran, Mundia, Nazuk, Katha, Banarsi Pewandi, Banarsi Karaka and Nehrumandal . The number of flowers per cluster varies between 08 - 20 depending upon the cultivars. The time of anthesis for Gola, Katha and Umran was between 12.55 PM to1.30 PM where as time of anthesis was between 7.00 to 9.00 AM in Banarasi Pewandi, Seb, Mundia, Nazuk and Nehrumandal.

Frost resistance in *ber*

Observations were recorded with regards to frost incidence during the year 2000 and observed that cultivars Chhuhara, Tikadi, Kathaphal, Kharki No1, Badami, Manukhi, Glori, Safeda Rohtak,etc. were unaffected from the frost. The investigation was to be carried out this year as well. However, this year observation could not be recorded due to non incidence of frost.

Fruit fly resistance in *ber*

Data with regard to fruit fly tolerance/resistance among the cultivars/ genotype were recorded during the year 2001. Although the infestation of fruit fly was not so severe during this year as compared to year 2000 eventhough the cultivars Gola, Seb, Kaithali showed more susceptability in comparison to Illaichi, Katha and Umran. The study needs indepth investigation combining several others parameters so as to arrive a definite conclusion regarding the ability of cultivars resistant against to fruit fly.

Fruit set study in *ber*

Due to high temperatue at the time of anthesis, pollination and fertilization there was severe flower/fruit drop in most of the cultivars of ber but CIAH-Sel-1(NRCAHB15), CIAH H-1(Seb x Katha), Gola, Umran Katha, Illaichi, Seb, Banarsi Penwandi etc. gave the best performance with respect to fruit yield.

***Ziziphus mauritiana* var. rotundifolia**

22 genotype of *Z. rotundifolia* have been maintained in the germplasm block and is being evaluated for their morphological characters.

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

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 of decidous in nature and rest 95 were of 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).

New introduction

In addition to earlier introductions, two Anardhana types of Pomegranate were collected one each from Himachal Pradesh and IIHR Bangalore.

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.

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.

Collection and evaluation of germplasm

A total 52 date palm varieties/ collections including exotic germplasm were maintained in repository. Gap filling of offshoots was done as per availability of suckers. Ten local as well as imported varieties were also collected from Date Palm Research Center, G.A.U., Mundra, Kachchh. The offshoots were treated with IBA 1000 ppm and Bavistin 0.2 % and kept in the nursery for hardening and rooting. Except one plant, all plants survived and are growing well in the nursery. Medjool variety was collected from Jetsar Farm and planted in the month of October in germplasm block.

In most of the genotype, spathe emergence started from middle of the February and completed in first week of March. First time flowering and fruiting was observed in three years old plant of Halawy, Khadrawy, Zahidi, Dayari, Shamran, Sewi, Medini, Umshok, Sayer, Saddami and Sabiah cultivars. However, late spathe emergence (third week of February) was recorded in cultivars Khadrawy, Medini, Sabiah and Umshok. The spathe opening was also earlier in varieties in which emergence of spathe was earliest.

The average number of bunch/palm varied from 01 (Shamran and Dayri) to 9 (Sabiah) during the first year of fruiting. On an average, 04 bunch/palm were observed in Halawy, Saddami, Sewi and Khadrawy cultivars.

The initiation of doka stage was earliest in variety Halawy followed by Shamran, Khadrawy, Sewi, Umshok, Dayari, Saddami and Sabiah.

Length of bunch was maximum in Sabiah (70 cm) followed by Sayer (60 cm) while more than 30 cm. bunch length were measured in Halawy, Zahidi and Umshok (Table 1). Maximum average weight of fruit 11.5 g was recorded in Dayari, Medini and Umshok while 5 to 7 g weight of fruit were observed in Sabiah, Saddami and Sewi cultivars. Big size fruits were observed in cultivars Sayer, Medini, Shamran, Dayari in comparision to other genotypes. Small size (2.40 x 1.51 cm) fruit was formed in cultivar Saddami which may be due to improper pollination and fertilization during the year. Yellow berry colour was noted in almost all cultivars except Umshok and Dayari. Maximum seed weight (2.11 g) was in Medini followed by Dayari. In the other genotypes, seed weight ranged from 0.70 g to 1.15 g (Table1).

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

Cultivars	Spathe emer-gence	Opening of spathe	No. of bunch/ plam	Length of bunch (cm.)	Colour of berry	Doka stage	Av. berry weight (g)	Size of fruit (cm) LxB	Seed weight (g)	Size of seed (cm)
Halawy	16 Feb.	9.3.2001	4	35	Yellow	13.7.2001	880	3.95x1.95	0.98	2.49x0.97
Khadrawy	20 Feb.	20.3.2001	3	44	Yellow	17.7.2001	7.80	3.29x2.10	1.15	2.38x1.20
Zahidi	14 Feb.	12.3.2001	2	35	Light yellow	20.7.2001	8.70	3.38x2.15	1.11	2.26x1.70
Shamran	16 Feb.	22.3.2001	1	57	Yellow	16.7.2001	9.30	4.52x2.25	1.12	2.25x0.86
Dayari	16 Feb	23.3.2001	1	51	Red	20.7.2001	11.40	4.13x2.04	1.70	3.16x0.94
Umshok	26 Feb.	20.3.2001	2	31	Dark red	20.7.2001	11.70	3.97x2.22	0.76	2.78x0.97
Sewi	16 Feb.	20.3.2001	4	50	Yellow	19.7.2001	6.40	2.96x1.86	0.92	2.08x0.95
Medini	19 Feb.	17.3.2001	2	45	Reddish yellow	19.7.2001	10.00	4.16x2.43	2.11	3.56x1.20
Sayer	14 Feb.	19.3.2001	3	60	Yellow	21.7.2001	8.20	4.0x1.92	0.88	2.45x0.84
Sabiah	21 Feb.	16.3.2001	9	70	Yellow	19.7.2001	6.95	3.21x1.95	1.00	2.24x0.90
Saddami	17 Feb.	15.3.2001	5	50	Yellow	19.7.2001	5.26	2.40x1.51	0.70	2.20x0.75

An exploration trip to Kachchh Region (Gujarat) was undertaken during the month of July, 2001 and 46 collections/fruit samples were made. Considerable variability in fruit shape (round, oval, oblong, elongated) fruit length (2.27-5.37 cm); width (1.64-3.65 cm); berry weight (3.14-34.15 g); bunch weight (5-20 kg); number of bunches/ palm (5-12); fruit colour (yellow to yellowish red and dark red) at *doka* stage, pulp weight (4.61-32.70 g); pulp:stone ratio (4.83-30.72); seed weight (0.65-190 g); seed length (1.73-3.87 cm); seed diameter (0.75-1.16 cm); taste (astringent to sweet, very sweet and juicy type) with loose to compact bunch characters were observed with available genotypes. Diversity in vegetative growth (upright 5-20 m high); emergence of spathe/ flowering in February-March; fruit maturity in June to late July and productivity (50 to 200 kg/palm) was observed with these genotypes. Elite palm were identified and offshoots will be collected in due course of time for date palm repository.

Varietal evaluation

Development of an experimental block having six promising date cultivars viz. Halawy, Khalas, Zahidi, Medjool, Shamran and Khadrawy was under taken. Gap filling in varietal block was done after procuring offshoots from Bikaner, CAZRI, Jodhpur, Central State Farm, Jetsar (Sri Ganganagar). Survival of plants were observed and it was found that rate of mortality in Medjool and Halawy cultivar were comparatively more than Zahidi and Shamran during the year.

Performance of tissue culture plants

Tissue culture plants of cultivars Dhamas, Khasab, Khalas, Khunezi, Nubsully, Yakoobi, Fard and Nagal supplied by M/S A.V. Thomas Company, 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 m height of plant was recorded. In cultivar Khasab, Fard, Khuneizi and Yakoobi 1 or 2 new suckers formation were also recorded. However, as far as flowering and fruiting is concerned, spathe emergence was very poor and very late in Dhamas cultivar only. However, proper fruit set / fruiting was not observed in tissue culture plants.

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 maintained in the nursery. On an average seedlings attained height of 50-60 cm having 6-7 initial leaves after 18 months of growth. On the boundary of date palm experimental block, seedlings of date palm were transplanted at 2 x 4 m spacing during the month of September– October. Seedlings were planted for the assessment of plant growth, ratio of male and female palm, variability/fruiting behaviour in seedling palms under arid environment. Survival of seedlings was 80 % when it was noted in the month of March after six month of planting.

Photosynthetic rate measurement in date palm cultivars

An experiment on photosynthetic rate measurement was under taken in some promising date varieties i.e. Halawy, Medjool, Khadrawy, Shamran and Zahidi at different stages (vegetative growth, spathe emergence and fruit set and development) with the objective to find out the variation among the varieties for photosynthesis rate. Further, it was also measured at same stage in plants developed by seeds, tissue culture and offshoots. For this, inner side mature leaves were selected at each stage. Maximum photosynthetic rate was observed at spathe emergence stage in all varieties when compared with other stages of observations.

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

Survey and identification of *aonla* genotypes from Himachal Pradesh

Twelve elite type frost tolerant *aonla* genotypes were identified from Shimla and Solan (H.P.) through survey during October 2001. Six genotypes were identified from Shimla i.e. Rampuri Kewthal, Banoda, Laddi, Galot, Panesh & Chamba villages and another six genotypes were identified from Solan i.e. Ayal, Lavighat, Raipur and Ranu villages. Samples of five fruits were collected from each genotype and seeds are sown in nursery for further evaluation. Bud wood of identified genotypes will be collected during August 2002. (Table 2).

Floral biology of *aonla*

Observation with respect to concentration of female flowers/shoot and time of anthesis was recorded in cultivars Chakaiya, Krishana, Kanchan, NA-6, NA-7 and NA10 of aonla. Concentration of female flower varied from 3 to 25 mostly located on upper part of the shoots which varies from variety to variety. Peak time of anthesis in Chakaiya, Krishna, Kanchan and NA-10 is 6.00 - 6.30 PM whereas it was 7.15 - 7.30 PM in NA-6 and NA-7 (Table 3).

Varietal evaluation of *aonla*

During the year 2001-2002 profuse flowering and better fruit set was observed in cv. NA7, NA-6, Chakaiya, Krishna, Kanchan and NA-10. Based on observation recorded with respect to yield and yield attributing traits it was found that NA7 performed better over others. Maximum yield was recorded in NA-7 i.e.143kg/plant and average yield was approximately 50 kg/plant. Besides average fruit weight was recorded 35-51g depending on cultivar.

Table 2. Genetic diversity in fruit characteristics of aonla germplasm collected from Himachal Pradesh

S No.	Collection	Plant age (Yr)	Plant height (Ft)	Plant spread (ft)		Fruit weight (g)	Pulp weight (g)	Stone weight (g)	Pulp (%)	Stone (%)	Stone/ Pulp ratio	Fruit size (cm)		TSS (%)
				EW	NS							Length	Breadth	
1	AKS/ CIAH-E-O-6	30	32	5	10	9.50	7.89	1.63	82.87	17.13	4.80	2.50	3.04	22.20
2	AKS/ CIAH-E-O-7	35	45	15	15	9.40	7.88	1.55	83.56	16.44	5.08	2.26	3.00	21.00
3	AKS/ CIAH-E-O-8	13	18	8	9	6.84	5.41	1.43	79.09	20.91	3.78	1.96	2.52	19.80
4	AKS/ CIAH-E-O-9	17	22	10	12	4.21	3.40	0.81	80.76	19.24	4.19	2.64	3.28	20.66
5	AKS/ CIAH-E-O-10	25	35	15	15	9.07	7.74	1.33	85.33	14.67	5.81	2.64	3.00	20.60
6	AKS/ CIAH-E-O-11	16	12	9	9	8.22	6.60	1.62	80.29	19.71	4.07	1.72	2.40	19.00
7	AKS/ CIAH-E-O-12	10	15	6	6	5.13	3.70	1.43	72.12	27.78	2.59	1.86	2.28	21.50
	AKS/ CIAHE-O-13	25	25	20	12	4.48	3.15	1.33	70.31	29.69	2.36	1.94	2.56	20.50
	AKS/ CIAH-E-O-14	5	12	6	7	5.87	4.53	1.34	77.17	22.83	3.56	2.06	2.28	18.80
10	AKS/ CIAH-E-O-15	4	8	4	5	8.22	6.42	1.80	78.10	21.90	3.56	2.24	2.88	20.20
11	AKS/ CIAH-E-O-16	7	12	7	8	9.59	7.75	1.84	80.81	19.19	4.21	2.28	.68	20.20
12	AKS/ CIAH-E-O-17	5	12	4	5	7.72	6.21	1.51	80.44	19.56	4.11	2.31	.82	21.25

Table 3. Floral biology of *aonla*

S. No.	Name of variety	Time of anthesis	No. of female flowers/shoot
1	N.A.-7	6.45-7.30 P.M.	14-25
2	N.A.-6	6.50-7.45 P.M.	11-19
2	Krishna	5.50-6.30 P.M.	4-9
4	Chakaiya	5.55-6.15 P.M.	3-10
5	Kanchan	6.50-6.30 P.M.	3-13
6	N.A –10	6.00-6.30 P.M.	3-11

Frost management studies in *aonla*

Different concentrations of H_2SO_4, NaCl and Urea were applied through foliar spray but since severe incidence of frost was not reported so far during 2001-2002. Therefore, it needs further repeatition to find out the effect of treatments in forthcoming year.

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

Gonda or Lasora

32 genotypes of *Gonda* (*Cordia myxa*) having wide range of variability were collected and seedlings were raised in the nursary to study their germination and growth under arid ecosystem. These 32 types were planted in experimental block for field evaluation on 13.11. 2001.

Periodic observations were recorded on growth and developmental parameters. Four months after planting maximum height (160 m) and maximum girth (2.6 m) was recorded in collection-28 and maximum spread (120 x 80 cm) was recorded in Collection-25.

Phalsa

In addition to existing *phalsa* collections, 3 types collected from Rajasthan and Gujarat areas were raised in the nursery and planted in underutilized fruit block for field evaluation on 13.11. 2001.

Four months after planting max. height (75 cm was recorded in Coll.-1 followed by Coll-3 (71cm). Maximum spread (75 x 42 cm) was also recorded in Coll-1.

Karonda

To evaluate the performance of *Karonda* under hot arid environment of Bikaner, so far four types from different locations viz., Bastar(1), Jodhpur(2), Udaipur (1) have been made. The collected germplasm will be planted in the coming monsoon.

Exotics

Seedlings of seven exotic date palm raised through seeds are to be planted in the field for further evaluation.

Exotic fruit plants (Carob, Chinese jujube, *ber*, Marula nut) are being maintained in nursery mother block. 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*) under arid region. Flowering in Marula plant (raised by seed) was observed after three years of planting, however, no fruit set was recorded. Vegetative growth in Carob (*Ceratonia siliqua*) plant was slow. Effect of frost was minimum in Chinese jujube and Carob while Marula plant was susceptible to low temperature/frost.

Effect of pruning on growth, fruiting and and yield of Phalsa

A trial was initiated in first week of December, 2000 with an objective to study the influence of pruning on *phalsa* fruit yield, growth and vigour.

Observations taken during April 2001 reveals that pruning in first week of Dec. up to the height of 50 cm was most effective to produce maximum height of new growth (1.51 m). Flowering/fruiting was recorded early in case of pruning height of 40 cm and where no pruning was done (control).Flowering and fruiting was delayed by 7 days in case of 50-70 cm height of pruning. Maximum yield (4.0kg/tree) was recorded in case of pruning up to 50 cm. Maximum TSS 20.5° Brix of fruits was also recorded in case of pruning up to the height of 50 cm. The fruits were bold and firm in appearance.

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

For planting of rootstock, land leveling/field preparation work was done during the year. To raise *in situ bael* germplasm repository, rootstocks were raised in the nursery and maintained for planting. A survey trip for collection of better genotype of *bael* was undertaken to Chomu area of Jaipur. A thin skin (pericarp), good flesh, yellow colour, sweet in taste, fruit type was collected. Seven genotype of *bael* fruits were also collected from forest / farm field from A & N Islands and seedlings were raised for planting. Bud wood of a *bael* genotype was collected from CAZRI, Jodhpur and budding was done to raise budded plants. A seedling selection was also collected during the month of October from Udaipur. Further, work on collection of bael genotype is in progress.

A.1.7 Collection and evaluation of *Vitis* varieties and root stocks under arid ecosystem.

Under the project, cuttings of five grape cultivars viz., Tas-A-Ganesh, Perlette, Anab-e-shahi, Flame seedless and Pusa seedless (10 each) were collected form NRC on grapes, Pune during April 2001. Likewise six root stocks viz., St. George, 110 R, Dogridge, 1613 C, Salt creek and 1616 were collected from the same Institute. From Abohar (Punjab) ten cuttings each of Perlette and Thompson seedless were collected.

The project was presented and discussed during RAC, held on 6.08.01. It was suggested by the members that as *Vitis* is not a mandatory crop of arid region, the experiment may be dropped. It was further suggested to take up experiments on aonla based cropping system.

A. 1.8 Collection, conservation and evaluation of Cactus pear (*Opuntia ficus indica* L. Mill.) under hot arid conditions.

Out of 107 Cactus pear genotypes, which were under multiplication and evaluation, 08 genotypes could not survived due to rotting (Foot rot disease) of cladodes in nursery. Rest genotypes were maintained for evaluation for different uses. Better plant growth was observed in clone 1270, 1271,

1280, 1281, 1269, 1378, 1458 under multiplication. Indigenous cactus types started flowering and fruiting during winter (Dec.-Jan.) months while flowering and fruiting in exotic ones was recorded during summer season. Local indigenous types produced red colour fruits of about 34 gm., 6.3 x 3.4 cm size and sweet sour in taste. Better sprouting in all 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 tree's 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 growing cladodes and the number was 8 to10 fruits per pad. More number of hard seeds was also present in fruits of indigenous types. Moreover, fruit size of indigenous types was smaller than exotic ones. However, better plant growth, flowering and fruiting was observed in clone 1270 and 1271 under hot arid conditions.

A.1.9 Introduction and evaluation of different citrus species and root stocks under arid ecosystem.

Under this sub project Kinnow mandrin was introduced during October 2000 to study its performance under arid ecosystem. About two and half years after planting > 90% survival was recorded in the field. At this stage average height of the plant was recorded up to 1.4 m having average girth of 4.1 cm and spread of the plants was 1.3 x 1.3 m across and along the row, respectively. These budded plants of Kinnow mandrin are performing better in the field.

55 budded plants of Mosambi plants having Pectinofera as root stock were collected from Abohar for planting in the field in coming season of mon soon.

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

Realising the importance of cucurbit vegetables in arid and semi-arid regions of north-western parts of India particularly in the drought hardy species of *Citrullus* and *Cucumis*, research initiative were undertaken since 1994 at 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*), roundmelon (*Citrullus fistulosus*), bottlegourd (*Lagenaia siceraria*) and *kakdi* (*Cucumis* spp.) were collected over the years for systematic evaluation and conservation. As a results of exploration and collection over the years this institute is holding active collections of *mateera* (193), *kachri* (558), snapmelon (90), muskmelon (55) and other cucurbits (>100) for the maintenance of PGR and for future use. During the year 2001-2002, the work under this project

is only deposition of 510 *kachri* accession seeds in National Gene Bank at NBPGR, New Delhi for safe conservation (Table 4).

Table 4. Arid vegetable crop germplasm deposited for conservation in National Gene Bank at NBPGR by CIAH, Bikaner.

S.No.	Crop	No. of Accessions	Year	Status of material
1.	Kachri (Cucumis callosus)	510	2002	Pre-NATP, CIAH material collected during 1994-1995
2.	Muskmelon (Cucumis melo)	55	2001	NATP-CIAH material collected during 2000 through exploration.
3.	Chilli (Capsicum annuum)	132	2002	Pre-NATP-CIAH material collected during 1998 through exploration
4.	Indian bean (Lablab perpureus)	10	2002	CIAH material collected during 2000.

At CHES, Godhra

A 3. Collection, introduction and evaluation germplasm of some semi-arid fruits

Ber

Cataloging of ber germplasm were assigned to this station under All India Coordinated program which has been completed by compiling the available information alongwith suitable photographs.

Prevalent drought conditions for the consecutive third year badly affected ber crop though initially there was fruit set however further growth and development was adversely affected. There was heavy fruit drop and many small set fruit dried on the plant itself and hence no observations could be recorded.

Pomegranate

Germplasm lines obtained from IIHR, Bangalore were evaluated for growth, fruit set, fruit retention and 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 (3.08 m) and it was minimum in line –H (1.63m). North-South plant spread was maximum in line –A (2.02 m) whereas East-West plant spread was maximum in line –E (2.23 m) and was minimum in line –D (0.97m

and 1.05 m respectively). Stem diameter was maximum in line - E (48.93 mm) and it was minimum in line – D (19.63mm).

Maximum number of stems per plant, however, were observed (11.00) in line –F and it was minimum in line – K (3.67). The plants came into flowering and fruiting for the first time; data on number of fruit retained per plant revealed that it was maximum in line –H (36.33). Maximum fruit weight, fruit skin weight, fruit length, fruit diameter and percent acidity were recorded in line- H (125.67 g , 43.77 g , 5.89 cm ,6.27 cm and 10.74, respectively). T.S.S. was, however ,maximum in line –E (19.83 ^{0}Brix). The weight of 100 aril was maximum in line – B (94.00 g) and was minimum in line-E (32.33 g) whereas the weight of 100 seed was maximum in line – J (24.10 g) and minimum in line –F (13.97 g).

Aonla

Aonla clonal selections were further evaluated for vegetative growth parameters. All the lines were at par for these parameters. Observations recorded on number of clusters per shoot, number of clusters with female flowers, number of fruit set per shoot, number of fruit retained per shoot and percentage retention differed significantly. However, number of female flowers per cluster of length of middle cluster was found to be non significant. Yield (kg/ plant) was highest in plant selection 6 (120.57), percent retention was highest in selection-7 (63.15). Though maximum number of fruit (1018) was in selection –2, fruit retention was highest in selection –6 (490.33). As regards flowering behaviour, number of clusters per shoot was highest in selection –7 (319.67),whereas number of clusters with female flowers and percent clusters with female flowers per shoot were highest in selection- 6 (179.33 & 70.57, respectively). The data clearly indicated superiority of selection-6 which was closely followed by selection-7.

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. Cricket ball was found to be most vigorous of all in respect of all the vegetative characters and cv. Co-2 was found to be the least vigorous.

Maximum number of flower clusters per shoot and fruit set per shoot were recorded in cv. Jumakhia (79.78 and 169.00 respectively). Fruit retention per shoot was ,however, maximum in Pilipatti (79.66). Maximum yield per plant was recorded in Kalipatti (97.77 kg) and was minimum in Co-2 (25.62 kg).

Physico-chemical analysis of the cultivars revealed that fruit weight (116.67 kg), fruit length (62.03 mm), fruit diameter (59.53 mm) and fruit skin weight (11.33 g) were maximum in cultivar Co- 2, whereas physiological loss in weight was highest in cv. Jumakhia. Pulp: stone ratio and T.S.S. was

maximum in Kalipatti (42.16 and 31.67 °Brix, respectively). Percent acidity was found to be non significant amongst different cultivars.

Jamun

During survey, 7 genotypes (fruit samples) were collected from Kheda District of Gujarat. Based on the observations, maximum fruit weight was recorded in collection No.2 (20.0 g.). Highest pulp-stone ratio (84.55 %) and vitamin –C (59.49) content was observed in collection-2.

Tamarind

2 varieties viz. Pratisthan and T-263 from Aurangabad were collected. Amongst the 15 promising genotypes collected from adjoining areas of Panchamahals, it was observed that highest pod weight (26.5 g.) and pod length (17.14 cm.) was observed in collection-11.

Moringa

19 annual and perennial type drumstick genotypes were collected from TN, AP and Gujarat. Cultivar PKM-2 was found superior with respect to vegetative growth yield and fruit quality parameters.

Genetic improvement

Mission B: Genetic Improvement in arid horticultural crops.

At CIAH, Bikaner

B. 1 Improvement in *Ber*

BCF_1 (P1 & P13){Seb x F1 (Seb x Katha)} was evaluated for resistant to fruit fly and quality traits. Further in other plants viz.,P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12 & P14 there was no fruiting due to high temperature at the time of flowering and fruit set, therefore obsrevation could not be recorded.

Two strains of *ber* named as CIAH-Hybl(H1) (Seb x Katha) and CIAH-Selection I (sel 1) were found precocious and prolific bearer. These two strains were subjected to organoleptic taste on 6th February, 2002. The fruits of ber varieties Gola and Sandura were used as standard against H-1 and Sel-1. There was a panel of 15 judges of this institute who scored on 10 point scale. The allotted scores were pooled to draw conclusion regarding the performance of varieties. On the basis of initial observations (fruit shape, skin colour, fruit surface, flesh colour, juiciness, flesh texture and taste) it was observed that cultivar Gola excelled the over all acceptability scoring 6.94 followed by 6.21 in H-1 and 6.10 in Sel-1. The taste of Sel-1 was liked most by the panel of judges and rated the same at score of 7.13. Further, the juiciness and flesh texture of H-1 was score highest 6.93 and 6.43 respectively.

B. 2 Improvement in pomegranate by selection and hybridization

15 F1 progenies of desirable parental combination and 6 open pollinated seedling progenies were evaluated during 2001-2002. The F1 progenies of DKS/797/003 cross combination (Jalore Seedless x Mridula) showed promising attributes of highest fruit quality. After 2 years of planting this combination showed desirable blood red, bold and soft aril with TSS >20.0° Brix.

Evaluation of seedling progenies

The open pollinated seedling progenies (AHP/OP/JS/98), developed through fruits of selected plant in seedling originated orchards of pomegranate cv. Jalore Seedless and also five seedling progenies (OP/AHPG/98/S3, S4a, S4b, S5 and S6) developed through open pollinated high quality fruits collected from Iran, planted at closer spacing (2x1m) at CIAH, were evaluated for growth, flowering and fruiting, fruit quality characters and periodically observations were being recorded for the characterization.

Evaluation of hybrid

During the period under report, 15 hybrids developed during 1997 and 1998 only were properly evaluated at a close planting space (2x1m). Of these, the F1 progeny (DKS/H/ 97/003) depicted

excellent fruit quality parameters i.e. soft, bold and red aril having TSS around 20° Brix. At closer spacing the fruit weight, length and diameter were 75.84g, 5.15 and 5.46 cm respectively. Therefore, it is concluded that among the hybrids evaluated this is the promising for comparison with Jalore Seedless and Mridul at proper distance and agronomic practices.

B.3 Improvement in cucurbit vegetables under hot arid environment

Evaluation of advance generation for quality improvement in *mateera* (*Citrullus* lanatus) Summer 2001

In continuation of the work in drought hardy *mateera* through hybridization to improve flesh quality parameters particular firmness, colour and sweetness, during the summer 2001, five parental lines (*Mateera* AHW 19, *Mateera* AHW 65, Sugar Baby, Charleston Local and Mahobobi) were evaluated alongwith 15 advance progenies (F_5). The characters related to agro-morphology, earliness and yield contributing fruits were recorded to assess the yield potentialities under extreme of higher temperature of arid environment to screen the material and better comparision. The *mateera* varieties AHW 19 and AHW 65 out yielded among the parental lines. In F_5 generation, seven advance progenies of cross combination *Mateera* AHW 19x Sugar Baby, showed desirable trends in growth, earliness, number of fruits and fruit yield/plant *at par* with *Mateera* AHW 19 but depicted high level of superiority for flesh firmness, content, colour (red-dark red) and TSS (>10° Brix). The fruits of the high yielding advance progeny (5-11a) *Mateera* AHW 19x Sugar Baby were superior and highly acceptable in quality depicting internally as good as Sugar Baby and outside as of *Mateera* AHW 19.

Rainy 2001

On the basis of higher early yield and the highest flesh quality characters of fruits in F_5 generation during summer 2001, the two out yielded advanced progenies of *Mateera* AHW 19 x Sugar Baby (F6/a and F6/b) were tested in replicated trial during *kharif* season 2001. The advanced progeny F6/a (*Mateera* AHW 19 x Sugar Baby) depicted highly desirable fruit quality characters alongwith higher early yield potential. Therefore, the high yielding single plant which bear better quality fruits at the earliest nodes were selected and to harvest bulk seed for the further evaluation (Table 5).

Improvement for higher early yield in *kachri* (*Cucumis callosus*)

The advanced *kachri* selection AHK 119 and AHK 200 were tested during summer and rainy season of 2001 to assess earliness and yield potential characters over the season and detailed observation related to growth, flowering, earliness, fruit bearing capacity, yield and marketable fruits (A,B and C grade) were recorded to assess the potentiality over the seasons. During 2001, the yield potential of *kachri* AHK 119 and AHK 200 was 95.5 and 112 q/ha respectively.

Table 5. Range value of best performing advance progenies of *Citrullus lanatus*

Characters	Mateera AHW-19 x Sugar Baby	
	F5	F6
Days to female flower (DAS)	46.2-58.6	32.5-38.9
Days to first harvest (DAS)	75.4-94.2	70.4-74.6
Marketable fruits/plant	3.2-5.0	3.5-5.0
Fruit weight (kg)	2.0-3.9	4.9-5.2
Edible flesh thickness (cm)	13.7-17.4	16.5-18.4
Non-edible flesh thickness (cm)	1.1-2.2	1.5-1.8
TSS (°Brix)	10.1-12.8	10.5-11.8
Flesh colour	Red, deep pink, pink	Red, deep pink, pink

Improvement for higher early yield in snapmelon (*Cucumis melo* var. *momordica*)

Snapmelon varieties recommended by CIAH, Bikaner i.e. AHS 10 and AHS 82 were tested during the summer and rainy season of 2001 to assess the yield potential over the season and years under varying agro-climatic conditions under arid environment. The snapmelon variety AHS 10, produces on an average 4.8 fruits/plant in summer and 4.2 fruits/plant during the rainy season with an yield potential of 207 and 198 q/ha respectively. The variety AHS 82 with average yield potential 235 q/ha in both the season with desirable fruits at earliest node, fruit quality and more number of fruits/plant (5.6).

Improvement for straight fruit and higher yields in *salad kakdi (Cucumis melo)*

Two advanced progenies of *salad kakdi* var. AHC 2 were evaluated for earliness, flowering and fruiting behaviour, quality and yields under extrems of temperature and climatic conditions during summer 2001. The major emphasis to evaluate this advance generation was to obtain good shaped straight fruits at the earliest nodes with desirable fruit quality at tender stages (8-12 days after anthesis). The important characters related with marketable fruits like infestation to fruit fly and fruit shape were also taken in to account while selecting the plants to generate advanced progenies.

Improvement in bottlegourd and roundmelon

During the year, two advanced progenies of bottlegourd (AHLS Long 1 and AHLS Round 1) and Roundmelon (AHRM 1) were evaluated for flowering and fruiting behaviour and yield potential under arid conditions.

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

As a result of intensive surveys in chilli growing areas of western Rajasthan during 1998 and thereafter, evaluation of chilli germplasm and advanced progenies at CIAH, Bikaner during 1999 and 2000, it is clear that there are four types of typical land races/open pollinated farmers varieties i.e. Mathania, Haripur-Raipur, Mehsana and Mandoria type are in cultivation having different fruit quality and yield contributing traits. The main objective of this work is to recognize the original Mathania type chilli population which is at present completely a mixture of various land races and losses its quality attributes for which it was popular in arid region. Therefore, even under poor crop performance due to extremes of temperature (July-October), single plant selections were made on the basis of earliness and fruit quality parameters to raise advance generation during 2000. During the year 2001, eighteen progeny resembling to Mathania and Haripur-Raipur types were evaluated but the performance was again poor owing to very high temperatures for longer period (July-October) and scanty rainfall during the crop growth. Although critical observations were recorded and single plants were marked on the basis of fruit character to purify the material for the advancement of generation.

Vegetative propagation

Mission C: Rapid multiplication of propagules of fruit crops.

At CIAH, Bikaner

C 1. Propagational studies in arid fruits

To refine and standardize vegetative propagation in arid fruits like aonla (*Emblica officinalis*), lasoda (*Cordia myxa*), pomegranate (*Punica granatum*) and tamarind (*Tamarindus indica*), some experiments were initiated at CIAH, Bikaner. The aonla, lasoda and tamarind were propagated by budding while pomegranate was propagated by semi-hardwood cutting.

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

T1: Sand

T2: Sand + Sheep Manure (1:1)

T3: Sand + Sheep Manure (2:1)

T4: Sand + Sheep Manure (1:2)

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)

B. Polycontainers

PC1: Polythene bag (15 x 10 cm)

PC2: Polythene bag (25 x 10 cm)

PC3: Polythene bag (25 x 15 cm)

PC4: Polythene tube (25 x 10 cm)

The observations indicated that the seed germination varied from 69.09% to 82.76% under different filling mixture (Table 6) 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 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 (Table 7). The vigour of seedling stock was also measured in term of seedling height (Table 8) and stock girth (Table 9). It was found that the seedling vigour was poor in case of sand mixture and it was better where either pond soil or manures were used as filling mixture. There was wide variations in the height of the seedlings but variation in the stock girth was less under different treatments. The experiment is in progress.

Table 6. Effect of filling mixture and polycontainers on germination (%)

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	62.50	72.20	74.15	68.00	69.09
T2	76.00	78.50	80.50	75.05	77.57
T3	74.00	74.00	76.50	77.15	75.41
T4	75.12	76.25	80.85	78.05	77.57
T5	74.50	78.05	82.40	79.00	78.49
T6	73.50	74.50	80.15	75.00	75.79
T7	75.15	80.50	83.35	79.55	79.64
T8	71.00	73.15	78.50	73.00	73.91
T9	80.15	85.04	85.85	80.00	82.76
Mean	73.55	76.91	80.25	76.09	

Table 7. Effect of filling mixture and polycontainers on seedling stock (%)

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	58.20	64.26	68.20	60.45	62.77
T2	74.00	76.15	78.44	74.50	75.72
T3	72.00	71.50	75.50	76.00	73.75
T4	74.00	75.00	78.50	76.15	75.91
T5	72.50	77.50	81.00	70.00	75.25
T6	70.25	72.40	78.50	74.00	73.79
T7	74.00	79.15	81.50	77.25	77.98
T8	68.50	70.10	77.25	72.15	72.00
T9	78.20	84.00	84.20	77.50	80.98
Mean	71.29	74.45	78.12	73.11	

Table 8. Effect of filling mixture and polycontainers on seedling height (cm)

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	30.15	32.18	35.18	33.00	32.63
T2	46.00	52.00	69.50	54.15	55.41
T3	35.55	41.50	46.25	39.55	40.71
T4	44.00	48.20	71.55	56.18	54.98
T5	48.50	55.15	68.25	52.00	55.98
T6	34.00	40.52	48.58	40.50	40.90
T7	50.25	52.25	70.50	55.25	57.06
T8	32.20	35.55	52.05	36.15	38.99
T9	50.55	56.00	72.25	58.15	59.23
Mean	41.24	45.92	59.34	47.21	

Table 9.Effect of filling mixture and polycontainers on Stock girth (cm)

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	1.02	1.00	1.11	1.04	1.04
T2	1.20	1.10	1.26	1.10	1.17
T3	1.00	1.16	1.17	1.11	1.11
T4	1.20	1.25	1.30	1.10	1.21
T5	1.10	1.18	1.30	1.15	1.18
T6	1.00	1.20	1.15	1.08	1.11
T7	1.20	1.24	1.50	1.21	1.28
T8	1.15	1.20	1.23	1.16	1.19
T9	1.12	1.20	1.52	1.25	1.27
Mean	1.11	1.17	1.28	1.12	

In case of tamarind, the preliminary survey was made in some part of western Rajasthan to find out resistant source of frost-free materials. Meanwhile, to standardize vegetative propagation in tamarind, under Bikaner conditions, an experiment was initiated by using rootstocks raised from the seeds collected from Jagdalpur, Baster (Chattisgarh). The budding was done at regular intervals starting from Ist 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 (Table 10).

In pomegranate, two types of cuttings i.e. (i) hardwood cutting, and (ii) semi-hardwood were used by treating with the IBA-2500 and 5000 ppm as quick dip and 50, 100, 200 ppm as prolonged dip method. First year observations indicated that semi-hardwood cutting had given better performance than hard wood cuttings. January-February and July-August is congenial time for planting of cutting and use of IBA did not make any impact on rooting of pomegranate cuttings.

To standardize the vegetative propagation of Lasoda by budding, experiment of budding at an interval of 15 days from July to Sept. during 2001 was carried out . Budding around 15th Aug. was found to be best for maximum success (95.5%) and length of sprout (15.67 cm)

Table 10. Response of time of budding in propagation of tamarind

Treatment	Sprouting (%)	Bud take (%)	Linear growth (cm)	Radial growth (cm)
1st June	80.0	60.0	30.0	0.7
15th June	60.0	20.0	40.0	0.6
1st July	100.0	90.0	54.0	0.8
15th July	90.0	80.0	50.0	0.8
1st August	100.0	80.0	55.0	0.9
15th August	70.0	30.0	25.0	0.4
1st September	70.0	50.0	40.0	0.6
15th September	90.0	70.0	45.0	0.7
1st October	50.0	20.0	25.0	0.5
15th October	30.0	10.0	8.0	0.4

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 water stress on growth and development of *mateera* and watermelon

Dry matter allocation under water stress

An experiment was planted in field, using randomized block design, to evaluate the effect of water stress on growth and development of mateera and watermelon. In all 4 treatments were given viz. 2,4,6 and 8 irrigation. Observations on plant dry matter distribution were recorded at 75 days after sowing. The data is presented in Table 11-12.

Perusal of data reveals that dry matter accumulation does not get reduced with the imposition of water stress upto 4 irrigation level. Only in cv. AHW 65 there was a marked reduction in dry matter accumilation at 2 irrigation. Despite the fact that total dry matter accumulation is slightly less under water stress, the percentage dry matter distribution remains fairly constant in mateera (Table 11).

Perusal of data for water melon reveals that maximum dry matter accumulation was at 8 irrigation level in both the cultivars. Imposition of water stress even by reducing two irrigation reduced dry matter accumulation by 50%. Another characteristic feature encountered was that under water stress, roots accumulates more dry matter. This is illustrated by the fact that in cv. Sugar baby, the percentage dry matter accumulation in roots was 4.62%, 4.66%, 2.42% and 2.64% at 2, 4, 6 & 8 irrigation levels respectively (Table 12).

Photosynthetic activity under water stress

In the same experiment, the rate of photosynthesis, was estimated using LICOR 6200 Infra Red Gas Analyzer at 45 & 60 days after sowing. It was observed that at 45 days after sowing the photosynthetic rates do not differ much in both mateera and water melon. This is illustrated by the fact that at 8 irrigation levels, the Pn varies from 19.68-22.06 μ mol/m^2/s in mateera and from 16.21 to 21.17 μ mol/m^2/s in water melon. However, with the imposition of water stress, there is marked reduction in net photosynthesis rate in water melon, but in mateera the reduction was only marginal (Table 13).

Perusal of data at 60 days after sowing reveals similar trend. At this stage the magnitude of reduction in Pn at 2 irrigation was nearly 50% to that encountered at 8 irrigation stage (Table 13).

Table 11. Dry weight of mateera cv. AHW 19 & AHW 65 at different irrigation levels

Treatment	Dry weight (g)							
	AHW 19				AHW 65			
	Stem	Root	Leaf	Total	Stem	Root	Leaf	Total
2 Irrigation	22.44	1.17	42.74	66.35	20.11	0.78	33.18	54.07
	(33.82)	(1.76)	(64.41)		(37.19)	(1.44)	(61.36)	
4 Irrigation	25.14	1.57	33.56	60.27	26.81	1.28	33.25	61.34
	(41.71)	(2.60)	(55.68)		(43.70)	(2.08)	(54.20)	
6 Irrigation	24.74	1.65	40.16	66.55	32.12	1.12	48.18	81.42
	(37.17)	(2.47)	(60.34)		(39.44)	(1.37)	(59.17)	
8 Irrigation	23.50	0.75	37.26	61.51	39.89	1.73	62.65	104.27
	(38.20)	(1.21)	(60.57)		(38.25)	(1.65)	(60.08)	

*Figures in parenthesis are percentage.

Table 12. Dry weight of water melon cv. Sugar Baby & Mahobobi at different irrigation levels

Treatment	Dry weight (g)							
	Sugar Baby				Mahobobi			
	Stem	Root	Leaf	Total	Stem	Root	Leaf	Total
2 Irrigation	14.09	1.45	15.82	31.36	-	-	-	-
	(44.92)	(4.62)	(50.44)					
4 Irrigation	15.55	1.64	17.97	35.16	16.80	0.81	15.34	32.95
	(44.22)	(4.66)	(51.09)		(50.98)	(2.45)	(46.55)	
6 Irrigation	12.75	0.86	24.33	37.19	22.72	0.76	26.37	49.85
	(34.28)	(2.47)	(65.42)		(45.57)	(1.52)	(52.89)	
8 Irrigation	24.82	1.75	39.47	66.04	33.68	2.40	60.51	96.59
	(37.58)	(2.64)	(59.66)		(34.86)	(2.48)	(62.69)	

*Figures in parenthesis are percentage.

Table 13. Photosynthesis in Water melon and Mateera with different irrigation levels at 45 & 60 days

Irrigation level	Photosynthesis (μ mol/m^2/s)							
	45 Days				60 Days			
	AHW-65	AHW-19	Sugar Baby	Mahobobi	AHW-65	AHW-19	Sugar Baby	Mahobobi
2	17.45	23.61	15.89	--	23.25	25.00	16.18	--
4	24.37	22.22	15.36	19.23	21.25	27.61	24.68	18.16
6	19.85	24.19	19.99	23.86	25.90	22.28	28.24	20.49
8	22.06	19.68	16.21	21.17	25.30	31.75	29.04	27.59

Transpiration and water use efficiency under water stress

The data on transpiration rate and water used efficiency under water stress was also calculated in above experiment.

Perusal of Table 14 reveals that in mateera the transpiration rate was highest (0.088/0.089 mol/m^2/s) at 8 irrigation which dropped to 0.0032 mol/m^2/s at 4 irrigations and to 0.0026 mol/m^2/s at 2 irrigation levels. Showing thereby that the transpiration rate is checked as the water stress is imposed in mateera (Table 14).

The data in water melon reveal that the transpiration rates at 45 days after sowing is as high as 0.08 mol/m^2/s at 8 irrigation which drops only to 0.06 mol/m^2/s at 2 irrigation level. This illustrates that water melon is not able to check transpiration with imposition of water stress (Table 14).

Carboxylation efficiency under water stress

The carboxylation efficiency (at 45 & 60 days after sowing) in mateera and water melon was estimated under different levels of irrigation. It was observed that in mateera, the carboxylation efficiency was to the tune of 0.087 at full irrigation which increased with the imposition of water stress (Table 15). On the contrary, in water melon, the carboxylation efficiency remained nearly constant. At 60 days after sowing too, the carboxylation efficiency was 0.107 in AHW 65 at 8 irrigation which

increased to 0.132 at 2 irrigation level. On the contrary, in Sugar Baby, the carboxylation efficiency was 0.118 at 8 irrigations which dropped to 0.063 at 2 irrigations level (Table 15). Thus, the results reveal that mateera is able to maintain high carboxylation efficiency even at low moisture level.

Identification of screening parameters

An attempt was made to identity & develop screening parameters for drought resistance. Among large number of parameters available to screen the germplasms 2 viz. plant height stress index (PHSI) and dry matter stress index (DMSI) were tested. It was noted that both the parameters hold good in screening germplasm for drought resistances. For instance in drought resistant material (mateera, kachari and snap melon) the value of plant height stress index remained more than 70% whereas in water melon it was as low as 50%. Similarly, the values of dry matter stress index also reveals that the values are more than 60% in stress tolerant cultivars but was less than 50% in susceptible cultivars (Table 16).

An attempt was also made to evaluate the role of germination under water stress as a parameter for screening. In this case seeds of water stress tolerant (Snap melon, Kachari, Mateera) and susceptible (Musk melon) were germinated in control and 1 MPa solution. It was observed that no reduction in germination percentage was observed during present study (Table 17).

Table 14. Transpiration in Water melon and Mateera with different irrigation levels at 45 & 60 days

Irrigation level	Transpiration (n mol/m^2/s)							
	45 Days				60 Days			
	AHW-65	AHW-19	Sugar Baby	Mahobobi	AHW-65	AHW-19	Sugar Baby	Mahobobi
2	0.0026	0.005	0.06	--	0.069	0.072	0.05	--
4	0.0032	0.0026	0.07	0.08	0.064	0.069	0.07	0.062
6	0.057	0.055	0.09	0.07	0.083	0.076	0.08	0.087
8	0.088	0.089	0.08	0.11	0.123	0.175	0.07	0.088

Table 15. Carboxylation Efficiency in Water melon and Mateera with different irrigatio levels at 45 & 60 days

Irrigation level	Carboxylation Efficiency							
	45 Days				60 Days			
	AHW-65	AHW-19	Sugar Baby	Mahobobi	AHW-65	AHW-19	Sugar Baby	Mahobobi
2	0.132	0.202	0.067	--	0.132	0.104	0.063	--
4	0.174	0.265	0.066	0.073	0.083	0.120	0.100	0.069
6	0.087	0.096	0.081	0.070	0.108	0.089	0.118	0.079
8	0.087	0.079	0.063	0.079	0.107	0.170	0.118	0.120

Table 16. Stress index for screening drought tolerant lines

Genotype	Dry Matter Stress Index	Plant Height Stress Index
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
Snap melon		
AHS 82	91.11	80.95
AHS 10	88.70	72.32
Tinda	49.00	82.37
Mateera		
AHW 65	66.75	77.58

Table 17. Seed germination in selected plant species under control and stress conditions

Plant type	Control	Stress
Snap melon - AHS 10	91.65	93.30
Kachari - AHK 200	100.00	98.33
Mateera - AHW 65	41.65	41.65
Tinda	90.00	88.00
Musk melon	98.33	98.33

D 2. Studies on water status, photosynthetic activity and productivity in *Ziziphus* spp.

During the period under report, growth and development studies were undertaken 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 18. 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 2.5-4.0 m. Similar, results were also observed for plant spread where the variation was very less in both the groups.

Table 18. Morphometric parameters of *ber* cultivators.

Variety	Plant height (m)	Spread (m)		Cir. (cm)
		E-W	N-S	
Gola	3.25	3.20	4.00	51.00
Umran	2.50	4.38	4.05	26.00
Banarsi Pewandi	2.50	3.77	4.12	28.30
Katha Phal	3.00	4.00	5.00	44.76
Sanaur- 5	3.00	5.00	5.00	53.00
Kaithali	4.00	4.97	5.00	40.70

Perusal of data on tree volume (Table 19) reveals that the tree volume varied from 10.54 m^3 in Umran to 19.94 m^3 in Kaithali. However, in cultivars showing mid day depression it was 11.70 m^3 in Gola, 10.54 m^3 in Umran and 15.78 m^3 in Banarsi pewandi. Similarly, it was 13.50 in Katha phal, 15.0

in Sanaur-5 and 19.94 in Kaithali. The results reveal that none of the morphometeric parameters are affected by mid day depression.

Data on fruit yield reveals that the yield of fruits are higher in case of cultivars not showing mid day depression as compared to these showing mid day depression. This is illustrated by the fact that cultivars Gola, Umran and Banarsi pewandi gave 31.50, 25.00 and 29.00 kg/tree as compared to Katha phal, Sanaur-5 and Kathali which produced nil, 23.00 and 14.75 kg/tree respectively (Table 19).

The diurnal variation in RWC in leaves of ber cultivars was also recorded. It was observed that the leaves of Gola, Umran and Banarsi pewandi maintained the RWC as high as recorded in forenoon and evening but the cultivars Kathaphal, Sanaur-5 and Kaithali shows reduction in RWC during mid day. Thus, it illustrates that the group which do not show mid day depression makes osmotic adjustment to maintain turgidity of leaves (Table 20).

Table 19. Morphometric parameters of *ber* cultivars.

Variety	Crown area (Sq/m)	Tree volume (m^3)	Yield (kg/tree)
Gola	3.24	11.70	31.50
Umran	4.44	10.54	25.00
Banarsi Pewandi	3.89	15.78	29.00
Katha Phal	5.06	13.50	No fruiting
Sanaur- 5	5.300	15.00	23.00
Kaithali	5.00	19.94	14.75

Table 20. Relative water content of *ber* cultivars

Variety	RWC (%)		
	At 9 AM	At 12 Noon	At 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

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, 2001. 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, 2001 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 to monitor the moisture retention in different treatments. The average fruit weight, fruit yield, fruit quality such as juice acidity, total soluble sugars, ratio of TSS and juice acidity were recorded. 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.

Plant growth

Although growth data was measured every month but in report the data measured in the month of October 2001 have been presented in table 21. The mean plant height data was in the range of 1.10 to 1.84 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 (59.1%) in T_3 and minimum (20.2%) in T_4 treatment over control treatment (T_{11}) were estimated.

The plant spread was also measured in every month and in report the data pertain to October, 2001 month have been given. The data presented in table 21 revealed that maximum tree spread (2.58 m^2) was recorded in T_3 and T_{10} followed in T_1, T_8 which were statistically at par while in other treatments (T_2, T_4, T_5, T_6, T_7, T_9 and control, tree spread were in lower side in the month of October, 2000. The

percent increase in plant spread in different treatments over control was also estimated and found that maximum plant increase (98.5%) was estimated in T_{10} treatment while minimum increase (11.5%) in spread over control was worked out in T4 treatment.

Table 21. Effect on plant growth parameters to different sources of manures and fertilizers

Treatment	Plant height		Plant spread	
	(m)	% Increase	(m^2)	% Increase
T_1	1.65	50.0	2.40	84.6
T_2	1.48	34.5	2.05	58.0
T_3	1.75	59.1	2.58	98.5
T_4	1.32	20.2	1.45	11.5
T_5	1.54	40.0	2.00	53.8
T_6	1.62	47.3	2.06	58.5
T_7	1.56	41.8	1.88	44.6
T_8	1.62	47.3	2.45	88.5
T_9	1.50	36.4	1.88	44.6
T_{10}	1.84	67.3	2.58	98.5
T_{11} (control)	1.10	-	1.30	-
SEm±	0.09	-	0.13	-
CD (5%)	0.22	-	0.35	-

Fruit weight

In pomegranate crop, fruit weight is also an important character and it was recorded at harvest of the crop in each treatment. The data presented in table 22 revealed that fruit weight in different treatment was in the range of 120 to 240 g and average maximum fruit weight (240 g) was recorded in T_{10} and it was statistically par in T_1, T_3, T_6 and T_8 treatments and average minimum fruit weight (120 g) was recorded in T_{11} treatment.

Fruit yield

The data pertain to average fruit yield ha^{-1} have been presented in Table 22. The data revealed that fruit yield was found in the range of 14.40 to 28.00 kg ha^{-1}. The maximum (28.00qha^{-1}) and significantly higher fruit yield was recorded in T_{10} treatment and which was statistically at par in T_1, T_3, T_8 and T_{10} treatments and minimum fruit yield was recorded in control treatments. The increase in fruit yield in

different treatments over control was also estimated and was found that maximum (94.4%) increase in fruit yield was recorded in T_{10} treatment while minimum increase over control was estimated in T_4 treatment.

Table 22. Effect on fruit and fruit yield to different sources of manures and fertilizers

Treatment	Average Fruit Weight	Fruit Yield	
	(g)	(q ha^{-1})	% Increase
T_1	210	25.2	77.1
T_2	200	24.0	66.6
T_3	220	26.0	80.5
T_4	130	18.0	25.0
T_5	180	22.0	52.8
T_6	220	26.0	94.4
T_7	175	21.0	45.8
T_8	225	25.0	73.6
T_9	165	19.6	36.1
T_{10}	240	28.0	94.4
T_{11}	120	14.4	-
SEm±	12.34	1.45	-
CD (5%)	34.50	3.12	-

Fruit quality

The fruit quality of pomegranate is also being evaluated (Table 23). The total soluble sugars, juice acidity and their ratios were estimated in different treatments. The total soluble sugar in different treatments was in the range of 12.00 to 14.00 degree Brix. The maximum TSS content (14.00° Brix) was estimated in T_3, T_6, T_8 and T_{10} treatments and minimum TSS was estimated in T_{11} treatment. The fruit juice acidity was estimated in different treatments and was found in the range of 0.15 to 0.25 percent. The minimum juice acidity (0.15 per cent) was recorded in T_8 treatment while it maximum 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 calculated to evaluate the fruit quality and data shows that this was in the range of 48.00 to 93.33. The maximum value (93.33) was observed in T_6 and T_8 treatments while it was minimum in T_{11} treatment.

Table 23. Response of different manures and fertilizers to TSS, acidity and TSS/acidity of pomegranate fruits

Treatments	TSS (° Brix)	Juice acidity (%)	TSS/ Acidity
T_1	13.00	0.18	72.22
T_2	13.00	0.18	72.22
T_3	14.00	0.16	87.50
T_4	13.00	0.22	59.09
T_5	13.00	0.18	72.22
T_6	14.00	0.15	93.33
T_7	13.00	0.19	65.00
T_8	14.00	0.15	93.33
T_9	13.00	0.20	63.16
T_{10}	14.00	0.16	87.50
T_{11}	12.00	0.25	48.00
SEm±	-	0.009	-
CD (5%)	NS	0.030	NS

Leaf mineral composition

The data regarding leaf mineral composition are given in table 24. The data revealed that the nitrogen content was in the range of 1.50 to 2.25% and maximum N content was recorded in T_{10} and minimum in T_{11} treatment. The P content was in the range of 0.18 to 0.28%. 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 1.30 to 1.54% and maximum K content was recorded in T_3 treatment and minimum K content was estimated in control treatment. Among the micronutrients, Zn, Cu, and Fe contents were measured and data presented in table 4 revealed that zinc was in the range of 28 to 35 ppm and maximum Zinc content was measured in T_8 treatment and minimum in T_2, T_7 and in control (T_{11}) treatments. The copper contents were more or less same in all treatments. The iron content was in the range of 50 to 72 ppm. The maximum iron content was observed in T_{10} and T_7 treatment while minimum was in control treatment.

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 25 revealed that photosynthetic activity (P_N) was recorded in the range of 0.3580 to 0.5800 mg CO_2 m^{-2} s^{-1}. The maximum P_N activity was recorded in T_8 followed in T_6 (0.5760 mg CO_2 $m^{-2}s^{-1}$), T_3 (0.5750 mg CO_2 $m^{-2}s^{-1}$). The minimum activity (0. 3255 mg CO_2 m^{-2} s^{-1}) was recorded in T_4 treatment.

The transpiration rate was recorded in the range of 1.125 to 1.430 µg H_2O m^{-2} s^{-1}. The mean maximum followed in T_3, T_6, T_8 and T_1 treatments. The minimum water use efficiency was recorded in T_{11} control treatment.transpiration rate (1.430 µg H_2O $m^{-2}s^{-1}$) was recorded in T_{11} treatment followed in T_1 (1.380 µgH_2O $m^{-2}s^{-1}$) and T_8 and T_6 treatments (Table 25) and minimum water transpired (1.125 µg 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 (45.87%) was estimated in T_{10} treatment

The stomatal resistance was found in the range of 0.445-to-0.570 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. Stomatal conductance was in the inversely proportionate to resistance values and stomatal conductance was observed in the range of 1.75 to 2.24 cm s^{-1}.

Table 24. 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	1.80	0.21	1.52	2.35	0.30	30	4	45	60
CM	1.78	0.24	1.48	2.35	0.25	25	4	40	50
VC	2.05	0.28	1.60	2.55	0.35	35	4	50	70
IF	1.70	0.25	1.52	2.05	0.20	30	3	35	50
CM:SM	1.80	0.24	1.50	2.45	0.25	32	4	40	65
CM:VC	1.98	0.28	1.59	2.45	0.26	36	4	45	55
CM:IF	1.74	0.23	1.45	2.25	0.22	30	3	40	70
SM:VC	2.02	0.28	1.56	2.45	0.25	35	4	50	55
SM:IF	1.80	0.23	1.52	2.35	0.20	28	3	40	40
VC:IF	2.15	0.25	1.58	2.45	0.25	32	4	50	70
Control	1.50	0.18	1.40	2.00	0.18	22	3	40	45

Table 25. Effect of manure and fertilizers on physiological activity of pomegranate plant

Treatments	P_N ($mgCO_2 m^{-2}s^{-1}$)	Transpiration rate ($\mu g\ m^{-2}\ s^{-1}$)	Water use efficiency (%)	Stomatal resistance ($s\ cm^{-1}$)	Stomatal conductance ($c\ ms^{-1}$)
SM	0.5530	1.380	40.07	0.520	1.92
CM	0.5000	1.265	39.52	0.525	1.90
VC	0.5750	1.270	45.28	0.445	2.25
IF	0.3255	1.320	24.65	0.570	1.75
CM: SM	0.5365	1.350	39.74	0.540	1.85
CM: VC	0.5760	1.330	43.30	0.465	2.15
CM:IF	0.4400	1.260	34.92	0.570	1.75
SM: VC	0.5800	1.350	42.96	0.460	2.17
SM:IF	0.4865	1.255	38.76	0.540	1.85
VC:IF	0.5160	1.125	45.87	0.460	2.17
Control	0.3580	1.430	25.04	0.550	1.81

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 26. It was noticed that on 3rd day after irrigation, soil moisture was in the range of 11.0 to 15.8% and maximum moisture content was measured in T_6 and T_7 followed in T_1, T_3 and T_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 and on 7th day and the soil moisture content was in the range of 8.3 to 11.8%. 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. 1). 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.

Table 26. Soil moisture pattern as influenced by different treatments

Treatments	3rd day	5th day	7th day
SM	16.2	14.3	11.0
CM	15.8	13.2	8.8
VC	14.3	12.6	10.8
IF	10.2	8.6	7.2
CM: SM	16.8	14.6	12.5
CM: VC	18.2	15.4	10.6
CM:IF	13.2	11.6	9.5
SM: VC	16.6	13.8	10.2
SM:IF	15.2	13.2	10.0
VC:IF	12.0	11.0	9.00
Control	11.2	10.1	8.1

Soil fertility build 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 27). 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 0.18 per cent after three years. The maximum organic carbon (0.18%) was estimated in T_3, T_5, T_6 and T_8 treatments. In control treatment the organic carbon content was recorded lower than initial organic carbon (0.09%). The available N content has increased in all treatments except control where the value was lower than initial value. The maximum nitrogen build was observed in T_{10} followed by T_4.The available P content was only 11.5 before deployment of treatments and reached maximum (18.5 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 206 kg ha^{-1} in T_{10} treatment followed in T_3 and T_8 treatments

Table 27. 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	0.17	134.5	14.0	198.0
T2	0.18	132.0	15.4	194.0
T3	0.17	144.0	17.0	202.0
T4	0.09	148.0	15.0	196.0
T5	0.18	138.0	15.0	198.0
T6	0.18	142.0	17.0	202.0
T7	0.14	140.0	15.0	196.0
T8	0.18	142.0	16.0	200.0
T9	0.15	140.0	15.4	196.0
T10	0.15	149.0	18.5	206.0
T11	0.07	123.0	11.4	186.0
Initial level	0.09	124.6	11.5	186.4

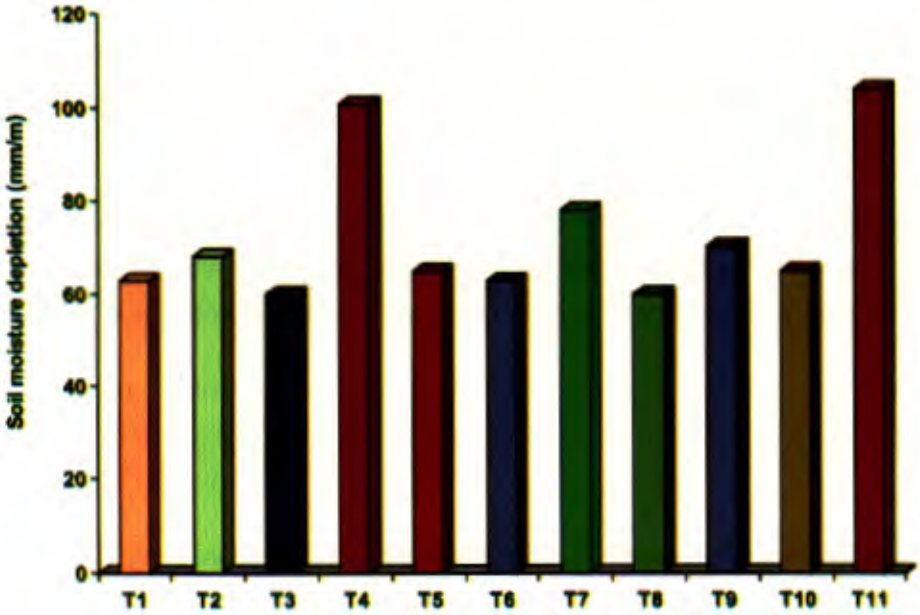


Fig. 1. Soil moisture depletion under different treatments

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 biofertiolizers like phosphate solublizing bacteria *Azospirillium* culture, VAM and phosphate + *Azospirillium* resulted in significant effect on all the vegetative , physico-chemical and yield attributes of pomegranate cv. Ganesh.

Maximum plant height (1.86 m), plant spread N-S (1.62 m), E-W (1.54 m), stem diameter (26.3 mm) was recorded in application of phosphate + *Azospirillium* culture. Similarly maximum fruit weight (196.25 g), fruit length (71.50 mm) , fruit diameter (66.85 mm) and T.S.S. (17.20 °Brix) was recorded in the same treatment.

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

Effect of organic and inorganic sources of N on growth, yield and quality of pomegranate cv. Ganesh.

Partial replacement of inorganic source of Nitrogen with organic source like castor cake and F.Y.M. found to have beneficial effect on plant growth, fruit development, chemical characters of fruit, yield per plant and N content of leaf.

Application of N 50 % in the form of F.Y.M. + 25 % in the form of Castor cake and 25 % in the form of Urea found to have maximum influence on vegetative growth parameters. Maximum fruit weight (188.75 g), fruit diameter length (69.72 mm) and T.S.S. were observed in the same treatment.

Data on number of fruits set per plant (96.50), number of fruits retained per plant (57.0), per cent retention (59.40) and yield per plant (10.75 kg) was obtained in application of 50 % N in the form of F.Y.M., 25% N in the form of Castor cake and 25% in the form of Urea.

Leaf N content was maximum (3.15 %) in treatment application of N 100 % in the form of Inorganic N. However in II sampling, 2 months after fertilizer application, it was maximum in 50 % F.Y.M., 25% Castor cake, 25% Urea.

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 results revealed that pit size 1.5m with 60Kg. of FYM/pit had given highest yield of 36.6Kg.,39.3 Kg and 14.35kg,respectively, for pumpkin,bottlegourd and bitter gourd.

F.4 Nutrient management in fruit crops-aonla and sapota

Developing DRIS norms in Sapota

The survey for developing DRIS-norms in sapota on the basis of leaf-sampling survey was carried out in Western & Southern Districts of Gujarat. The nutrient status of sapota leaves revealed that N-varied between 1.035 to 3.465%, P between 0.04 to 0.27%, K between 0.23 to 1.09%, Ca between 0.74 to 2.375, Mg between 0.46 to 1.67% and sulphur between0.32 to 1.18%.

Effect of NPK fertilization in sapota

The results revealed that maximum plant spread was recorded in 600g N/tree. Similarly, maximum plant height was observed in 600g of K.

Post Harvest Technology

Mission H : Post harvest handiling and processing studies in arid zone horticultural crops.

H 1 : Post harvest handling and processing studies in arid zone horticultural crops.

Preparation of *Mateera* juice

An experiment on post harvest utilization of *mateera* fruits were conducted by prepairing its juice with six different treatments. Treatment 3 (*Mateera* juice + sugar + salt + lime) was found best in organoleptic taste (29.05.2001) by the panel of judges. It was followed by T5 (*Mateera* juice+lime+sugar+black salt+lime) and T6 (*Mateera* juice +sugar+black salt).

Preparation of RTS and Squash

Bael: The fully matured bael fruits of Faizabad collections were collected from the progeny block. The creamy yellow pulp were extracted from the fruits and mixed with water to get thin consistency. Sugar was added till it attains 15° Brix. Then the juice are packed in bottles. The quality of fresh bael juice was assessed from the staffs of CIAH and found that it was generally good but further works are in progress to get better quality juice.

Ber: The fully matured ber fruits of cv. Gola were harvested from CIAH Farm. The fruits are washed in tap water, the skin were peeled and seeds were removed, then mixed with sugar, to get 15°Brix by adding sufficient amount of water. Then filtered and packed in bottles. The fruit juice was served. It was found good and further trials are to be executed in coming season.

***Ber* squash:** The fully matured fruits of *ber* var. Gola were harvested. Peeled and made into juice with the ratio 2:1 pulp:water and kept for over night then the supernatent liquid is siphoned and added with 50% sugar solution, 0.5% KMS and 2% citric acid. The squash was packed in a sterilized bottle and kept under refrigerated conditions. Further trial are to be carried out in the coming season.

Pomegranate: The fully matured fruits of pomegranate fruits var. Jalore seedless were harvested. Arils were collected carefully and then mixed in a mixer along with sugar so as to get 15°Brix TSS. Then the juice was filtered and filled in bottles for storage studies under refrigerated condition. The juice was tested good as fresh but it got fermented after a week.

Preparation of chhuhara (dry dates)

The date palm fruits of cv. Shamran were harvested at doka stage and brought to the lab. The fruits are sorted, cleaned with running water. Then the fruits treated with different level of boiling viz. 5

minutes, 10 minutes and 15 minutes with a control (without boiling). Fruits were dried in oven at 45±5°C for about 3 days. The fruits are stored. Further works are in progress.

Dehydration of *kachari*

The fully matured *kachari* fruits of AHK-200 were harvested from CIAH farm. The fruits sorted and washed. The fruits were dried in two methods-1. Fruit skin were peeled and cut into pieces, 2. Fruits skin was not peeled and cut into pieces. Both the fruits were dried in sun and oven. The kachari powder without peel was appealing good. Further work are to be carried out in the coming season.

Preparation of aonla product

Aonla shreds: *Aonla* shreds were prepared from small fruits. The fruits were cleaned and crated in crating machine having hole size of 0.3-0.5 cm and treated with four level of common salt and black salts (2%, 2.5%, 3%, 3.5% and 4%). Shreds were dried under shade. The product with 4% salt was found best. Further trial has to be performed in coming season.

Aonla candy: The fully matured *aonla* fruits of variety NA-7 were harvested. The fruits were graded into uniform good big size fruits. The fruit are washed and treated with 2% calcium carbonate for two days, then washed thoroughly in tap water. The fruits were boiled and seeds were removed. Then the pulp were dipped in 40% sugar syrup for 24 hours and the concentration of sugar syrup was increased to 50, 60, 70 and 75% at 24 hours intervals. Then they are drained from sugar syrup and dried in oven for 24-26 hours. They are packed in polythene bags. The further experiments are to be continued in coming season.

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 dseases of arid fruits and vegetables

Characterization of Antagonistic Microbes

Characterization of biological control agents is important for proper maintenance, further experimentation and augmentation in large scale. Therefore, the native isolates were investigated for their variability in distinct characters. Among the 23 isolates of *Trichoderma*, only few isolates are having similarly in conidiogenesis while rest of the isolates are morphologically different. Majority of the isolates are spreading uniformly with sporulation. Isolates CIAH-186, CIAH-149 and CIAH-89 are characteristic with sporulation at terminal with ring pattern. Similarly microscopic investigation of *Trichoderma* isolates revealed the variability in size, shape and pattern of phiallids and conidia.

Molecular charaterization

Molecular characterization on the total protein profile of 9 isolates of *Trichoderma* was performed through SDS-PAGE technique. The concentrated protein using ammonium sulphate was better in yield of intensive protein bands than protein extracts using only extraction buffer. Almost, similar pattern of protein bands with varing intensity were visualized in *Trichoderma* isolates. However, further standardization is under progress.

Evaluation on resistance of *Trichoderma* isolates against common fungicides

The native isolates of *Trichoderma* (CIAH-148, CIAH-149, CIAH-151, CIAH-175, CIAH-181a, CIAH-186, CIAH-225 and CIAH-240) were evaluated by in different non systemic fungicides viz. copperoxy chloride, mancozeb and wettable sulphur at 100, 250, 500 and 1000 ppm active ingredients. Different growth parameters of these isolates including synthesis of antimicrobial substances in growth medium have been recorded upto 15 days of incubation (Plate 1& 2). Data from different treatments were analysed and the following are the salient findings.

Among 8 isolates, cent percent growth was recorded in CIAH-225 at 250 ppm of copper oxychloride. It was followed by CIAH-149 and CIAH-151 with good sporulation and antibiotics production. In addition to the best isolate, CIAH-186, CIAH-175 and CIAH-240 could tolerate in this fungicide upto 500 ppm and the spare colour remains to be green (Table 28). The mycelial growth of isolate CIAH-175 was on par with check up to 500 ppm of mancozeb, and even at 1000 ppm, the mycelial growth was upto 70.6 mm with good antibiotic production on 3rd day observation. In subsequent investigation, this particular isolate was able to tolerate upto 10, 000 ppm on 12th day

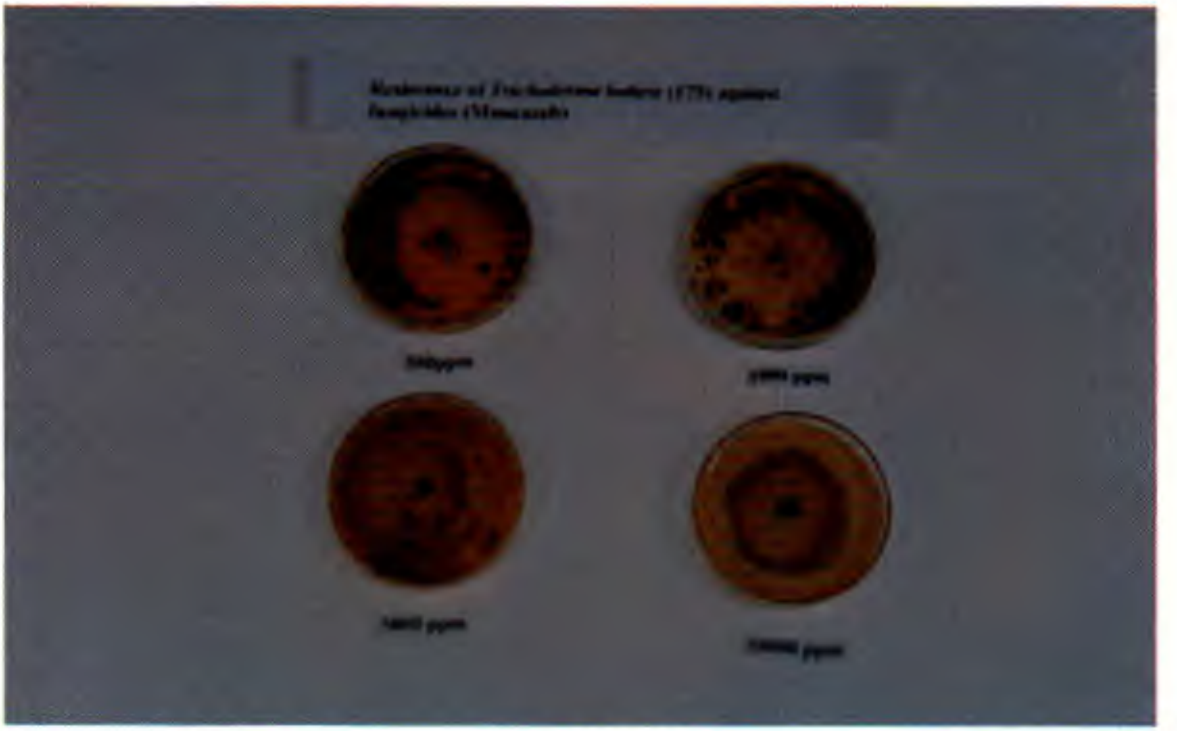


Plate 1. *Trichoderma* isolate (CIAH-175) resistant to mancozeb.

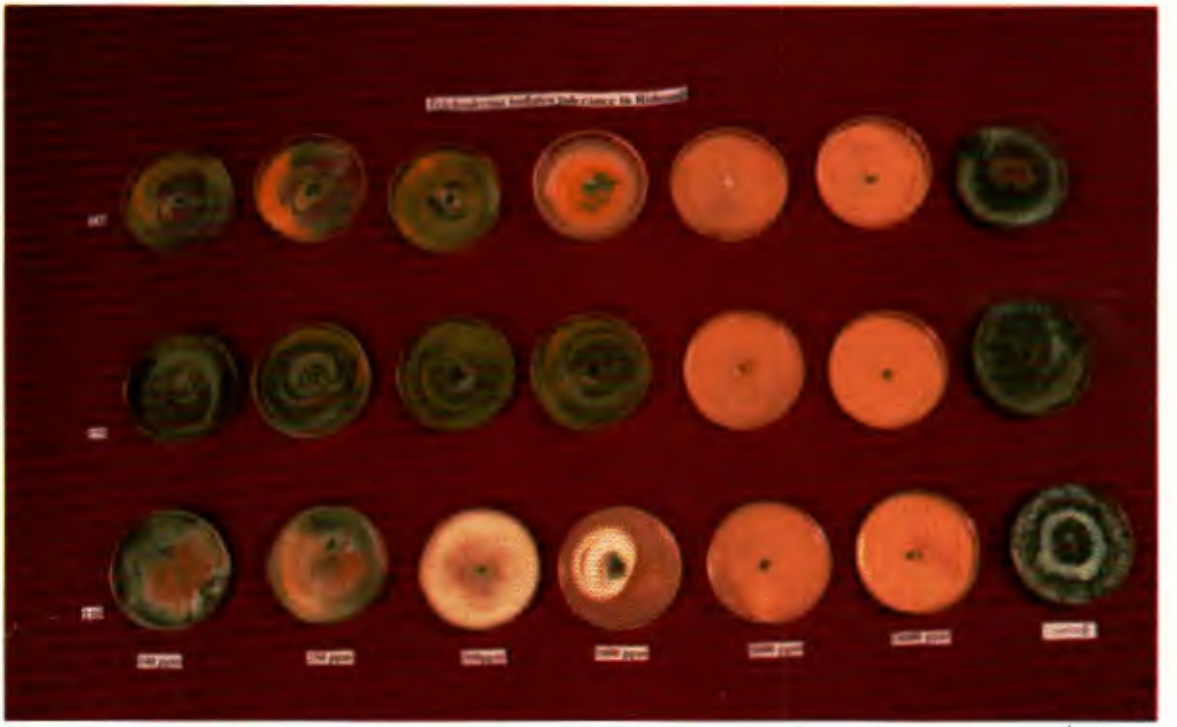


Plate 2. *Trichoderma* isolate (CIAH-148,175 and 240) resistant to *Redomil*

showing its high resistance nature to mancozeb. However, spore colour changed from green to yellow at higher concentrations. In case of rest of the isolates (CIAH-149 & CIAH-181a), the mean mycelial growth level was 32.2 and 32.7 respectivley (Table 29). In case of settable sulphur, mycelial growth, sporulation antibiotic production of isolate CIAH-186 were excellent up to 1000 ppm and on par with control, showing its resistance nature. Better gtowth was found in other isolates viz. CIAH-181a, CIAH-175, CIAH-240, CIAH-14 and CIAH-225 (Table 30).

Table 28. Mycelial growth of *Trichoderma* isolates in Copper oxy chloride

Isolates	Fungicide concentrations (ppm)					
	Check	100	250	500	1000	Mean
CIAH-148	90.0	70.0	55.7	00.0	00.0	40.5
CIAH-149	90.0	90.0	90.0	00.0	00.0	32.7
CIAH-151	90.0	90.0	90.0	00.0	00.0	38.7
CIAH-175	90.0	38.7	32.0	28.0	00.0	86.1
CIAH-181a	90.0	90.0	26.3	26.3	00.0	32.2
CIAH-186	90.0	73.7	45.3	22.7	00.0	50.3
CIAH-225	90.0	90.0	90.0	33.3	00.0	41.0
CIAH-240	90.0	40.7	37.3	34.7	00.0	46.4
Mean	90.0	72.5	57.5	14.8	00.0	

Values are means of 4 replicates

C.D. ($p \leq 0.05$) Isolate : 0.26; Concentrations= 0.21 IxC= 0.59

Table 29. Mycelial growth of *Trichoderma* isolates in Mancozeb

Isolates	Fungicide concentrations (ppm)					
	Check	100	250	500	1000	Mean
CIAH-148	90.0	50.7	00.0	27.3	00.0	40.5
CIAH-149	90.0	60.7	12.7	00.0	00.0	32.7
CIAH-151	90.0	82.0	21.3	00.0	00.0	38.7
CIAH-175	90.0	90.0	90.0	90.0	70.6	86.1
CIAH-181a	90.0	71.0	00.0	00.0	00.0	32.2
CIAH-186	90.0	56.3	45.3	45.3	00.0	50.3
CIAH-225	90.0	90.0	13.7	11.3	00.0	41.0
CIAH-240	90.0	67.7	41.3	24.3	08.7	46.4
Mean	90.0	71.5	33.8	24.8	00.0	

Values are means of 4 replicates

C.D. ($p \leq 0.05$) Isolate : 0.51; Concentrations= 0.41 IxC= 1.149

Table 30. Mycelial growth of *Trichoderma* isolates in wettable sulphur

Isolates	Fungicides concentration (ppm)					
	Check	100	250	500	1000	Mean
CIAH-148	90.0	90.0	59.3	27.3	00.0	53.3
CIAH-149	90.0	90.0	65.0	60.0	30.7	67.0
CIAH-151	90.0	90.0	84.7	00.0	00.0	52.9
CIAH-175	90.0	90.0	70.3	69.3	67.7	82.0
CIAH-181a	90.0	90.0	90.0	80.3	50.0	76.1
CIAH-186	90.0	90.0	90.0	90.0	90.0	90.0
CIAH-225	90.0	75.3	54.0	50.0	44.7	62.8
CIAH-240	90.0	88.2	90.0	72.0	29.7	71.9
Mean	90.0	88.2	73.9	56.1	36.6	

Values are means of 4 replicates

C.D. ($p \leq 0.05$) Isolate : 0.21 Concentrations= 0.16 IxC= 0.47

In order to find out the resistance level of *Trichoderma* isolates against some of the systemic fungicides viz. carbendazim, metalaxyl+mancozeb and thiophenate methyl were tested. Among 8 isolates, maximum resistance level was recorded in CIAH-175 up to 1000 ppm of metalaxyl + mancozeb. Rest of the isolates viz. CIAH-151, CIAH-148 and CIAH-225 could grow better in the same concentration. This particular fungicide changed the sporulation from green to yellow. Higher concentration (5000 and 10000 ppm) did not favour growth of these isolates (Table 31). The isolates CIAH-175 was able to grow (15 mm) up to 500 ppm of thiophenate methyl also. The mean mycelial growth of CIAH-175, CIAH-181a and CIAH-225 was more than 40 mm with good sporulation and antibiotic production upto 250 ppm concentration after 3 days of inoculation. However, isolate CIAH-186 was highly sensitive to this particular fungicide expressing no growth in any of the concentrations tested (Table 32). None of the isolates were able to grow in any of the concentrations of fungicides of carbendazim. The resistant isolates identified from this basic research would be utilized for integration with less concentrations of fungicides. In addition, the isolates with high tolerance capacity to the fungicide can be utilized for genetic improvement of isolates by biotechnological approach.

Table 31. Mycelial growth of *Trichoderma* isolates in metalaxyl + mancozeb

Isolates	Fungicide concentrations (ppm)					
	Check	100	250	500	1000	Mean
CIAH-148	90.0	84.7	73.7	30.0	13.0	40.3
CIAH-149	90.0	70.7	54.3	25.6	00.0	30.1
CIAH-151	90.0	79.0	75.7	62.0	14.0	46.1
CIAH-175	90.0	79.6	70.3	66.0	60.6	73.3
CIAH-181a	90.0	52.0	10.0	10.3	00.0	32.5
CIAH-186	90.0	66.3	44.7	31.0	00.0	46.4
CIAH-225	90.0	61.3	59.3	45.0	22.3	37.6
CIAH-240	90.0	21.3	15.7	10.3	00.0	27.5
Mean	90.0	64.4	50.5	35.0	13.7	

Values are means of 4 replicates

C.D. ($p \leq 0.05$) Isolate : 0.26 Concentrations= 0.21 IxC= 0.59

Table 32. Mycelial growth of *Trichoderma* isolates in thiophenate methyl

Isolates	Fungicide concentrations (ppm)					
	Check	100	250	500	1000	Mean
CIAH-148	90.0	37.0	32.0	0.0	0.0	31.8
CIAH-149	90.0	32.0	0.0	0.0	0.0	24.4
CIAH-151	90.0	82.0	0.0	0.0	0.0	34.4
CIAH-175	90.0	72.0	54.0	15.0	0.0	46.2
CIAH-181a	90.0	67.0	62.0	0.0	0.0	43.8
CIAH-186	90.0	0.0	0.0	0.0	0.0	18.0
CIAH-225	90.0	81.0	78.0	0.0	0.0	49.8
CIAH-240	90.0	34.0	12.0	0.0	0.0	27.2
Mean	90.0	50.6	30.0	1.9	0.0	

Values are means of 4 replicates

C.D. ($p \leq 0.05$) Isolate : 0.77 Concentrations= 0.61 IxC= 1.73

Evaluation on resistance of *Pseudomonas fluroscens* against common fungicides

Integration of bacterial anatagonists along with fungicides would be beneficial for reducing the chemicals concentrations. However, the test antagonists must have the compatibility with particular fungicide for better efficacy. Therefore, the promising isolatesof *P. fluoresens* (CIAH-111 & CIAH-311) were tested in four common fungicides viz. thiophenate methyl, wettable sulphur, carbendazim and metalaxyl + mancozeb at 100, 250, 500 and 1000 ppm concentration. The multiplication of the bacteria was assessed spectrophotometerically at 24 hrs., 48 hrs. and 76 hrs. of growth of bacteria. The over all results revealed that both the isolates multiplied well in the metalxyl + mancozeb. However, CIAH-111 could not produce the fluorescent compounds even at 100 ppm concentrations whereas, in case of CIAH-311, the fluorescent compounds production was correspondingly decreased upto 500 ppm and at 1000 ppm, it was restricted (Table 33 & 34).

Table 33. Fungicides on multiplication of *P. fluorescens*

Fungicides	Concentration (ppm)	Hours of observation			Fluorescens intensity
		24	48	72	
Check	0.0	0.713	1.487	1.959	+ + + -
Metalaxyl+Mancozeb	100	0.668	1.420	1.620	+ +
	250	0.616	1.357	1.420	+ +
	500	0.520	1.015	1.191	+
	1000	0.367	0.766	0.938	-
Wettable sulphur	100	0.605	1.044	1.614	+ + + -
	250	0.584	0.924	1.589	+ + + -
	500	0.565	0.893	1.103	+ + + -
	1000	0.143	0.793	1.03	- + +
Carbendazim	100	0.381	0.946	1.730	+ + + -
	250	0.362	0.914	1.450	- + +
	500	0.278	0.812	1.250	- + +
	1000	0.014	0.579	1.040	+ +
Thiophenate methyl	100	0.438	1.420	1.620	+ + + -
	250	0.343	1.182	1.612	+ + + -
	500	0.284	1.052	1.146	+ + +
	1000	0.211	0.420	0.638	+ + +

Values are means of 4 replicates

The growth, multiplication and production of fluorescent compounds of both the isolates were excellent as compared to check. Isolate CIAH-311 was having high compatibility upto 500 ppm while moderate level of compatibility was observed in isolate CIAH-111. In case of carbendazim, bacterial multiplication and fluorescent compounds secretion were excellent at 100 ppm by both isolates. However, there was slightly decreasing trend in fluorescent compounds secretion with increase of fungicide concentrations. Both isolates were compatibility than CIAH-111. In brief, these two native isolates are variable in their growth and fluorescent compounds secretion. Therefore, according to the nature of fungicides, the bacterial antagonists can be integrated for better efficacy in disease control.

Table 34. Fungicides on multiplication of *P. fluorescens*

Fungicides	Concentration (ppm)	Ist Day	IInd Day	IIIrd Day	Fluorescens intensity
Check	0.0	0.450	1.357	0.796	
Metalaxyl+Mancozeb	100	0.439	0.679	1.373	-
	250	0.364	0.665	1.359	-
	500	0.301	0.458	1.057	-
	1000	0.282	0.292	0.816	-
Wettable sulphur	100	0.165	0.676	1.445	+ + +
	250	0.103	0.575	1.347	+ + +
	500	0.048	0.562	1.039	+ + +
	1000	0.026	0.398	0.953	+ + +
Bavistin	100	0.487	0.863	1.714	+ + - +
	250	0.463	0.459	1.160	- + +
	500	0.168	0.450	0.910	- + +
	1000	0.097	0.075	0.075	+ +
Topsin	100	0.655	1.325	1.509	- + +
	250	0.602	1.315	1.469	- + +
	500	0.480	1.222	1.341	+ +
	1000	0.405	0.802	1.246	+ +

+ + + + : Very Good + + + : Good + + : Moderate + : Less - : Nil

Values are means of 4 replicates

Standardization of substrates for mass multiplication of *Trichoderma* isolates

Two isolates of *Trichoderma* i.e. CIAH-186 & CIAH-181a were multiplied in farm yard manure, sheep manure and vermicompost with supplementation of finger millet or wheat as carbohydrate sources. In order to find out the efficacy of carbohydrates assessment bioagents colonies were performed by serial dilution technique after 20 days of incubation. The results revealed that addition of carbohydrate source to the manure/ vermicompost could increase the colonies tremendously. Among 6 treatments attempted, the isolate CIAH-186 could grow and proliferate better in farm yard manure combined with finger millet was best followed by vermicompost plus wheat (Table 35).

Table 35. Suitability of substrates onopulation of *Trichoderma* isolates

Substrates	Population 10^7 cfu/g of soil	
	Isolates	
	CIAH–181a	CIAH-186
Sheep manure + Ragi	30	85
FYM + Ragi	53	135
Vermicompost + Ragi	25	43
Sheep manure + wheat	30	54
FYM + wheat	39	80
Vermicompost + wheat	37	90

Values are means of 4 replicates

Evaluation of growth factors on multiplication of biocontrol agents

Laboratory experiments were designed to find out the growth and multiplication of native isolates of bioagents in different levels of hydrogen and temperature levels. Three isolates of *P. fluorescens* viz. CIAH-311, CIAH-111 and CIAH-188b were selected based on their earlier performance in other experiments. These isolates were grown in different pH ranging from 4 to 10. Growth and cell concentrations were excellent at pH 7 to 8. Isolate CIAH-188b expressed better multiplication at pH 7 to 9, while isolate CIAH-111 preferred the pH ranging from 5-8 for better growth and cell multiplication. Production of fluorescent compounds was also good at pH 5 and 6 and it was moderate at pH 7 to 9 (Table 36). Similarly, *Trichoderma* isolate (9 Nos.) were tested for their growth and sporulation at different temperature ranging from 5 to 35oC with 5°C fraction. The optimum growth and sporulation of CIAH-186 were recorded at 25°C. Even high temperature (35°C) the growth upto 33 mm while at low temperature (5°C) there growth and sporulation (Table 37).

Table 36. Hydrogen ion concentration on multiplication of *P. fluorescens*

Isolates	pH	Ist Day	IInd Day	IIIrd Day	Fluorescens
CIAH-311	4.0	0.102	0.099	0.117	Nil
	5.0	1.271	1.393	1.492	+ + +
	6.0	1.197	1.295	1.443	+ + +
	7.0	1.357	1.455	1.512	+ – + +
	8.0	0.802	1.126	1.224	– + + +
	9.0	0.665	1.052	1.226	+ =
	10.0	0.302	0.395	0.570	= +
	Control				
CIAH-111	4.0	0.205	0.197	0.232	Nil
	5.0	1.174	1.266	1.442	+ + –
	6.0	1.303	1.401	1.500	+ – +
	7.0	1.235	1.344	1.449	+ +
	8.0	1.051	1.204	1.390	+ +
	9.0	0.498	0.685	0.758	+ –
	10.0	0.305	0.390	0.675	+
	Control				
CIAH-188b	4.0	0.042	0.550	0.603	–
	5.0	0.366	0.750	0.808	–
	6.0	0.696	0.872	0.963	+
	7.0	0.740	0.760	1.221	– + +
	8.0	0.628	0.749	1.293	+ + +
	9.0	0.357	0.449	0.837	+ + +
	10.0	0.352	0.414	0.880	+
	Control	0.073			

Values are means of 4 replicates

Table 37. Growth of *Trichoderma* isolates in different temperatures

Trichoderma Isolates	Temperatures (°C)				
	5	15	25	35	Control
CIAH-186	---	27.3	90.0	50.7	47.7
CIAH-181/a	---	25.0	90.0	48.6	48.7
CIAH-175	-	33.0	90.0	45.7	51.3
CIAH-151	-	31.7	90.0	39.7	50.6
CIAH-89	--	30.3	90.0	40.3	47.0
CIAH-149	--	30.6	90.0	41.3	50.0
CIAH-150	--	28.6	90.0	42.3	50.3
CIAH-240	--	30.0	90.0	39.0	52.0
CIAH-177	--	31.3	90.0	34.3	49.3

Values are means of 4 replicates

Production of Antimicrobial compounds (Antibiotic/Toxins) by *P. fluorescens* isolates

Secretion of toxic metabolites is one of the basic characteristics of bacterial antagonists. The toxic metabolites/antibiotics are to be active to suppress the plant pathogens. Therefore, native isolates (2 promising isolates) were screened out from a sequence of experiments and tested on growth and secretion of toxic metabolites in liquid state of KB's medium. The solvent extract of bacterial cell free suspension was subjected to thin layer chromatogram. The compounds were seen through ultraviolet radiation. The active spots were re-extracted from silica gel. These compounds are being used to evaluated for their fungicidal/antimicrobial efficacy against fungal pathogens particularly *A. alternata* of *ber*.

Management of virus diseases of mateera using Microbial Antagonists

In arid vegetables, particularly in case of mateera, virus disease are major problem and there is no effective management practices. Induction of systemic resistance using microbial antagonists is a recent approach for management of virus disease. Therefore, the field experiment was laid out using three *P. fluorescens* and two isolates of *Trichoderma*. Three kinds of treatments viz. seed treatment, foliar spray and seed treatment followed by foliar spray were given in mateera. Seed treatment with bacterial antagonists enhanced the germination and plant vigour than fungal antagonist. Further observation are in progress.

I. 2 Evaluation of arid fruits and vegetables germplasm/hybrids against disease

Ber

In *ber*, powdery mildew did not appeared due to unfavourable environmental conditions and hence the systematic evaluation will be carried out in response to disease appearance. There was no disease incidence in aonla during the reporting period. The germplasm collection of vegetables, chilli have been evaluated.

In *ber*, fruit rots due to different types of fungal pathogens are a major constrain under arid region. In order to manage this newly emerging disease, identification of resistant genotypes in addition to fungicidal sprays was initiated. *Ber* germplasm collection was evaluated and it was found that the incidence was less than 10%. Most of the genotypes were free from fruit rot incidence.

Field evaluation is resource intensive in terms of land, labour and time. Moreover, disease escape also can not be ruled out under natural incidence. Therefore, reliable and less resource intensive method using pathogen's toxins has been tried instead of using fruit rot pathogen. The toxic metabolites (*A. alternaria*) were produced in liquid medium containing *ber* fruit juice and extracted with help of chilled acetone. After a sequence of partial extraction, the powder of the toxic metabolites (200 micro gram per milli litre) was inoculated in healthy fruits. The fruit rot symptoms production was compared with simultaneous inoculation of conidal suspension of the test pathogen in another set of fruits of different cultivars. The results are comparable to field screening. Further investigations are under progress to standardize this *in vitro* technique for more precision and large scale adoption.

In hybrid lines and selections of *ber*, there was no incidence of powdery mildew during the reporting period. However, sporadic incidence of *Alternaria* fruit rot was observed. Evaluation of hybrid lines showed that out of 16 lines, 5 lines, were having less than 2.5% incidence while 2 lines were free from fruit rots. Nine lines did not have minimum requirement of fruits for evaluation. In hybrids i.e. SebxKatha (P1) recorded 3.3% incidence; SebxKatha (P2) recorded with 1.7% and in selection-1, there was no incidence during the reporting period.

Pomegranate

Germplasm and hybrid lines of pomegranate were evaluated against leaf and fruit spot diseases. Diseases (leaf and fruit spots) of pomegranate were very negligible due to unfavourable climatic conditions and therefore, the systematic evaluation will be continued in subsequent seasons. Fruit spots/rots due to *Aspergillus* sp. has been noticed in most of the genotypes. Pathogenicity of this fungal pathogen was confirmed. In all the hybrid lines, there was no incidence of disease so far.

Vegetables

The cucurbits (mateera, kachri, snap melon and tinda) were evaluated during summer as well as winter season. During summer season, 35 advance progenies along with 2 standard varieties i.e. AHW-19 and AHW-65 were evaluated against virus and fungal diseases. Out of these, 16 lines (1a x SB aI (2b, 3a and aIII (4a), dI, F II, g-I, g-III, Ia x SB (23a,b), SB x Char (29a), 9 x SB mix IV (18a, la, b) were free from virus diseases. Lines Viz. 1a x SB-C, 1a x SB mix-I recorded more than 8.0% incidence of virus diseases while rest of the lines were affected with virus diseases ranging from 3.2 to 8.0%. The standard checks recorded with 5.5% and 7.6% respectively.

In case of musk melon, out of 55 collection, 12 were found free from diseases. Maximum incidence of 26.9% was observed in collection No. 47 and No. 10 recorded a minimum of 4% incidence. The standard check line CHES-268 was infected with 7.5% incidence. Similarly, the cucurbits lines were evaluated during winter season also. The advance generation of mateera, kachri AHK-119, tinda and snap melon recorded maximum incidence of 38.2% followed by 25% in tinda and 13.7% in kachri. In case of mateera selection 1 and 2, only 4.7 and 5.5% incidence was recorded respectively. During both the seasons, negligible level of fungal diseases was recorded.

At CHES, Godhra

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

Powdery mildew in *ber*

Causal organism

The casual organism of powdery mildew at Godhra was identified as *Oidium zizyphi*. This organism infects both cultivated species *Z. mauritiana* and wild species *Z. nummularia*. Thus, the wild host helps the fungus in perpetuation during summer. The wild host is new recorded for the fungus.

Disease Management

Amongst different spray treatments tried to control the powdery mildew, best disease control was recorded in Bayleton (0.1%) (PDC=98.64) followed by Karathane (0.1%) (96.06), Bavistin (0.1%) (93.95), Roko (0.1%) (85.79) and Sulfex (0.2%) (78.48) treatments. Application of first two sprays with costly but highly effective fungicides and remaining two sprays with cheaper chemical Sulfex also provided good disease control (PDC=79.74 to 92.49). Alternated sprays of Bayleton with KH_2PO_4 (0.1M soln.) also recorded good disease control (83.35).

Control of *Pseudocercospora punicae* leafsposts of pomegranate

The results revealed that thiophanate methyl (PDI=4.9) sprays at 0.1% conc. were found to be the best treatment as compared to untreated control (14.57).

I. 4 Investigations on the fungal, viral and mycoplasma diseases of solanaceous, cruciferous and bulbous vegetables

Integrated disease management in post emergence damping off due to *Pythium* spp

In chilli and tomato, seed dressing and soil drenching with Ridomil-MZ, Blitox and Captaf provided best protection to the seedlings. Fumigation with formalin and incorporation of *Trichoderma harzianum* spores in soil @ 2 x 10^6cfu/g soil gave good control of the disease (PDC varing between 50.24 to 91.80 in chilli and 47.24 to 89.76 in tomato) and provided higher number of healthy seedlings.

Tomato

Alternaria blight of tomato was best controlled by a combination of chemical (Blitox 0.3%) sprays and cultural and biological control methods (PDI=5.58) when compared with untreated plots (PDI=19.71). Kavach 0.2% (7.3) and Captaf 0.2% (11.93) sprays also provided good protection against the blight.

Fruits of tomato were found infected with *Rhizoctonia solani* rot. Stacking of the plants, addition of the neemcake in soil and incorporation of *Trichoderma viridae* spores @2 x 10^6 cfu/g in soil was able to check the spread of the disease and reduced the disease incidence by 27.2%.

Tomato crop transplanted before 30th July was found to have about 25% less disease incidence of TSLV as compared to late transplanted crop.

Chilli

Maximum alternaria leaf spot control (PDC = 71.66) was recorded in the treatment in which different control strategies (Chemical + cultural : selection of healthy seedlings, removal of infected debris, summer ploughing and culling of infected fruits before seed extraction, inoculation of seedlings with VAM fungus and spraying the crop with mancozeb 2g/l) were combined. This treatment also recorded maximum yield (4.8 Kg/plot in var. Pusa Jwala) as compared to control (2.93 kg/plot), Kavach (4.2 kg/plot) and mancozeb treatments (4.15 kg/plot).

Powdery mildew of chilli was found to be effectively managed by two Sulfex sprays at 0.2% concn. Alternated with foliar sprays of $KH_2PO_4$and $KMnO_4$.

Cluster bean

Guar crop was found infected with powdery mildew caused by *Oidium* sp; which is different from

the common pathogen *Oidiopsis taurica*. Besides this, anthracnose, alternaria leafspots and fusarium root rot were also observed infecting guar crop during last week of August and September months.

I. 5 Pest management in *ber*, pomegranate, *aonla* and sapota

Ber

Effective control of fruitfly and fruit borer infesting ber was achieved by a schedule of control involving two applications of either fenvalerate(0.005%), decamethrin (00.0015%), acephate(0.05%) or dimethoate(0.05%) at 21 days interval followed by two applications of NSKE(5.0%) at ten day interval.

Pomegranate

Thrips *Scirtothrips dorsalis* Hood on pomegranate was effectively controlled by fortnightly applications of acephate (0.05%) or dimethoate (0.05%) followed by NSKE (5.0%) at 7-day interval.

Aonla

Seasonality of insect pest of *aonla* indicated the economic status of pests, which may cause considerable loss to the grower. Hence, a preliminary trial on the control or borer complex in aonla was conducted which clearly indicated the superiority of all treatments over control. Further studies need to be carried out to develop an effective IPM against the major pests in aonla.

I.6 Pest management in chillies and brinjal

Chilli

Population of thrips *Scirtothrips dorsalis* Hood could be suppressed effectively by fortnightly sprays with monocrotophos (0.005%), diamethoate (0.05%) or phosphamidon (0.05%) followed by weekly sprays with NSKE (5.0%) As a consequence of this, the incidence of leaf curl was drastically reduced. Even half dose of monocrotophos (0.025%) + NSKE (2.5%) was found equally effective.

Brinjal

The population of brinjal jassid was effectively reduced to a significant level by the application of phosphamidon (0.05%), monocrotophos (0.05%) or endosulfan (0.07%) followed by weekly sprays with NSKE 5.0%. However, the incidence of fruit borer was effectively reduced by forthnightly application of fenvalarate (0.05%)(two sprays) followed by weekly sprays with NSKE (5.0%).

Plant production

Mission K: Production of planting materials

At CIAH, Bikaner

K 1. Multistrata *aonla* based cropping system

As per the decision of RAC held on 6th August 2001, experiment on "Multistrata Aonla Based Cropping System" with six cropping models have been framed out. For carrying out the research work an area of 2.0 ha has been earmarked. Lay out of the experiment was carried out in 1.0 ha area and *aonla* seedlings have been planted in 0.5 ha area during Feb 2002. The survival per cent of the seedlings recorded during last week of march was 92.3 per cent. Seeds of *saji* (*Suaeda fruticosa*) which forms one of the components of the cropping system have been collected from Lunkarsar area of Bikaner. Cuttings have also been tried.

K 2. Establishment of Nursery

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- 38).

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 2001, 02 types of tamarind from Baster and Nokha; 01 bael from Jodhpur; 01 Jamun from Bikaner have been collected and maintained. About 400 seedling of date palm were raised from the seeds collected from Kachchh region of Gujatrat.

K 3. Evaluation of fruit trees

The fruit plants maintained under Progeny Block are also under evaluation to see their performance under irrigated arid ecosystem. 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 39.

Table 38. Status of arid crops in Nursery at CIAH, Bikaner

Fruit type	No. of collection	Place of collection
1. *Ber*	05	Jodhpur, Godhra
2. *Aonla*	06	Faizabad
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

Table 39. Vegetative vigour and fruit yield of some arid fruits planted in the nursery.

Fruit type/ cultivar	Year of plantation	Vegetative vigour		Fruit yield (kg/tree)	
		Plant height (m)	Crown spread (m^2)	2000	2001
Bael					
Pant Aparna	August, 1997	2.75	9.25	--	--
Pant Sujata	August, 1997	4.16	13.80	--	2.67
Pant Swarna	August, 1997	5.25	16	3.0	1.10
Pant Shivani	August, 1997	5.00	12.5	--	8.00
Pant Urvashi	August, 1997	5.16	7.00	--	15.50
NB 5	August, 1997	5.13	20.50	--	20.50
NB 7	August, 1997	4.35	13.25	--	--
NB 9	August, 1997	2.60	12.5	15.2	3.60
Ber					
Mundia	Sept., 1998	1.70	3.75	--	4.20
Umran	Sept., 1998	1.30	1.89	--	5.80
Seb	Sept., 1998	1.72	4.04	--	8.25
Gola	Sept., 1998	1.21	4.97	--	10.50
Goma Kirti	Aug., 1999	0.94	1.08	--	3.60
Citrus					
Sweetorange: Mosambi	August, 1997	2.25	5.94	2.0	4.00
Mandarin: Kinnow	August, 1997	2.80	5.20	--	--
Malta	August, 1997	2.77	5.87	--	--
Grapefruit:Marsh Seedless	August, 1997	2.50	5.25	--	--
Red Blush	August, 1997	2.20	4.95	--	--
Lemon:					
Pant 1	August, '997	3.45	10.78	--	0.80
Godhra	August, 1997	2.40	6.60	--	3.28
Abohar	August, 1997	3.55	5.73	--	--

Guava					
Allahabad Safeda	Sept., 1997	2.53	9.59	--	4.20
L 49	Sept., 1997	1.70	1.50	2.5	8.50
Karonda					
KS 1	July, 1997	1.30	2.21	--	--
KS 2	July, 1997	1.27	3.02	--	1.10
KS 3	July, 1997	1.00	1.86	--	--
KS 4	July, 1997	1.12	2.49	--	1.13
KS 5	July, 1998	1.08	0.87	--	--
***Lasoda**					
LS 1	July, 1997	3.68	15.08	--	--
LS 2	July, 1997	5.50	40.30	4.5	75.40
LS 3	July, 1997	6.08	40.97	8.9	90.65
Pomegranate					
Ganesh	July, 1997	2.05	5.14	1.2	1.64
G 137	July, 1997	2.15	4.05	1.7	2.75
Jalore Seedless		1.80	3.10	0.5	4.25
Mulberry	July, 1998	3.00	12.00	0.7	4.50

*Tender fruits for vegetable purpose

K 4. Multiplication of planting materials

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 40). Some ornamental plants were also multiplied by seeds/ cuttings/ suckers under growing structures for the purpose of campus beautification. Besides vegetative propagation, 3000 seedlings of desi ber were raised for hedge row plantation around experimental blocks. 2500 aonla seedling rootstocks were also raised for gap filling in establishing aonla block and also for budding purpose. As a source of revenue generation, Rs. 6416/- have been generated by on-spot selling of above mentioned planting materials and guarpatha leaves for vegetable purpose to the farmers.

Table 40. Production of planting materials (2001)

Fruit types	Variety	Propagation method	Plant material produced (No.)	Purpose	
				Experimental	For sale
Ber	Gola	Patch budding	500	100	400
	Seb	Patch budding	50	--	50
	Umran	Patch budding	60	--	60
	Kaithali	Patch budding	--	-	--
	Mundia	Patch budding	--	-	--
	Others	Patch budding	100	100	-
Aonla	NA 6	Patch budding	50	--	50
	NA 7	Patch budding	150	--	150
Pomegranate	Jalore Seedless	Cutting	100	60	40
	Ruby	Cutting	25	25	--
	G 137	Cutting	30	30	--
Indian Aloe	Local Selection	Sucker	2000	1700	300

At CHES, Godhra

Production of planting material in vegetable crops

During the year quality planting material of various arid zone fruits like *Ber, Aonla,* Pomegranate, Custard apple, Mango, Sapota, *Phalsa, Jamun*, Guava, and *Kagzi* Lime was propagated and supplied to government organizations and farmers.

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 23,000 disease free seedlings of solanceous vegetables (Chilli, brinjal and tomato) were produced and sold to the farmers.

Agricultural extension

At CIAH, Bikaner

A. Extension Research Activities

Extension research projects entitled as (a) A study on horticultural development in IGNP area of Bikaner district, Rajasthan and (b) Assessment of arid horticultural status in Bikaner district of Rajasthan, were prepared. To initiate research work on these projects, interview schedule was also prepared to collect information from the respondents (farmers) as per need. This interview schedule was prepared pre tested and finalized to collect-intended information.

In the light of project so prepared, a bench mark survey was conducted in IGNP area of Bikaner district (Rajasthan). The information/data related to existing cropping pattern, adoption and yield gap level and constraints in adopting arid horticultural crops, were collect from the selected villagers of the IGNP area.

The data of preliminary survey reveals that poverty, low income and high cost of inputs, lack of credit and subsidy facilities, poor communication and transportation facilities, lack of reliable source of technical information and seeds/planting materials, lack of technical guidance, poor linkage between research centres and farmers, no training facilities for farmers, lack of location specific technologies, absence of reliable market to sell produce time, low return/benefit, poor and erratic rainfall, water scarcity, salty ground water, frequent drought, hot and high wind velocity, etc. are major constraints which inhibit the adoption and progress of the arid horticultural technologies.

B. Extension activities

(a) Farmer's visit to the institute farm

About 234 farmers from various villages of Bikaner district were brought to the institute and they visited the institute farm. The major pupose to bring these farmers to the institute was to impart the knowledge amongst the farmers 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. About 240 farmers, who grow or want to grow horticultural crops, were contacted personally. These farmers were interviewed to know about their need, desire and problems faced by them in adopting horticultural technologies. The opinion/ experiences of the farmers about the performance of adopted CIAH technologies (e.g. New varieties of mateera, kachari, snapmelon, ber, aonla, etc.) were also noted.

Farmers visit to CIAH Farm

Farm women trainees from FTC, Bhawnagar visiting *ber* orchard of CHES, Vejalpur.

(c) Popularization of the technologies available in the Institute

Mass awareness and popularisation programme of arid horticultural technologies developed by Institute was under taken through personal contact and mass media.

(d) Participation in *Krishi Vigyan Mela*

The institute participated in the state level Krishi Vigyan Mela organized by RAU, Bikaner on March 24, 2002. The arid horticultural technologies developed by CIAH were displayed in the mela by arranging an exhibition. The seed/planting materials and technical literature related to CIAH technologies were distributed to the farmers and technical persons. During visit of institute's stall/exhibition, the farmers interacted with scientists with respect to arid horticultural technologies. They showed keen interest in purchasing seeds of new varieties of vegetables as released by the institute. Farmers showed interest to grow arid fruits crops like aonla, ber and pomegranate, date palm etc. They were provided with required information and literature on arid horticultural technologies. The farmers and other persons appreciated the CIAH technologies and agreed to adopt them on their farm.

The arid horticultural technologies as developed by the institute were highly appreciated and the institute was awarded with first prize for best exhibition, stall arrangement and moringa fruits (pods) amongst all the Government and Non-Government Organization/ institutes who participate in the Mela.

CIAH Stall at State Level Kisan Mela at RAU, Bikaner on 24.3.2002

Hon'ble Rajasthan State Minister of Animal Husbandary & Dairy, Sh. Hari Singh Kumher and Dr. C.P.S. Yadav, VC, RAU, Bikaner on CIAH stall in State level Kisan Mela at RAU, Bikaner on 24.3.2002

Dr. D.G. Dhandar, Director, CIAH, Bikaner receiving First Prize for Best Stall during State level Kishan Mela at RAU, Bikaner on 24.03.2002

At CHES, Godhra

Strategies for adoption of integrated horticultural technologies

The technologies generated by Central Horticultural Experiment Station, Vejalpur are collected, listed and documented. This technological inventory acted as a basic material for preparation of interview schedule. An interview schedule is prepared in consultation with IIHR, Bangalore, and libraries of GAU, Anand and PDKV, Akola. *Aonla* (*Emblica officinalis* Gaertn.) growing farmers of Panchmahals and Vadodara districts were interviewed. The information was quantified in the form of master table. The data is analyzed using statistical packages.

Knowledge of *aonla* cultivation technology

The level of knowledge of *aonla* cultivation technology as a whole is relatively high at 65 per cent. Majority of the farmers have medium level of knowledge of *aonla* cultivation technology. The farmers have high knowledge in practices like season, intercropping, varieties, rainfed cultivation, spacing, flowering, harvest, fertilizer application and propagation. They have less knowledge in pest management, disease management and self-incompatibility of pollination. They have full knowledge of season and rainfed cultivation; partial knowledge of fertilizer application and spacing; and no knowledge of self-incompatibility of pollination and disease management. They have high knowledge of FYM, Nitrogen and Phosphorous application whereas low knowledge of Potash application. They have high knowledge in all spheres of intercrops cultivation like necessity of intercropping, number of years of intercropping and number of intercrops. They have low knowledge regarding name of disease and absolutely no knowledge of control measures. Role of women is positively and significantly associated with knowledge of *aonla* cultivation technology.

Adoption of *aonla* cultivation technology

Adoption of *aonla* cultivation technology as a whole is 57 per cent. Majority of the farmers followed medium level of adoption of *aonla* cultivation technology. All the farmers followed correct season of planting. Majority of the farmers cultivated intercrops. There was high level of adoption of practices like season, rainfed cultivation, varieties, flowering, harvest, and spacing. Low level of adoption was observed in pest management, fertilizer application, propagation, disease management and self-incompatibility. There was medium level of adoption of FYM, Nitrogen and Phosphorous application whereas Potash application was less. Control of disease was nil.

Technology gap

Technology gap of *aonla* cultivation technology as a whole is 43 per cent. Technology gap was very wide in disease management, and self-incompatibility. Technology gap was wide in propagation, fertilizer application and pest management.

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. Ashwani)

Objectives: To survey, collect, evaluate, characterize, multiply and maintain the bio-diversity of arid zone fruit and vegetable crop.

Lead Centre: **NBPGR, New Delhi**

Co-operating Centre: **CIAH, Bikaner**

Year of Start: **July, 1999**

Central Institute for Arid Horticulture, Bikaner is one of the co-operating center under NATP on Plant Bio-diversity of the Jai Vigyan National Science and Technology Mission on Conservation of Agro-bio-diversity (PGR) for collection, evaluation and maintenance of arid horticultural crops. Besides, the CIAH is also National Active Germplasm Site (NAGS) for the multiplication, maintenance and conservation of plant genetic resources of arid horticultural crops under Indian National Plant Genetic Resource Management System.

In pre-NATP era (1994-99) under mission mode approaches of NRCAH (Now CIAH), this center has made excellent growth in collection of plant genetic resources and its utilization particularly in arid zone fruits and vegetables. As a result of massive germplasm collection and augmentation programme at CIAH (1994-99), this center has developed *ex situ* field repository of *ber* (300), pomegranate (150), date palm (47), *aonla* (19), *bael* (5) and *lasora* (2) where as in vegetables a collection of 193 in watermelon (*mateera*), 558 of *kachri* 90 of snapmelon and 132 in chilli and later on the building up of PGR is continuing under NATP on plant bio diversity.

From Januray, 2000 to March, 2001, intensive explorations were undertaken for the surveys, identification and collection of horticultural plant bio diversity from parts of arid, semi arid and sub humid region of Rajasthan and Gujarat and also special explorations one each in Andamans, Himachal Pradesh and Kuchchh region of Gujarat were undertaken for the crop specific collections. As a result of this, identification of plustrees in arid fruits and collection have been made in *ber* (*Ziziphus mauritiana*) (19), *aonla* (*Emblica officinallis)* (17), *bael* (*Aegle marmelos)* (7), *ker (Capparis deciduas)* (64), *lasora* (*Cordia myxa)* (64), date palm (*Phoenix dactylifera* (46), muskmelon (*Cucumis melo)* (55) and *chilli* (*Capsicum annuum*) (52). Besides under this period, evaluation of germplasm received as a NAGS under NATP for the characterization and multiplication for long term conservation at National Gene Bank, New Delhi in vegetable crops was done which includes. *Cucumis callosus* (33), *Cucumis melo* (55), *C.*

melo var. *momordica* (12), *C.m.* var *agrestis* (12), *C. hardvickii* (11), *C. sativus* (4), *C.prophaterum* (2), *C. trigonus* (1), Luffa hermophodita (1), *Citrullus lanatus* (13) and *Citrullus fistulosus* (14).

1. Exploration and collection of germplasm

Exploration for the identification and collection of *ber* and *bael* germplasm from Andamans (B.B.Vashishtha and D.B.Singh)

This exploration was under taken in April, 2001 as special programme to Andamans for the identification and collection of *ber* types tolerating powdery mildew. As a result of exploration, four elite genotypes tolerate to powdery mildew has been identified and collected. Besides, collection of seven *bael* genotypes from Andamans. Now, these collection of *ber* and *bael* are under evaluation for the characterization and conservation in field repository of the respective crops at CIAH.

Exploration for the survey, identification and collection of *aonla* from parts of Himachal Pradesh (Arun Kumar Shukla)

This exploration was undertaken during December, 2001 for the identification and collection of frost tolerate types in *aonla* from parts of Shimla and Solan district in Himachal Pradesh. As a result of this, intensive crop specific exploration, twelve plus trees have been identified on the basis of fruit quality and yield contributing traits from these areas.

Exploration for the survey, identification and collection of *ker* and *lasora* bio-diversity from parts of Rajasthan, 26.5.2001 to 1.6.2001 (D.K.Samadia)

Under this exploration 32 collection of ker and 32 of *lasora* were made from parts of Bikaner, Jaisalmer, Barmer, Jalore, Sirohi, Udaipur, Rajsamand, Pali and Jodhpur districts of Rajasthan during May-June, 2001. A wide range of diversity have been explored and recorded during the course of surveys. Hot spots and elite trees have been identified and seedling progenies raised from open pollinated fruit samples of elite trees for evaluation and characterization of germplasm at CIAH (Plate 3&4).

Exploration for the survey, identification and collection of date palm germplasm from Kachchh region of Gujarat, 23-28 July 2001

(R.S.Singh and D.K.Samadia)

This exploration was undertaken during July, 2001 in Kachchh region of Gujarat where enormous genetic diversity in date palm exists in the form of natural and cultivated seedling originated population in the country. A wide range of variations was observed for fruit quality and yield contributing traits in dates. A total 46 genotypes have been collected on the basis of fruit quality at *doka* stage to raise seedling progenies for the evaluation and also assessment of extent of genetic diversity in

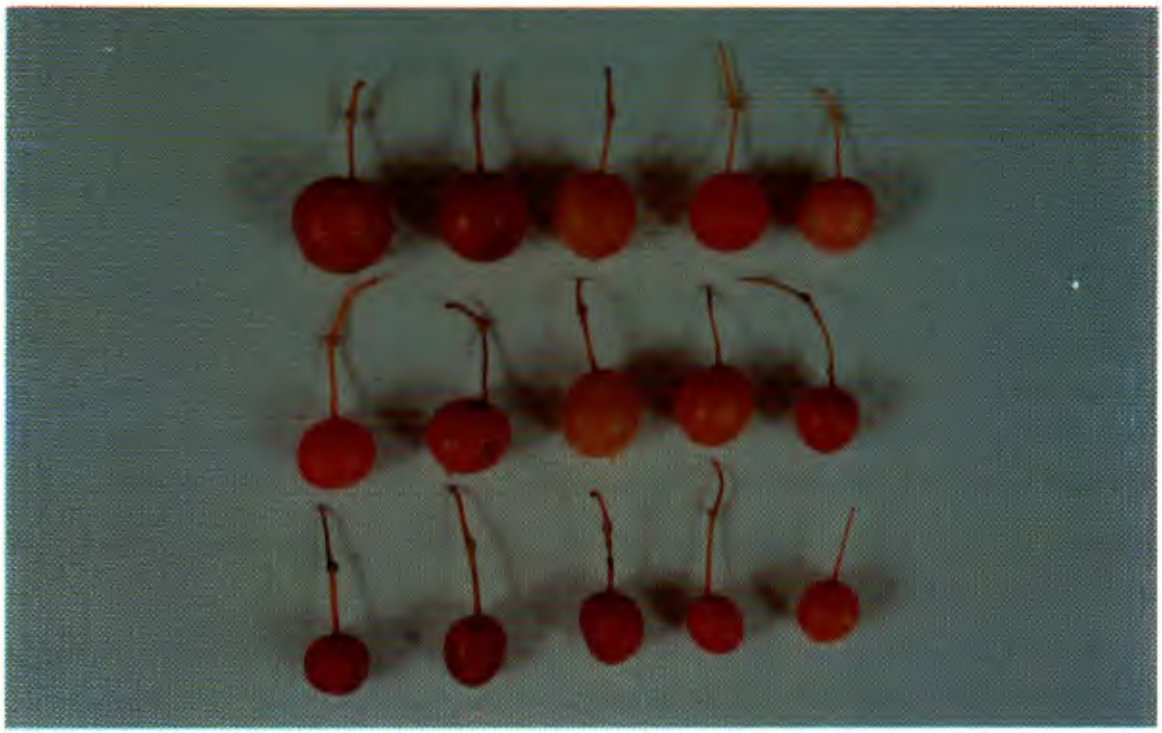


Plate 3. Genetic diversity in fruits of *ker* (*Capparis decidua*)

Plate 4. Genetic diversity in fruits of Lasora (*Cordia myxa*)

the progenies. Besides, 25 plus trees of date on the basis of fruit quality, colour and fruiting behaviour have been marked for the collection in the form of off-shoot for the conservation at CIAH (Plate 5).

Exploration for the survey and collection of chilli germplasm from parts of Rajasthan and Gujarat, 10-20 December, 2001 (D.K.Samadia)

This exploration was made during December, 2001 in chilli growing areas of Rajasthan and Gujarat covering arid, semi arid and sub humid agro climatic. A total 52 collections were made from parts of Nagour, Ajmer, Sikar, Jaipur, Alwar, Bharatpur, Karoli, Sawaimadhopur, Tonk, Kota, Bundi, Bhilwara, Chittorgarh, Banswara, Dungarpur, Udaipur, Rajsamand, Sirohi, Jalore, Pali and Jodhpur districts of Rajasthan and also Dahod, Baria and Panchmahal district of Gujarat and wide range of genetic variability was explored and collected in the form of fruits. A number of observations were recorded for crop growth behaviour, production aspects, productivity factors, fruit quality and seed characters. The range of variation recorded for plant height (35-80 cm), number of branches/plant (1.5-5.6), fruits/plant (8.5-110.5), red ripe fruit yield (25.5-240.6 q/ha), red ripe fruit weight (2.25-18.26g), fruit length (2.82-15.20 cm), fruit diameter (0.65-4.25 cm), dried fruit weight (0.33-4.77 g), dried pulp weight (0.2-3.95g), seed weight/fruit (0.10-1.05 g) and number of seed/fruit (12-117) table 41 (Plate 6).

Table 41. Range and Mean in traits of chilli germplasm collected during exploration under NATP (PB) 2001.

Characters	Range	Mean	Sd.
Plant height (cm)	35.5-80.5	58.17	10.42
Branches/plant (No.)	1.5-5.6	3.75	0.67
Fruits/plant (No.)	8.5-110.5	32.51	16.02
Picking/crop (No.)	1.3-4.5	3.06	0.63
Red ripe fruit yield (q/ha)	25.5-240.6	110.77	46.74
Red ripe fruit weight (g)	2.25-18.26	7.91	4.18
Fruit length (cm)	2.83-15.20	9.29	2.64
Fruit diameter (cm)	0.65-4.25	3.60	1.77
Dried fruit weight (g)	0.33-4.77	1.85	1.02
Dried pulp weight/fruit (g)	0.20-3.95	1.21	0.76
Dried seed weight/fruit (g)	0.10-1.05	0.61	0.27
Seeds/fruit (No.)	12-117	52.14	22.91

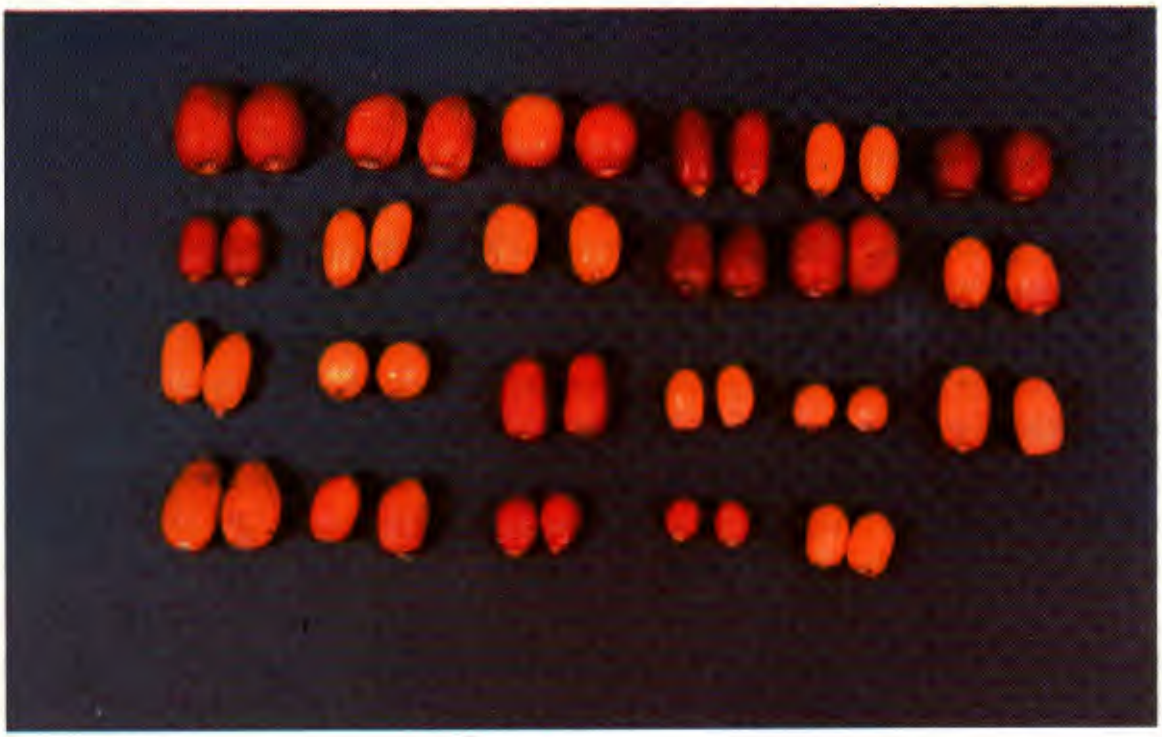


Plate 5. Genetic diversity in fruits of date palm *(Phoenix dactylifera)*

Plate 6. Variability in fruits of chilli

2. Characterization and multiplication of germplasm

Evaluation for the characterization and multiplication of muskmelon germplasm (D.K.Samadia)

Fifty five muskmelon germplasm collected from parts of arid, semi arid and subhumid areas of Rajasthan under NATP on plan bio-diversity by CIAH during summer season of 2000 were evaluated alongwith seven cultivars/lines during the summer 2001 for detailed evaluations and characterization of germplasm on plant growth, flowering, earliness, fruit yield and quality traits and resistance to fruit fly infestation, incidence of diseases and fruiting behaviour, sun burns and fruit cracking under extreme of high temperature of arid environment. Detailed observations were recorded to categorized the muskmelon genetic diversity available in arid and semi arid areas of Rajasthan. Out of 62 genotypes evaluated, seven collections, two lines and three varieties depicted desirable trend for higher fruit yield and having quality characters. A set of 55 multiplied seed germplasm of muskmelon has also been deposited to the National Gene Bank at NBPGR, New Delhi for conservation of genetic diversity.

Evaluation for characterization and multiplication of Indian bean (*Labab purpureus* (L) Sweet)

[D.K.Samadia]

Indian bean, Dolichus bean, field bean, or *sem* is one of the important drought tolerate legume of Indian origin. It is also grown as minor crop in very small pockets in arid and semi arid regions. Eighteen diverse collections of Indian bean evaluated during 2000-2001 were re-evaluated during rainy-winter season of 2001-2002 for the characterization and multiplication of seed germplasm. Detailed information have been compiled related to crop growth and flowering and fruiting behaviour, pod and seed yield and pod quality attributes under arid conditions. All the collections were grouped according to pod harvest (early, mid or late), length of fruiting period, nature of plant growth (viny, semi-erect or erect), pigmentation on foliage and pods, flower colour, pod quality, tenderness and seed content. etc. Among the viny type genotype AHDB 16 and AHDB 15 were early maturing and short duration and AHDB 3 late maturing and long duration were promising for higher yields. After categorization, one set of ten accessions have been deposited at National Gene Bank, NBPGR, New Delhi for conservation of the germplasm.

Project 2. Development of propagation techniques for *Capparis deciduas* (R.Bhargava, P.L.Saroj, Neelam Chauhan and Pyush Verma)

1. Research Achievements

Survey the natural biodiversity of *Capparis* in Rajasthan for identification of elite type.

Since no systematic work on this crop has been done, hence it was planned to identify the elite types from the natural plantation of *Capparis*. For the survey of biodiversity in *Capparis decidua* in the state of Rajasthan the schedule has been prepared in consultation with Co-PI and other scientists of the

Institute. The first preliminary survey was conducted in September, 2001 in Jaisalmer district of Rajasthan covering mainly Falodi and Pokran area. Since, this was second fruiting period, hence it was difficult to ascertain the actual productivity level of the plants. Moreover, the plants were growing naturally on community land, that too damaged by the wild life. To overcome this difficulty in selecting elite types, we interacted with the farmers in the locality. Accordingly, we have marked some promising plants in the Falodi area. Since the major emphasis will be laid on fruiting behaviour and fruit charactersitics, the survey will be undertaken during fruiting period (i.e. April- June, 2002).

Standardisation of vegetative propagation technique in *Capparis decidua*

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

Standardisation of optimum nature of cutting

In order to standradise the optimum nature of the cuttings, an experiment was laid using softwood (av. dia. 0.40-0.60 cm), semi-hardwood (av. dia.0.95-1.25 cm) and hard wood (av. dia.1.20-1.30 cm) cuttings in Growth chamber as well as nursery net house . The treatments given were 5000,7500 and 10000 ppm IBA along with 1000 ppm Thyamine. The growth chamber was maintained at 33°C with 80% RH during September, 2001. The results revealed that among various types of cuttings planted, only semi-hardwood cuttings showed sproutings in both, growth chamber and nursery (40 and 30%, respectively). Therefore, our results reflects that semi-hardwood cuttings are most suited for propagation studies (Table 42).

Table 42. Effect of nature of cuttings on sprouting

Types of cutting	Per cent sprouting	
	Growth Chamber	Nursery
Softwood	-	-
Semi hardwood	40	30
Hardwood	-	-

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 43). The treatments were given either in aqueous medium or organic medium (DMSO). For each treatment, 20 semi hardwood cuttings were selected and given dip treatment. Subsequently one set of cuttings were planted in growth chamber and

second 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 43 and 44.

Effect of PGRs on sprouting of cuttings under Growth Chamber

The results obtained in cuttings planted in growth chamber maintained at 33^0C are given in Table 43 . It is evident that out of the various combinations tried, treatment of semi-hardwood cuttings with 7500 ppm IBA + 1000 ppm Thymine in DMSO showed maximum sprouts. The month wise sprouting under different treatments revealed that in November, the sprouting was observed under all treatments. 50 per cent sprouting was observed in the treatment 7500 ppm IBA+1000 ppm Thymine followed by 30% 7500 ppm IBA + 1000 ppm Thymine (aq). In other treatments, the sprouting was very less. During February 40% sprouting was observed in 7500 ppm IBA + 1000 ppm Thymine (DMSO), whereas, it was 30% in7500 ppm IBA + 1000 ppm Thymine (aq). In other treatments, the per cent sprouting was less than the control. In the month of March almost similar trend was followed as observed during February. Maximum sprouting (50%) was reported with 7500 ppm IBA + 1000 ppm Thymine in DMSO as well as in 7500 ppm IBA + 1000 ppm Thymine (aquous). Among other treatments 10000 ppm IBA + 1000 ppm Thymine (aq), 5000 ppm IBA+1000 ppm Thymine (DMSO), 10000 ppm IBA + 1000 ppm Thymine (DMSO) gave sprouting whereas other treatments failed to produce any sprout. Despite the fact that cuttings produced good sprouts, the rooting was very poor during these months.

Effect of PGRs on sprouting of cuttings under nursery

Perusal of data on cuttings planted at nursery (Table 44) reveals that cuttings treated with 7500 ppm IBA + 1000 ppm Thymine in DMSO (20%) and 5000 ppm IBA + 1000 ppm Thymine in DMSO(10%) recorded sprouting during November and December, respectively. During January and February, no spouting was observed under any treatment. In March, maximum sprouting was reported with 7500 ppm IBA + 1000 ppm Thymine in DMSO (40%) followed by 7500 ppm IBA + 1000 ppm Thymine as aquous medium (20%). 10000 ppm IBA + 1000 ppm Thymine as aquous medium, 5000 ppm IBA + 1000 ppm Thymine in DMSO and 10000 ppm IBA + 1000 ppm Thymine in DMSO gave 10 per cent sprouting in each. Other treatments including control failed to produce sprouts.

Table 43. Effect of plant growth regulators on sprouting of cuttings in Growth chamber (45 days after planting)

Treatment	Per cent sprouting				
	Nov.	Dec.	Jan.	Feb.	March
Control	20	-	-	20	-
IBA (5000 ppm)+ 1000 ppm thyamine (Aqueous)	10	-	-	-	-
IBA (7500 ppm) 1000 ppm thyamine (Aqueous)	30	-	-	30	50
IBA (10000ppm) + 1000 ppm thyamine (aqueous)	20	-	-	-	30
IBA (3750 ppm)+NAA (3750 ppm) + 1000 ppm thyamine (Aqueous)	10	-	-	-	-
IBA (5000ppm)+NAA(5000 ppm) +1000 ppm thyamine (Aqueous)	10	-	-	-	-
IBA (5000 ppm)+1000 ppm thyamine (DMSO)	10	-	-	-	20
IBA (7500 ppm) + 1000 ppm thyamine (DMSO)	50	-	-	40	50
IBA (10000 ppm) + 1000 ppm thyamine (DMSO)	10	-	-	20	20
IBA (3750ppm)+NAA (3750 ppm)+ 1000 ppm thyamine (DMSO)	10	-	-	20	-
IBA (5000 ppm)+NAA (5000 ppm) (DMSO)	-	-	-	-	-

Table 44. Effect of plant growth regulators on sprouting of cuttings in nursery

Treatment	Per cent sprouting				
	Nov.	Dec.	Jan.	Feb.	March
Control	-	-	-	-	-
IBA (5000 ppm)+ 1000 ppm thyamine (Aqueous)	-	-	-	-	-
IBA (7500 ppm) 1000 ppm thyamine (Aqueous)	-	-	-	-	20
IBA (10000ppm) + 1000 ppm thyamine (aqueous)	-	-	-	-	10
IBA (3750 ppm)+NAA (3750 ppm) + 1000 ppm thyamine (Aqueous)	-	-	-	-	-
IBA (5000ppm)+NAA(5000 ppm) +1000 ppm thyamine (Aqueous)	-	-	-	-	-
IBA (5000 ppm)+1000 ppm thyamine (DMSO)	-	10	-	-	10
IBA (7500 ppm) + 1000 ppm thyamine (DMSO)	20	-	-	-	40
IBA (10000 ppm) + 1000 ppm thyamine (DMSO)	-	-	-	-	10
IBA (3750ppm)+NAA (3750 ppm)+ 1000 ppm thyamine (DMSO)	-	-	-	-	-
IBA (5000 ppm)+NAA (5000 ppm) (DMSO)	-	-	-	-	-

Carbohydrate profile in cuttings of *Capparis decidua*

In order to ascertain the factors responsible for the sprouting and rooting of cuttings, attempts were made to study the metabolite profiles. The carbohydrate profile of the cuttings were estimated at monthly interval (Table 45). It was observed that level of reducing sugar was low during November which gradually increased upto March. Similarly, the variation in total sugars also revealed that maximum sugar was recorded during March. Whereas, in other months the level was nearly same. Perusal of data on starch content demonstrated that except Janauary the starch content was high in the cuttings.

Table 45. Level of reducing sugar, total sugar and starch during different months

	Carbohydrate (mg/g fresh weight)		
Month	Reducing sugar	Total sugar	Starch
Nov.	3.66	5.75	7.65
Dec.	4.58	6.25	8.63
Jan.	4.16	5.50	5.17
Feb.	5.16	6.66	7.12
March	5.83	7.50	7.87

FINANCIAL

Details of head-wise expenditure for the period June, 2001 to March, 2002 are given below:

S. No.	Head of Account	Sanctioned	Expenditure
A.	Recurring		
1	T.A	50,000.00	758=00
2	Training/International Conf./Symp.	30,000.00	-
3	Workshop	-	-
4	Consultancy		-
5	Contractual services	1,81,400.00	64,471=00
6	Operational expences	2,00,000.00	91,052=00
Total (A)		4,31,400.00	1,56,281=00
B.	Non-Recurrring		
1	Equipment	14,15,000.00	7,80,524=00
2	Furniture	20,000.00	-
3	Vehicles	-	-
4	Library books/Journals	-	-
5	Civil (renovation) works	2,00,000.00	1,48,280=00
Total (B)		16,35,000.00	9,28,854=00
C.	Institutional Charges	43,100.00	-
Total (A+B+C)		21,39,500.00	10,85,135=00

Project 3. 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

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 m, 8 x 8 m, 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.

The survival of ber plantation is more than 90 percent under field conditions in almost all the treatments. The plants are growing well and average plant height is 0.74, 0.73, 0.72 and 0.75m; plant spread is 1.1, 0.99, 1.12 and 0.92 m^2 under groundnut – wheat, cluster bean – mustard, Indian Aloe and sole plantation, respectively. The spread of plant is more than the height, indicated that the cultivar *Gola* is spreading in nature. The stock diameter, scion diameter and scion:stock ratio was also recorded to see the vegetative incompatibility of the component plants. So far, there was no apparent effect of groundstorey crops on vegetative vigour of perennial component. The data on plant survival, plant height, plant spread, stock diameter, scion diameter and stock: scion is presented in table 46, 47, 48, 49, 50 and 51 respectively.

Table 46. Plant survival (%) of *ber* cultivar *Gola*.

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	90.50	90.5	90.00	90.0	90.60	90.0	90.16
Cluster bean – Mustard	89.50	89.0	91.50	91.5	91.40	91.0	90.50
Indian Aloe	90.50	90.5	90.00	90.0	91.50	91.5	90.6
Sole plantation	88.20	88.0	88.50	87.5	89.20	88.5	88.0
Mean	89.78	89.5	90.00	89.75	90.67	90.25	

Table 47. Plant height (m) of *ber* cultivar *Gola*

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	0.66	0.73	0.65	0.74	0.66	0.76	0.74
Cluster bean – Mustard	0.66	0.74	0.63	0.71	0.68	0.75	0.73
Indian Aloe	0.63	0.70	0.63	0.73	0.64	0.74	0.72
Sole plantation	0.67	0.76	0.65	0.75	0.65	0.75	0.75
Mean	0.65	0.73	0.64	0.73	0.66	0.75	

Table 48. Plant spread (m^2) of *ber* cultivar *Gola*

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	0.94	1.03	0.89	1.01	1.15	1.26	1.1
Cluster bean – Mustard	0.85	0.96	0.86	0.98	0.94	1.03	0.99
Indian Aloe	1.10	1.23	0.78	0.89	1.10	1.23	1.12
Sole plantation	0.78	0.91	0.77	0.86	0.86	0.98	0.92
Mean	0.92	1.03	0.82	0.94	0.99	1.13	

Table 49. Stock diameter (cm) of *ber* cultivar *Gola*

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	1.42	1.53	1.46	1.57	1.63	1.72	1.60
Cluster bean – Mustard	1.49	1.57	1.56	1.58	1.57	1.68	1.61
Indian Aloe	1.40	1.49	1.40	1.51	1.56	1.66	1.55
Sole plantation	1.33	1.48	1.63	1.74	1.58	1.70	1.64
Mean	1.41	1.52	1.51	1.60	1.59	1.69	

Table 50. Scion diameter (cm) of *ber* cultivar *Gola*

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	1.26	1.37	1.25	1.36	1.53	1.62	1.45
Cluster bean – Mustard	1.35	1.45	1.32	1.43	1.33	1.44	1.44
Indian Aloe	1.28	1.39	1.36	1.48	1.35	1.46	1.44
Sole plantation	1.20	1.32	1.25	1.38	1.32	1.44	1.38
Mean	1.27	1.38	1.30	1.41	1.38	1.49	

Table 51. Scion:Stock of *ber* cultivar *Gola*

Crop rotation	Spacing (m)						
	6 x 6		8 x 8		16 x 4		Mean
	Sept. 2001	March 2002	Sept. 2001	March 2002	Sept. 2001	March 2002	March 2002
Groundnut – Wheat	0.89	0.90	0.86	0.87	0.94	0.94	0.90
Cluster bean – Mustard	0.91	0.92	0.85	0.91	0.85	0.86	0.90
Indian Aloe	0.91	0.93	0.97	0.98	0.87	0.88	0.93
Sole plantation	0.90	0.90	0.77	0.79	0.84	0.85	0.85
Mean	0.90	0.91	0.86	0.89	0.88	0.88	

Performance of groundstorey component

From the first year of cropping, more than 90.0 q/ha green pods of cluster bean, 5.38 q/ha groundnut, 18.0 q/ha Indian aloe leaf pad, 9.0 q/ha mustard and 3.0 q/ha wheat were harvested. There was no much variation in the yield of crops grown at different tree spacing but in general, the yield was better in sole cropping. The biomass production of all the crops was also recorded. The data on yield of groundstorey crops and biomass production is presented in table 52 and 53, respectively.

Table 52. Yield of groundstorey crops with *ber* based AFS (q/ha)

Spacing	Groundstorey crops				
	Kharif		*Rabi*		Perennial Crop
	Groundnut	Cluster bean*	Wheat	Mustard	Indian Aloe**
6 X 6 m	5.34	91.50	3.36	9.11	17.90
8 X 8 m	5.36	90.85	3.42	9.12	18.50
16 X 4 m	5.37	91.30	3.36	9.10	18.07
Sole Crop	5.46	92.80	3.48	9.23	18.40
Mean	5.38	91.61	3.40	9.14	18.22

* Dry pod yield ** Green leaf pad yield in first harvesting

Table 53. Biomass production of groundstorey crops (q/ha)*

Spacing	Groundstorey Crops			
	Groundnut	Cluster bean	Wheat	Mustard
6 x 6 m	37.76	35.22	8.58	29.0
8 x 8 m	37.35	35.15	8.78	29.37
16 x 4 m	37.20	35.10	8.79	29.22
Sole crop	38.95	36.90	9.72	30.10
Mean	37.82	35.60	8.97	29.42

* Dry weight basis

Moisture distribution pattern

The data on soil moisture distribution pattern under different treatments and depths were recorded at 15 days interval by using Neutron Moisture Probe. The distribution of soil moisture depicted in fig. 2 indicated that the maximum soil moisture was recorded in the plot of Indian Aloe followed by wheat and minimum under mustard plot, though the differences between mustard plot and wheat plot were very low. This indicated that the soil moisture vary with the frequency of the water applied to the crops. The soil moisture also increases with increasing depth of soil profile.

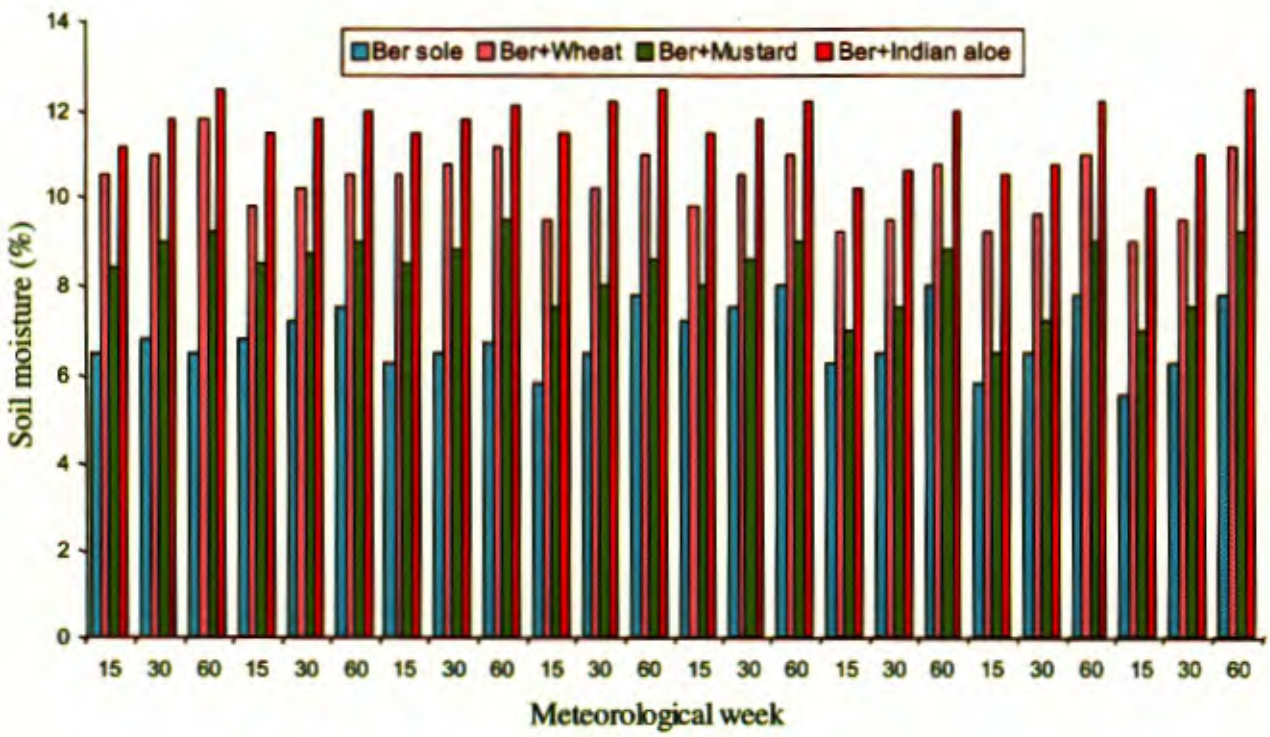


Fig. 2 Soil Moisture distribution under different crop combinations

Allelopathic studies

In allelopathic studies under laboratory conditions, there was no detrimental response of ber leaf aqueous extract on cluster bean, wheat and groundnut crops with regard to germination and seedling vigour. However, the germination and growth of mustard was adversely affected as compared to control. The germination of groundnut was also delayed up to some extent. The observation indicated that the allelopathic response of ber leaf aqueous extract is varied with crop but effect was not very detrimental (Table 54).

Table 54. Effect of ber leaf aqueous extracts on seed germination, seedling vigour and dry matter production of groundstorey crops

Groundstorey crops / parameters	Response		Reduction (%)
	Treated	Control	
Groundnut			
Germination (%)	87.60	94.20	6.60
Shoot length (cm)	15.72	18.16	13.44
Root length (cm)	6.54	10.30	36.50
No. of roots / plant	4.00	6.20	35.48
Root : shoot	0.42	0.57	--
Vigour index	1377.07	1710.67	--
Fresh weight (g)	2.16	2.86	24.47
Dry weight (g)	0.40	0.46	13.04
Cluster bean			
Germination (%)	95.20	98.00	2.80
Shoot length (cm)	6.96	7.06	1.42
Root length (cm)	6.24	6.34	1.58
No. of roots / plant	2.68	2.66	-0.75
Root : shoot	0.90	0.90	--
Vigour index	1787.86	2101.12	--
Fresh weight (g)	0.23	0.22	-4.54
Dry weight (g)	0.02	0.01	-100.0
Wheat			
Germination (%)	96.60	98.40	1.80
Shoot length (cm)	6.26	7.38	15.18
Root length (cm)	5.18	13.98	62.94
No. of roots / plant	2.20	4.20	47.62
Root : shoot	0.83	1.89	--
Vigour index	604.72	726.19	--
Fresh weight (g)	0.64	0.66	3.03
Dry weight (g)	0.20	0.27	25.92
Mustard			
Germination (%)	13.60	91.20	77.60
Shoot length (cm)	4.84	7.20	32.78
Root length (cm)	4.22	6.72	37.20
No. of roots / plant	2.40	4.60	47.83
Root : shoot	0.87	0.93	--
Vigour index	65.82	656.64	--
Fresh weight (g)	0.11	0.15	26.67
Dry weight (g)	0.01	0.02	50.00

Project 4. Horticulture and vegetable gardening for food and nutritional security (JAY VIGYAN – Household food and Nutritional Security)

'Goma Kirti' a clonal selection from Umran performed exceedingly well over Gola and Umran in respect of vegetable parameters as well as yield.

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.

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.

Experiment on performance of different varieties of pomegranate viz. Mridula, Ganesh, Ruby, Jalore seedless and Jyoti are in progress.

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.

B. Network Project on Drip Irrigation System in Perennial Horticultural Crops (Dr. B.D.Sharma)

Project title : National Network for Drip Irrigation System in Perennial Horticultural Crops

Pomegranate

The pomegranate crop was planted in September 1998 and in February 1999, the drip irrigation system was installed as per technical programme and in March 1999, the treatments were deployed. The irrigation requirement of the plant for different crops were calculated. The plant height, plant spread was recorded every month. In each year, for taking *mrig bahar* crop, the watering was with hold in the month of May. Basal dose of manures, phosphate and potash fertilizers were given in the month of June. The irrigation schedules were deployed as per technical programme. The fruits were matured were harvested in the months of November-December. The matured fruits were used for qualitative parameters.

Plant height: The plant height in each treatment was measured in each month but for final report, the data pertain to initial (March, 1999) and final (December, 2001) plant heights have been presented. The data presented in table 55 revealed that plant height responded to irrigation levels and nitrogen fertilizer doses applied through drip through drip and bubbler system. The maximum plant height (1.92m) was recorded at 0.90CPE level through drip irrigation and statistically at par with 0.75CPE

irrigation level (1.90m) and these were significantly higher over 0.50CPE through drip and 1.00CPE through pipe (bubbler). The total plant height increased during the experimental period was calculated by differencing the final and initial plant height in respective treatments. The data (Table 55) revealed that the plant height increased significantly in 0.90 and 0.75CPE level of irrigation through drip over 1.00CPE irrigation level through bubbler (pipe). It is also noticed from the data that initial plant heights were statistically at par in all treatments.

Table 55. Effect of irrigation levels and N fertigation on plant height of pomegranate.

Treatments	Plant height (m)		
	Initial (1998)	Final (2002)	% Increase
Irrigation			
0.90 CPE through drip	0.52	1.92	1.40
0.75 CPE through drip	0.46	1.90	1.44
0.50 CPE through drip	0.52	1.52	1.00
1.00 CPE through pipe	0.50	1.35	0.85
SEm±	-	0.23	0.26
CD (5%)	NS	0.55	0.52
Fertilization			
75% recommended dose of N	0.52	1.93	1.41
50% recommended dose of N	0.50	1.62	1.12
No Nitrogen	0.44	1.50	1.06
SEm±	-	0.21	0.15
CD (5%)	NS	0.46	0.35
A*B			
CD (5%)	NS	NS	NS

The average maximum plant height (1.93m) was recorded where 75% recommended dose of nitrogen through drip was provided over and which was significantly higher over no nitrogen ((1.50m) treatment. Increase in plant height during the report period was maximum (1.41m) in 75% RD of nitrogen through drip. However, irrigation and fertilizer interaction effect was not seen.

Plant spread: The plant spread was measured as per standard procedure in each month. In report, the data for initial and final were taken for the month of March 1999 and December 2001, respectively. Data of table 56 revealed that plant spread responded to irrigation levels and N fertigation. The

maximum plant spread (2.42m^2) was recorded in 0.75CPE level of irrigation through drip that is statistically at par (2.35m^2) with 0.9CPE and these were significantly higher over 1.00CPE through bubbler irrigation. The increase in plant spread during the period of study was estimated through subtracting the initial plant spread from the plant spread attained finally. The data in table 56 depicted that maximum plant spread (2.27m^2) was estimated at 0.75CPE irrigation through drip and minimum spread (1.17m^2) was obtained in 1.00CPE irrigation through bubbler system. Nitrogen fertigation also increased the plant spread and highest plant spread (2.45m^2) was recorded in those plants where 75% recommended dose of nitrogen be applied and minimum (1.52m^2) in no nitrogen treatment. Actual increment in plant spread was also calculated and found that highest (2.30m^2) in plant spread was also in the same treatment. However no interaction effect was observed.

Table 56. Effect of irrigation levels and N fertigation on plant spread of pomegranate.

Treatments	Plant spread (m^2)		
	Initial (1998)	Final (2002)	% Increase
Irrigation			
0.90 CPE through drip	0.16	2.35	2.19
0.75 CPE through drip	0.15	2.42	2.27
0.50 CPE through drip	0.16	2.00	1.84
1.00 CPE through pipe	0.15	1.32	1.17
SEm±	-	0.42	0.24
CD (5%)	NS	0.96	0.56
Fertilization			
75% recommended dose of N	0.15	2.45	2.30
50% recommended dose of N	0.16	1.96	1.80
No Nitrogen	0.15	1.52	1.37
SEm±	-	0.38	0.23
CD (5%)	NS	0.85	0.52
A*B			
CD (5%)	NS	NS	NS

Fruit yield: In the year 2000, 2001 and 2002, the yield data was recorded. Since the plant could not get full canopy during the study period thus, yield data could not be stabilized, however, the irrigation and nitrogen fertigation treatments showed the response to the yield. During year 2000, the yield potential was very less however; the pattern of yield (Table 57) revealed that maximum (6.50q/ha) was recorded in 0.90CPE irrigation level through drip and minimum (4.00q/ha) in 1.00CPE irrigation level through bubbler system. In the year 2001 the yield potential increased and maximum fruit yield (7.90q/ha) was recorded in 0.90CPE irrigation level through drip followed in 0.75CPE through (7.80qha) these were significantly higher over 1.00CPE level of irrigation through bubbler where, fruit yield was only 5.10q/ha. Again in the year 2002, yield potential increased and significantly higher yields i.e. 15.00 and 14.50q/ha were recorded at 0.90 and 0.75CPE irrigation level, respectively over irrigation level of 0.50CPE through drip and 1.00CPE through bubbler.

Table 57. Effect of irrigation levels and N fertigation on fruit yield of pomegranate.

Treatments	Fruit yield (q/ha)		
	(2000)	(2001)	(2002)
Irrigation			
0.90 CPE through drip	6.50	7.90	15.00
0.75 CPE through drip	6.12	7.80	14.50
0.50 CPE through drip	5.60	6.20	9.00
1.00 CPE through pipe	4.00	5.10	8.00
SEm±	0.85	0.82	2.15
CD (5%)	1.78	1.86	5.12
Fertilization			
75% recommended dose of N	6.25	7.50	15.00
50% recommended dose of N	6.00	6.75	12.00
No Nitrogen	5.25	6.00	7.50
SEm±	-	0.62	2.16
CD (5%)	NS	1.43	5.96
A*B			
CD (5%)	NS	NS	NS

The nitrogen fertigation also influenced the fruit yield in all three years although stability in yield could not be attained. In year 2000, the maximum yield was 6.25q/ha those plants who get 75% recommended dose of nitrogen and minimum (5.25q/ha) in no nitrogen treatment. In the year the trend was same as in year 2000. In the year2002, the yield potential has been increased by nearly double and maximum fruit yield (15.00q/ha) again in 75% recommended dose of nitrogen treatment.

The fruit yield data could not be stabilized because plants were not being fully-grown. In view of this, the pool analysis of data was not carried out. Since this study will be continued for some more year as an institute project. After stabilizing the yields, pooled analysis of the data will be performed.

Fruit quality parameters: In the year 2000, 2001 and 2002, the fruits of different treatment were evaluated for their quality parameters like total soluble solids and juice acidity (Table 58). In all the years, irrigation and nitrogen fertigation did not show any difference in total soluble solid content,

Table 58. Effect of irrigation levels and N fertigation on fruit quality of pomegranate.

Treatments	Quality parameters	
	TSS (° Brix)	Juice Acidity (%)
Irrigation		0.15
0.90 CPE through drip	16.00	0.15
0.75 CPE through drip	15.00	0.18
0.50 CPE through drip	16.00	0.20
1.00 CPE through pipe	16.00	0.02
SEm±	-	0.05
CD (5%)	NS	
Fertilization		
75% recommended dose of N	15.00	0.15
50% recommended dose of N	16.00	0.17
No Nitrogen	15.00	0.18
SEm±	-	-
CD (5%)	NS	NS
A*B		
CD (5%)	NS	NS

however, the maximum TSS was estimated (16.00° brix) in all irrigation levels except 0.75CPE through drip. Likewise, TSS was in the range of 15.00 to 16.00° brix in all N fertigation treatments. The juice acidity of fruits has been affected by irrigation level and significantly lowest juice acidity (0.15%) was recorded in 0.90 and 0.75CPE level of irrigation through drip and maximum acidity (0.20%) was in 1.00CPE irrigation through bubbler. The fertigation treatments did not change the fruit juice acidity.

Leaf mineral composition: The leaf samples were analysed for macro and micronutrients every year but levels of different nutrients were not stabilized. The leaf samples were collected is the month of July 2002 and analysed. The data pertain to N, P, K, Zn, Fe and Cu has been presented in table 59 & 60. The maximum nitrogen content (2.65%) was in 0.90CPE which was statically at par with 0.75 CPE irrigation through drip system followed in 0.50 CPE through drip and minimum content (1.53%) was estimated in leaves collected from 1.00 CPE irrigation water through bubbler. The N fertigation increased the N content in leaves and maximum N content (2.57%) was determined in 75% RD of N treatment and minimum N content (1.53%) in no nitrogen (control) treatment. The phosphorus content ranged from 0.19 to 0.21% but values were at statistically at par in all irrigation as well as in fertigation treatments. The potassium content did not change much due irrigation treatments, however, maximum potash content (1.55%) was estimated in 0.90 CPE water through drip treatment and statistically at par with 0.75 and 0.50 CPE through drip and 1.00CPE through bubbler irrigation treatments. The K content did not change significantly in different N fertigation treatments.

The Zinc contents were statistically different in different irrigation treatments and maximum zinc content (55ppm) was recorded in 0.90 and 0.75CPE irrigation levels through drip and these were significantly higher over 0.50CPE through drip and 1.00CPE through bubbler irrigation treatments. The nitrogen fertigation also influenced the zinc contents in plant leaves and maximum Zn content were estimated in 75% RD of nitrogen while Zn content were at par statistically in 50%RD of nitrogen and no nitrogen treatments. The iron and copper content did not change much with respect to irrigation and N fertigation treatments. At 0.90 and 0.75CPE irrigation level, the nitrogen content was above the optimal concentration in plant leaves.

Table 59. Effect of irrigation levels and N fertigation on N, P and K content in leaves of pomegranate.

Treatments	N (%) 2.50%*	P (%) 0.19%*	K (%) 1.47%*
Irrigation			
0.90 CPE through drip	2.65	0.21	1.55
0.75 CPE through drip	2.62	0.21	1.52
0.50 CPE through drip	1.82	0.19	1.50
1.00 CPE through pipe	1.53	0.20	1.40
SEm±	0.30	-	-
CD (5%)	0.78	NS	NS
Fertilization			
75% recommended dose of N	2.57	0.22	1.55
50% recommended dose of N	2.40	0.21	1.47
No Nitrogen	1.53	0.19	1.46
SEm±	0.39	-	-
CD (5%)	0.86	NS	NS
A*B			
CD (5%)	NS	NS	NS

*Optimal level of nutrient in leaf tissue.

Water use efficiency: In this study the water use efficiency was also evaluated in different treatments of irrigation. For calculating the WUE, the data pertains to fruit yield, and water used by the crop in different treatments are required. From these data, water used for producing unit value of produce can be calculated. Data given in the table 61, revealed that maximum water use efficiency (2.69gm/litre) was recorded in 0.75CPE irrigation level followed in 0.50CPE irrigation level and minimum WUE (1.11gm/litr) in 1.00CPE irrigation level through bubbler system.

Quantity of water: Considering the daily pan-evaporation, crop spacing (6 m x 4m), crop factor (0.6) and crop wetting area 20% the total amount of water given in different irrigation levels were worked out. The amount of water given in different treatments in different months have been calculated and depicted in table 61. Data revealed that total amount of water applied was 648000, 540000, 360000 and 720000litres/year/hectare in 0.90, 0.75 and 0.50 CPE through drip irrigation treatments and 1.00 CPE through bubbler, respectively.

Table 60. Effect of irrigation levels and N fertigation on Zn, iron and copper content leaves of pomegranate.

Treatments	Zinc (ppm) 55 ppm*	Iron (ppm) 375 ppm*	Copper (ppm) 5 ppm*
Irrigation			
0.90 CPE through drip	55	375	5
0.75 CPE through drip	55	365	5
0.50 CPE through drip	40	365	4
1.00 CPE through pipe	32	355	5
SEm±	4.65	-	-
CD (5%)	10.23	NS	NS
Fertilization			
75% recommended dose of N	56	375	4
50% recommended dose of N	50	365	4
No Nitrogen	45	360	4
SEm±	3.21	-	-
CD (5%)	6.76	NS	NS
A*B			
CD (5%)	NS	NS	NS

*Optimal level of nutrient in leaf tissue.

Table 61. The mean fruit yield of pomegranate, total water applied and water use efficiency as influenced by various treatments.

Treatment	Yield (q/ha)	% Increase in yield	Water use (Lit. /ha/year)	Water use efficiency (gm/lit)	Saving of water (%)
Irrigation					
0.90 CPE through drip	15.00	87.50	648000	2.31	10
0.75 CPE through drip	14.50	81.25	540000	2.69	25
0.50 CPE through drip	9.00	12.50	360000	2.50	50
1.00 CPE through pipe	8.00	-	720000	1.11	-

Moisture Distribution Pattern: The moisture contents were measured at different vertical and horizontal distances from the main trunk of the plant under different treatments. The distribution pattern is being presented in fig 3. In drip irrigation treatments the pattern was more or less but quantum of water at different vertical and horizontal distances are different in different levels of water but in bubbler system, the pattern was different. In drip irrigation treatments the maximum moisture content was measured at 30 cm horizontal distance while at 30-45 cm vertical depths, the maximum moisture content was determined. In bubbler system the maximum moisture was recorded at 15-20 cm horizontal distance while at 30-45 cm vertical depths the maximum moisture (7.5%) have been recorded. In drip irrigation system, water was applied at subsurface layers while in bubbler the water was applied at surface in basin.

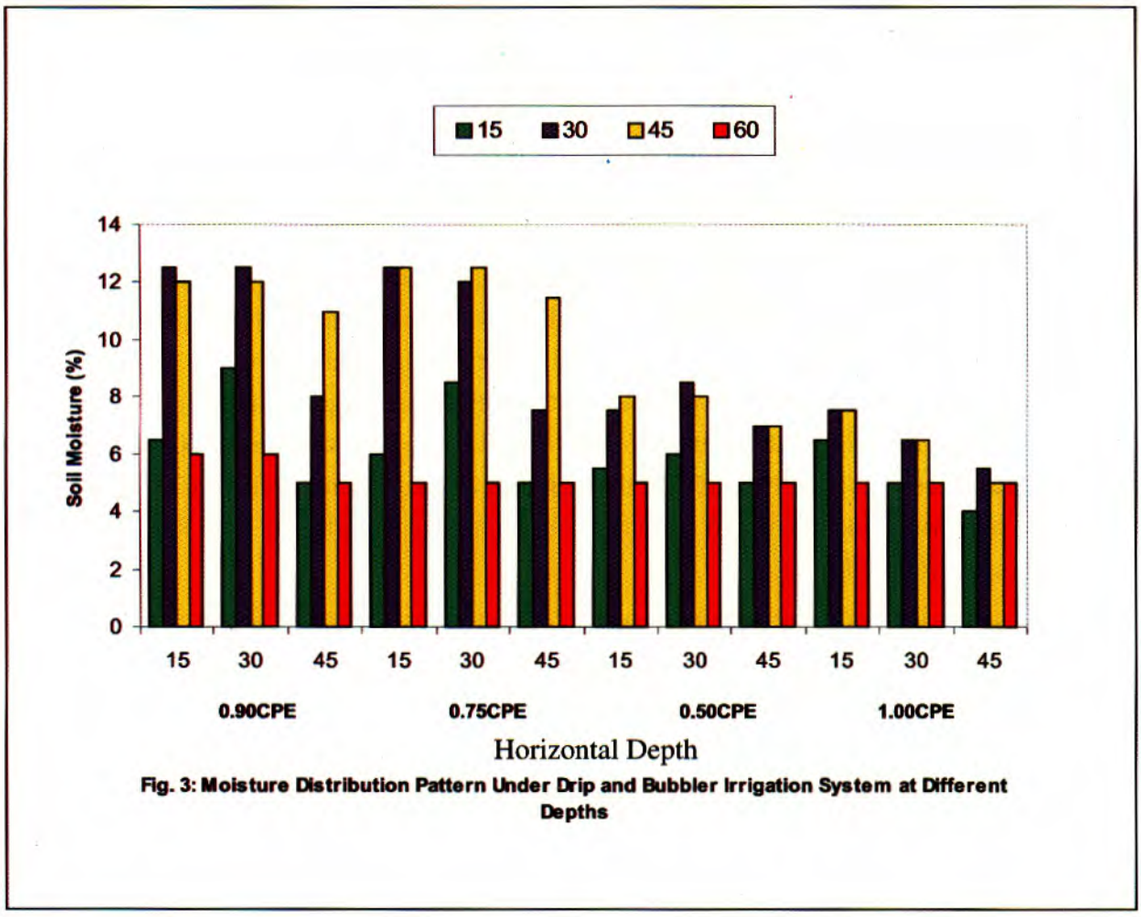


Fig. 3: Moisture Distribution Pattern Under Drip and Bubbler Irrigation System at Different Depths

Quantity of water: Considering the daily pan-evaporation, crop spacing (6 m x 4m), crop factor (0.6) and crop wetting area 20% the total amount of water given in different irrigation levels were worked out. The amount of water given in different treatments in different months have been calculated and depicted in table 61. Data revealed that total amount of water applied was 648000, 540000, 360000 and 720000litres/year/hectare in 0.90, 0.75 and 0.50 CPE through drip irrigation treatments and1.00 CPE through bubbler, respectively.

Ber

The experiment was undertaken on Gola cultivar of *Ziziphus mauritiana* (var. *rotundifolia*). The plants were pruned in the 2nd week of April 2001 and new flush emerged out in the last week of June 2001. The flowering was started in the month of September 2001 and fruit set was occurred in the month of October. The fruit harvesting has been started in the month of January and end up in the first week of February 2002. The growth and spread data was recorded from the month of August onwards. In this report, the plant height and spread recorded in the month of October 2001 have been reported as final and plant height and spread recorded in June 1999 as initial.

Plant height and spread: The maximum plant height (2.80 m) was recorded in those plants where irrigation was given @ 0.90 CPE through drip and this treatment was statistically at par with 0.75 CPE through drip where average plant height was 2.75 m and minimum plant height (1.90 m) was recorded in 1.00 CPE through bubbler. The plant height was also influenced by N fertigation and maximum plant height (2.75 m) was recorded in 75% recommended dose of N and it was statistically higher over control (No nitrogen) treatment (Table 62). The actual plant height attained by the plants during the experimental period, was evaluated by subtracting the initial plant height from the final height attained. The data given in table 62 revealed that maximum height (2.13m) was come in 0.90CPE irrigation level and it was statistically at par with 0.75CPE through drip where gain in height was 2.05m. Likewise in fertigation treatments, the maximum increment in height was recorded in 75% RD of nitrogen and minimum in control (1.48m).

The data pertain to plant spread and increase over the year is given in table 63. The maximum plant spread (16.80 m^2) was recorded in 0.90CPE through drip and statistically at par with 0.75CPE through drip irrigation treatment where spread was 12.50m^2. The plant spreads were statistically lower and at par in 0.50 CPE through drip and 1.00CPE through bubbler treatments against earlier ones. The increase in N application through drip increased the plant spread and maximum plant spread (16.00 m^2) was recorded in 75 % RD of nitrogen through drip followed in 50% recommended doses of nitrogen. The trend in plant spread increment was same as it was in final values and nearly in three four years, the maximum plant spread (12.96m^2) was recorded in 0.75CPE irrigation level and minimum (4.95m^2) in bubbler irrigation. In N fertigation the maximum plant spread (12.38m^2) increment was observed in 75% RD of nitrogen treatment and minimum (5.40m^2) in control treatment of fertigation.

Table 62. Effect of irrigation levels and N fertigation on plant height of ber.

Treatments	Plant height (m)		
	Initial (1998)	Final (2002)	Increase
Irrigation			
0.90 CPE through drip	0.67	2.80	2.13
0.75 CPE through drip	0.70	2.75	2.05
0.50 CPE through drip	0.66	2.00	1.34
1.00 CPE through pipe	0.65	1.90	1.25
SEm±	-	0.34	0.29
CD (5%)	NS	0.72	0.63
Fertilization			
75% recommended dose of N	0.68	2.75	1.97
50% recommended dose of N	0.66	2.50	1.84
No Nitrogen	0.67	2.15	1.48
SEm±	-	0.32	0.17
CD (5%)	NS	0.78	0.40
A*B			
CD (5%)	NS	NS	NS

Fruit yield: The fruit yield was recorded during the harvesting period in the year 2001 and 2002.In the year 2001, the maximum total fruit yield (62.50 q ha^{-1}) was recorded in 0.90 CPE irrigation treatment which was statistically at par with 0.75 CPE irrigation treatment followed by 0.50 CPE treatment (39.00 q ha^{-1}) and minimum (32.00 q ha^{-1}) in 1.00 CPE through bubbler irrigation treatment (Table 64). N fertigation also affected the fruit yield and maximum (58.00 q ha^{-1}) was recorded in that treatment where 75% of recommended dose of nitrogen was given followed by 50%RD of N treatment and minimum (42.00 q ha^{-1}) in control treatment. In the year 2002, the maximum fruit yield (58.50q/ha) was recorded to 0.90CPE irrigation level through drip and it was statistically at par with 0.75CPE through drip where yield was recorded to the tune of 55.00q/ha. The minimum fruit yield (39.00q/ha) was recorded in bubbler irrigation where the watering was provided at 1.00CPE level. With regards to N fertigation, the maximum, fruit yield (60.00q/ha) was recorded in 75% recommended dose of Nitrogen.

Table 63. Effect of irrigation levels and N fertigation on plant spread of *ber*.

Treatments	Plant spread (m^2)		
	Initial (1998)	Final (2002)	Increase
Irrigation			
0.90 CPE through drip	3.96	16.80	12.84
0.75 CPE through drip	3.54	16.50	12.96
0.50 CPE through drip	3.61	11.50	7.89
1.00 CPE through pipe	3.55	8.50	4.95
SEm±	-	2.64	2.16
CD (5%)	NS	5.23	4.03
Fertilization			
75% recommended dose of N	3.62	16.00	12.38
50% recommended dose of N	3.54	15.00	11.46
No Nitrogen	3.60	9.00	5.40
SEm±	-	2.62	2.21
CD (5%)	NS	5.34	4.56
A*B			
CD (5%)	NS	NS	NS

The yield data for both the years was pooled and pooled analysis was carried out. The pool analysis data (Table 64) revealed that in irrigation level 0.90 and 0.75CPE through drip gave the yields i.e. 60.50 and 57.50q/ha which were statistically at par and significantly higher over 0.50CPE through drip and 1.00CPE through bubbler irrigation. In N fertigation treatments the maximum yield (59.00q/ha) was recorded in 75% recommended dose of nitrogen and minimum yield (40.50q/ha) in control treatment of fertigation. The interaction effect of irrigation and N fertilization could be seen neither in respective years nor in pooled data analysis.

Fruit quality: The mature fruits were analyzed for acidity, total soluble solids (TSS) and acidity/TSS ratio. The data presented in table 65 revealed that minimum acidity (0.20%) was estimated in 0.90 CPE and 0.75 CPE through drip and maximum in bubbler irrigation treatment (0.22%) but differences among the treatments were not statistically different. The N fertigation did not show any significant response in the fruit acidity. The total soluble solids were in the range of 13.00 to 14.0° brix. Irrigation levels and N fertigation increased the acidity/TSS ratio.

Table 64. Effect of irrigation levels and N fertigation on fruit yield of *ber*.

Treatments	Fruit yield (q/ha)		
	2001	2002	Mean
Irrigation			
0.90 CPE through drip	62.50	58.50	60.50
0.75 CPE through drip	60.00	55.00	57.50
0.50 CPE through drip	39.00	44.00	41.50
1.00 CPE through pipe	32.00	35.00	33.50
SEm±	6.54	4.31	4.96
CD (5%)	16.65	10.21	11.20
Fertilization			
75% recommended dose of N	58.00	60.00	59.00
50% recommended dose of N	50.00	48.00	49.00
No Nitrogen	42.00	39.00	40.50
SEm±	5.34	4.32	4.21
CD (5%)	13.50	10.11	9.32
A*B			
CD (5%)	NS	NS	NS

The average fruit weight, seed weight and pulp stone ratio were determined in different treatments and presented in table 66. The maximum fruit weight (28.00g) was recorded in 0.90 CPE through drip and which was statistically at with 0.75CPE irrigation level through drip. The N fertigation also increased the fruit weight and maximum fruit weight was recorded in 75% recommended dose of nitrogen and minimum again in control treatment. The same trend was also observed in case of stone weight. The maximum pulp/stone ratio (17.67) was recorded in 0.90 CPE through drip irrigation treatments and minimum (11.41) in 1.00 CPE through bubbler. N fertigation increased the pulp/stone ratio and maximum (17.67) was observed in 75% recommended dose of nitrogen and minimum (11.90) in control treatment.

Table 65. Effect of irrigation levels and N fertigation on fruit quality of *ber*.

Treatments	Fruit quality parameters		
	Juice acidity (%)	TSS (° Brix)	Acidity/TSS
Irrigation			
0.90 CPE through drip	0.20	13.00	65
0.75 CPE through drip	0.20	14.00	70
0.50 CPE through drip	0.22	14.00	58
1.00 CPE through pipe	0.22	14.00	56
SEm±	-	-	
CD (5%)	NS	NS	
Fertilization			
75% recommended dose of N	0.22	14.00	70
75% recommended dose of N	0.20	13.00	59
No Nitrogen	0.21	13.00	54
SEm±	-	-	
CD (5%)	NS	NS	
A*B			
CD (5%)	NS	NS	

Water use efficiency: In this study, the water use efficiency was also evaluated in different treatments of irrigation. For calculating the WUE, the data pertains to fruit yield, and water used by the crop in different treatments are required. From these data, water used for producing unit value of produce can be calculated. Data given in the table 67, revealed that maximum water use efficiency (21.05gm/litre) was recorded in 0.75CPE irrigation level followed in 0.50CPE irrigation level (20.52gm/litr) and minimum WUE (8.42gm/litr) in 1.00CPE irrigation level through bubbler system.

Quantity of water: From the March 2001 to June 2001 watering was with held for defoliation and pruning. From July 2001 to February 2002. The watering was given as per technical programme. Considering the rainfall, the total was applied per hectare was 342000, 285000, 190000 and 380000 litres in 0.90, 0.75, 50 CPE through drip and 1.00 CPE through bubbler irrigation treatment (Table 67).

Table 66. Effect of irrigation levels and N fertigation on fruit physical parameters of *ber*.

Treatments	Physical fruit parameters		
	Av. fruit weight (g)	Seed weight (g)	Pulp/Stone
Irrigation			
0.90 CPE through drip	28.00	1.50	17.67
0.75 CPE through drip	27.00	1.52	17.42
0.50 CPE through drip	22.00	1.54	13.28
1.00 CPE through pipe	18.00	1.45	11.41
SEm±	1.87	-	1.43
CD (5%)	4.36	NS	3.89
Fertilization			
75% recommended dose of N	28.00	1.50	17.67
50% recommended dose of N	24.00	1.55	14.48
No Nitrogen	20.00	1.55	11.90
SEm±	1.92	-	1.46
CD (5%)	4.56	NS	3.24
A*B			
CD (5%)	NS	NS	3.32

Table 67. The mean fruit yield of *ber*, total water applied and water use efficiency as influenced by various treatments.

Treatment	Yield (q/ha)	% Increase in yield	Water use (Lit. /ha/year)	Water use efficiency (gm/lit)	Saving of water (%)
Irrigation					
0.90 CPE through drip	62.50	95.31	342000	18.27	10
0.75 CPE through drip	60.00	87.50	285000	21.05	25
0.50 CPE through drip	34.00	21.88	190000	20.52	50
1.00 CPE through pipe	32.00	-	380000	8.42	-

Pruned wood: The plants were pruned in the last week of April 2001. The dry pruned wood weight was recorded. The pruned wood weight in different treatments has been presented in Table 68. The maximum dry twig weight (35 kg/plant) was recorded in 0.90 CPE treatment followed in 0.75 CPE (34 kg plant^{-1}) and minimum pruned wood weight (15.00 kg plant $^{-1}$) in 1.00 CPE through bubbler irrigation treatment.

Table 68. Effect of irrigation levels and nitrogen fertigation on pruned wood of ber.

Treatment	Pruned wood (kg plant^{-1})
Irrigation	
0.90 CPE through drip	35
0.75 CPE through drip	34
0.50 CPE through drip	20
1.00 CPE through bubbler	15
SEm ±	1.46
CD (5%)	5.04

Relative water content: The pomegranate leaves were analyzed for turgidity in different irrigation treatments and it was found that leaves were most turgid in 0.90 and 0.75 CPE through drip irrigation treatments and relative water content was 85.50% and 83.00%. It was only 62% in 1.00 CPE through bubbler irrigation treatment (Table 69).

In same manner relative water content in different irrigation treatments for ber crop was calculated and found that the leaves were most turgid in 0.90 and 0.75 CPE irrigation through drip while leaves of 1.00CPE bubbler irrigation level were relatively dried. Among pomegranate and ber leaves, leaves of ber shows less stress than pomegranate in different irrigation treatments.

Table 69. Response of irrigation levels on relative water content in pomegranate and ber leaves.

Treatments	Pomegranate	Ber
Irrigation		
0.90 CPE through drip	85.50	83.00
0.75 CPE through drip	83.00	83.00
0.50 CPE through drip	70.00	79.00
1.00 CPE through pipe	62.00	76.00

Leaf Tissue Content: The leaf tissue samples were collected in the month of September 2001 and analyzed for N, P, K zinc, iron and copper content. The data pertains to these elements have been presented in Table 70 and 71. The maximum (2.65%) N content was recorded in 0.90 CPE through drip treatment and statistically at par with 0.75 CPE through drip (2.63%) followed to 0.50 CPE and minimum (2.10%) in 1.00 CPE through bubbler irrigation treatment. The doses of N application through drip responded to N content and maximum N content (2.65%) was estimated in 75% RD of nitrogen and minimum (2.20%) in control treatments. The phosphorus content did not change much in irrigation and N fertigation treatments and found statistically same irrespective of the treatment. The maximum potassium content (1.92%) was recorded in 0.90 CPE followed by 0.75 CPE treatments. The fertigation also could not change the K content significantly in different treatments. The zinc and iron content were in the range of 55-62 ppm and 335 to 350 ppm, respectively. The copper content was same in all the treatments. Irrigation and N fertigation treatments could not change the zinc, copper and iron content.

Table 70. Effect of irrigation levels and N fertigation on N, P and K content in leaves of *ber*.

Treatment	N (%)	P (%)	K (%)
Irrigation			
0.90 CPE through drip	2.65	0.24	1.92
0.75 CPE through drip	2.63	0.25	1.86
0.50 CPE through drip	2.40	0.23	1.82
1.00 CPE through pipe	2.10	0.23	1.76
SEm±	0.10	-	-
CD (5%)	0.21	NS	NS
Fertilization			
75% recommended dose of N	2.65	0.24	1.89
50% recommended dose of N	2.45	0.24	1.79
No Nitrogen	2.20	0.24	1.77
SEm±	0.08	-	-
CD (5%)	0.20	NS	NS
A*B			
CD (5%)	NS	NS	NS

Table 71. Effect of irrigation levels and N fertigation on Zn, Fe and Cu content in leaves of *ber*.

Treatment	Zinc (ppm)	Iron (ppm)	Copper (ppm)
Irrigation			
0.90 CPE through drip	62	350	4
0.75 CPE through drip	58	350	4
0.50 CPE through drip	55	340	4
1.00 CPE through pipe	56	335	4
SEm±	-	-	-
CD (5%)	NS	NS	NS
Fertilization			
75% recommended dose of N	65	350	4
50% recommended dose of N	58	345	4
No Nitrogen	54	340	4
SEm±	2.01	-	-
CD (5%)	4.32	NS	NS
A*B			
CD (5%)	3.65	NS	NS

Table 72. Meteriological data of year 2001 at Bikaner

Months	Max.Temp.(°C)	Min. Temp.(°C)	RH I (%)	RH II (%)	Evaporation (mm)
January	22.7	7.4	77.2	49.9	77.00
February	24.4	8.2	65.1	43.1	115.00
March	32.8	14.7	48.8	21.0	119.00
April	43.6	21.4	44.7	17.7	255.00
May	42.9	29.3	47.5	19.9	375.00
June	41.5	28.6	53.0	28.2	436.00
July	41.1	28.5	67.9	47.7	223.50
August	37.2	27.6	70.0	47.1	225.00
September	37.9	25.5	64.6	32.2	244.00
October	39.6	18.9	46.8	18.8	222.00
November	32.3	13.0	56.2	24.3	155.00
December	27.4	8.1	47.7	23.4	95.00

Total outlay of the Scheme RS. 74,85,100.00

Total outlay of CIAH center RS. 911,700.00

Total amount spent in previous year (March, 2000-February, 2001)

Head	Amount sanctioned (RS.)	Amount spent (RS.)
Establishment	1,21,440	1,32,039
RC include TA	55,000	53,927
Non RC	Nil	Nil
Institute charges	10300	Nil
Total	1,86,740	1,85,966

Total amount sanction/spent during report (March, 2001-February, 2002).

Head	Amount sanctioned (RS.)	Amount spent (RS.)
Establishment		1,06,574
RC include TA		1750
Non RC		Nil
Institute charges		Nil
Total	1,20,560*	1,08324

* Physically money has not been transferred to the institute from the council. Headwise details of the money have not been conveyed from the council.

C. Adhoc Scheme

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

Collection of Powdery Mildew Isolates

Powdery mildew isolates were collected from different locations viz. Rahuri (Maharashtra), Detai (Madhya Pradesh), Kumar Ganj, Faizabad, Jhansi (Uttar Pradesh), Hisar (Haryana) and Udaipur (Rajasthan). Leaf samples infected with powdery mildew were collected from terminal (tender), middle (maturing) and bottom (matured) portion of branches. Fruits samples of (immature and matured fruits) were collected from cv. Gola, Umran, Seb, Kaithali, Safer Chand, Illaichi and Amarwati. Samples were also collected from local cultivars of Jhansi and Detia. The morphological variations in powdery mildew

fungus were investigated microscope. Variability in conidiophores structure was not investigated last year thoroughly because powdery mass of powdery mildew was scattered and disturbed at the time of transportation, therefore, shape and size of conidiophores were investigated in different samples in this year. The conidiophores were relatively smaller and thin (45 x 15μ m) from Gola cultivar than stout and broad conidiophores from isolates collected from Faizabad. Conidiophores were longer from the isolate cv. Amarawathi from Datia and Banarasi karaka (Plate 7 & 8).

Variability in Powdery Mildew Isolates

In order to confirm the results of last year, that is on the size and shape of conidia, microscopic investigation were carried out in all the 30 samples collected from different location. The over all results revealed that size and shape of conidia are almost similar compare to last year observations. However, the conidia are little larger than previous year observations. For example, maximum size of 40 x 20 μm has been observed in samples from Jhansi (Jhansi local cultivar) and Banarasi Karaka followed by 38.5 x 17 μm from Rahuri (cv. Gola) and 32.5 x 10-15 μm in Gola and Kaithali from Faizabad and Detia respectively. Conidia from Amarawathi cultivar (Detia) were containing strong lipid layer. It confirms that the conidial size can be larger in case the powdery mildew infects the Gola cultivar. Size of the conidia was also influenced according to the environmental conditions of particular location. For example, powdery mildew isolates from Hisar (Haryana) are almost similar and larger (above 30 um x 16 μm) whereas conidial size from Detia (Madhya Pradesh) was relatively smaller.

Investigations on survival mechanisms of this destructive pathogen is also one of the important aspects and therefore, all the samples were critically evaluated for the resting and other structural features of ber powdery mildew. As similar to last year observations, ber powdery mildew pathogen could form its resting structures or sexual fruiting bodies i.e. cliestothecia in leaf and fruit samples. The cliestothecial formation has been confined to Detai (Maharastra), Jhansi and Faizabad (Uttar Pradesh) that is in Central Zone than and Northern and Western region of the country. The cliestothecial size was ranging from 120 to 155 um dia in Kumar Ganj (Faizabad) selection-3 and Seb from Jhansi respectively. It implies that the specific environmental conditions with special reference to relative humidity of these particular places may have impact on cliestothecial formation.

Establishment of Powdery Mildew Incidence

Budded plants of ber (Gola, Umran, Seb, Kaithali and Safar Chandi) were inoculated with conidial mass of individual isolates from different locations. Inoculated plants were observed at 24 hrs. intervals for powdery mildew infection under open environmental conditions. Due to erratic temperature and relative humidity, powdery mildew isolates did not infect even the highly susceptible cultivars.

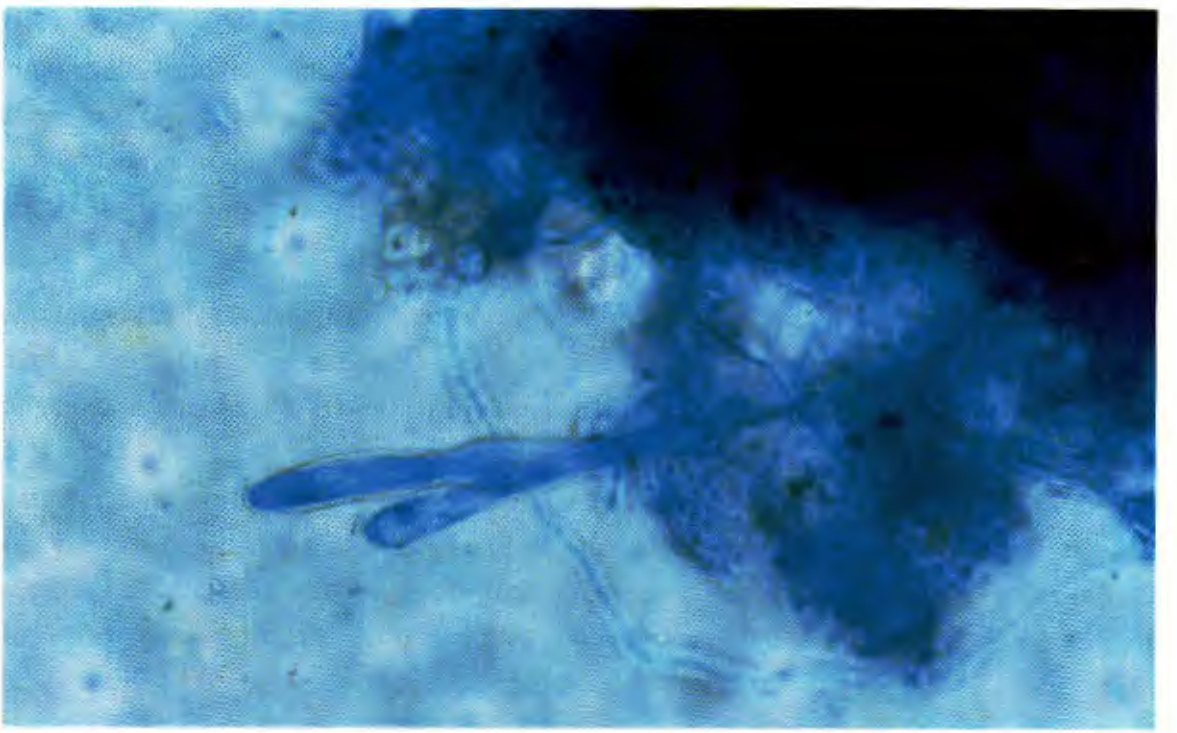


Plate 7. *Ber* powdery mildew conidiophores from cv. Amarawathi

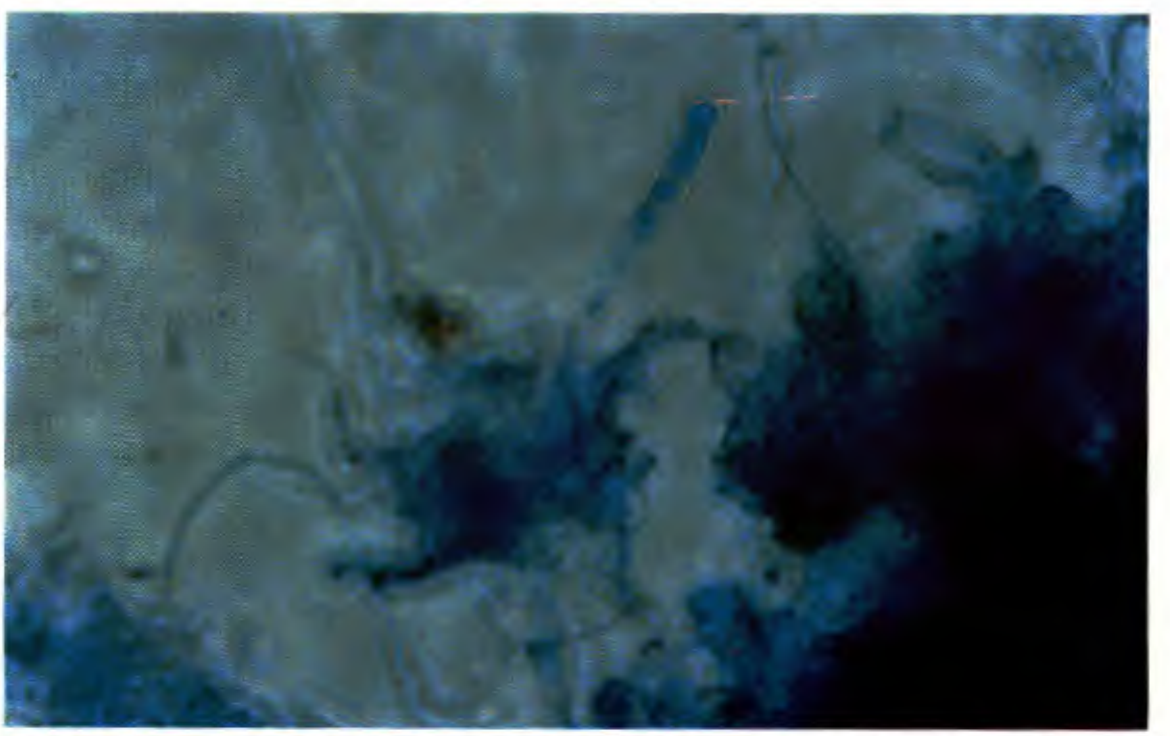


Plate 8. *Ber* powdery mildew conidiophores from Banarasi karaka

Powdery mildew isolates (Rahuri, Jhansi, Detia and Hisar) were inoculated in tender and matured fruits of Gola, Umran, Seb, Kaithali, Illaichi and Safer Chandi. Different methods of inoculation like-swabbing on healthy plants with infected samples, scarping of conidia separately and inoculation, detachment of powdery mildew conidia with help of cello tap and attachment over healthy parts were attempted. Inoculated plants and fruits were kept over moist chamber and incubated at ambient conditions. However, there was no expression of powdery mildew incidence.

The powdery mildew isolates of different locations were investigated on viability of conidia and possible mode of existence along with infected tissues. The collected samples were kept in sterile Petri dishes under laboratory conditions and the microscopic observations were made at every fortnight intervals up to 60 days. Generally, the conidial texture and sizes were not changed much up to 15 days. In some cases, the conidial wall could be disturbed. After 30 days of incubation, conidia of most of the isolates got shriveled and in some cases it was not possible to visualize under microscope and, after 60 days, conidia and mycelial structures were desicated. However, the cliestothecial/sexual resting structures were observed in some of the samples suggesting that such kind of fruiting bodies may serve as primary inoculums in the form of ascosporous in subsequent seasons. However, germ inability and virulence of the ascosporous need to be investigated thoroughly.

Physical factors on powdery mildew incidence

Powdery mildew isolates from different locations viz. Hisar (Haryana), Rahuri (Maharashtra), Detia (Madhya Pradesh), Faizabad and Jhansi (Uttar Pradesh) and Udaipur (Rajasthan) were artificially inoculated. The inoculation of powdery mildew conidia was carried out by collecting the conidia with the help of painting brush and swapped over the leaf surface. Ber leaves at bottom, middle and terminal portion of the stems were inoculated and kept under different combination of temperature and relative humidity in B.O.D. incubator. The first batch of experiment was conducted at 5°C with 70% relative humidity. Since there was incidence of powdery mildew, the experiment was repeated with 25°C with 90% relative humidity. Subsequently, the temperature was enhanced to 35°C with 80% relative humidity. In each experiments, the budded plants were inoculated with different isolates separately and incubated up to 15 days. Simultaneously, plants inoculated were kept under open environment as check. Plants were regularly monitored for the appearance of powdery mildew incidence.

The over all results revealed that, none of the isolates could express its infection and colonization under above mentioned temperature and relative humidity combinations. However, at 25°C with 90% relative humidity, some of the isolates viz. Gola, Umran (Hisar), Gola, Chhuhara (Rahuri) and Kumar Ganj Selection-1 i.e. Faizabad (Uttar Pradesh) showed germination of conidia in tender leaves. There was germination in middle and bottom (matured) leaves of the same plants. When the plants were incubated at 35°C with 80% relative humidity, even the tender leaves dried after 5 days of incubation

while the middle and bottom leaves turned yellow and senescenced after a week of incubation. The very low temperature of 5°C with 70% relative humidity also not favoured the powdery mildew infection. It was not possible to locate the conidia since they got shriveled at high temperature.

4. Relationship of biochemical levels on powdery mildew resistance

Total protein

Plant proteins are forming structural and functional basis of cells. It becomes necessary to distinguish the variation of proteins with respect to powdery mildew in incidence. The major proteins are characteristic of species concern and therefore actual quantification of total/major protein level become necessary and it could be useful to relate compatibility and incompatible interactions with powdery mildew infection.

The most common cultivars of ber (Gola, Umran, Seb, Kaithali, Safer Chandi and Illaichi) were estimated for total protein content. Ber powdery mildew pathogen always prefers to infect and rapid colonization on terminal/apical/tender leaves than maturing or matured/old leaves. Hence, leaf samples from bottom (matured), middle (maturing) and terminal/tender (young) portions of branches were collected. Similarly, in case of fruits also, early and intensive colonization of ber powdery mildew could be seen in young fruits than matured or ripening fruits. Therefore, total protein content of these two stages of ber fruits was also estimated.

The over all results depict that samples are having higher protein content than fruits. Among different position of leaves, apical or terminal portion are enriched with total protein followed by middle (maturing) and bottom (matured) leaves. Highest level of 27.5 mg protein in terminal leaves of cultivar Seb followed by 22.85 mg in Umran, 22.50 in Gola leaves that are from terminal portion has been estimated. Total protein in similar portion of leaves from Illaichi, Safer Chandi and wild species (*Z. numularia*) was relatively less than rest of the cultivar.

Similarly the fruit samples revealed that, immature fruits were constituted with high level of total protein than matured fruits (Fig. 4). Highly susceptible cultivars like Gola, Umran, Seb and Kaithali were rich in protein content than Illaichi and Safer Chandi. Tender fruits of Umran recorded a maximum of 19.50 mg followed by 17.50 in Kaithali and 13.00 mg in Gola fruits. Further works are under progress to correlate the protein content with level of powdery mildew resistance in different cultivars of ber.

Electrophoroation of total protein of ber cultivars

Comparative analysis of soluble protein bands of different isolates of ber powdery mildew would be important for better understanding on virulence and variations between the isolates. Therefore, powdery mildew isolates from different locations viz. Hisar (Haryana), Rahuri (Maharashtra), Detia (Madhya Pradesh), Jhansi and Faizabad (Uttar Pradesh) and Udaipur (Rajasthan) were subjected to

electrophoration (SDS-PAGE). Since most of susceptible *ber* cultivars are varying in total protein content, electrophoration was carried out in ber cultivars also.

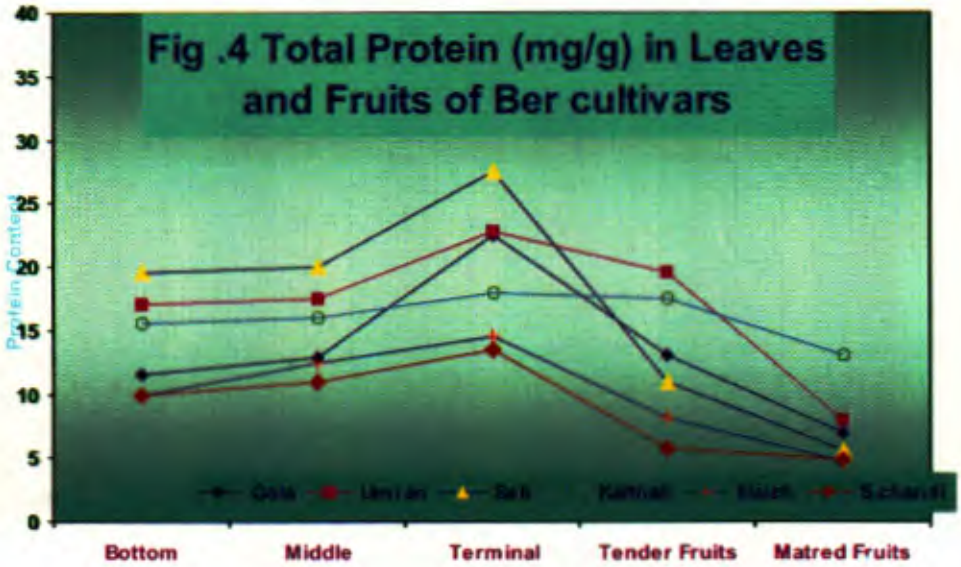
Protein extraction was carried out in leaf as well as fruits samples of Gola, Umran, Seb, Kaithali, Safer Chandi, Illaichi and wild species i.e. *Z. numularia*. Leaf protein were extracted from terminal, middle and bottom portion of branches and similarly fruit proteins were extracted from young as well as matured fruit and used for electrophorosis. Initially, the protein bands were not clear when the leaf samples were extracted with sample buffer. Subsequently, the proteins were extracted in extraction buffer with modification in SDS concentration and the extract was sequentially precipitated using ammonium sulphate. Polyacrlamide gels were run and stained with commassie brilliant blue. The protein bands were visualized in only in bottom of the gels. There were few bands above the intensive bands. All cultivars showed similar kind of bands with varying intensity between genotypes. It indicates the concentration of protein could be variable and therefore, in subsequent running of gels, equal quantitative levels of protein samples were loaded in each wells and again the similar results were observed. However, there was expression of particular protein bands in highly susceptible varieties like Gola, Umran and Seb. The protein concentrations in powdery mildew isolates were very less and this particular part will be repeated.

Calcium ions in relation to powdery mildew resistance in *ber*

Accumulation of calcium in plant cells under attack of obligate parasite like powdery mildew is an important phenomenon with disease resistance. In most of the host plants, constitutive calcium plays critical role in powdery mildew resistance. Calcium accumulation or depletion in epidermal cells has the relationship with penetration of infective hyphae of the powdery mildew pathogen. Therefore, analysis of calcium in leaf as well as fruit samples was performed because the level of incidence is variable in these parts. The leaf as well as fruits samples of Gola, Umran, Seb, Kaithali, Safer Chandi, Illaichi and wild species i.e. *Z. numularia* were digested in strong acid (H_2SO_4+HNO_3). Leaf samples from terminal, middle and bottom portion of branches and similarly fruit samples from young as well as matured fruits were prepared in powder form and 500 mg of samples were digested. Samples from different locations viz. Hisar (Haryana), Rahuri (Maharashtra), Detia (Madhya Pradesh), Jhansi and Faizabad (Uttar Pradesh) and Udaipur (Rajasthan) were subjected to calcium estimation.

The over all results indicated that leaf samples are having high level of calcium than fruit samples (Fig.5). Bottom (matured) leaves contained high level of calcium ranging from 0.0446% in Seb to 0.053% in Banarasi Karaka. In middle leaves, it was ranging 0.393% in Banarasi Karaka to 0.0405% in Umran. It is clear from fig. that tender leaves are having less calcium content (Fig.6) and therefore, susceptibility to powdery mildew is more than matured leaves. Similarly in case of tender fruits also, calcium ions are almost 40-50% lower than leaf samples. Since calcium accumulation is one of the

biochemical barrier and as also act as systemic molecules as messenger on disease resistance, the high content may be directly correlated with powdery mildew resistance. However, further works are under progress to find out the critical level of calcium content in leaf or fruit or fruit tissue as demarcation level in relation to powdery mildew resistance.



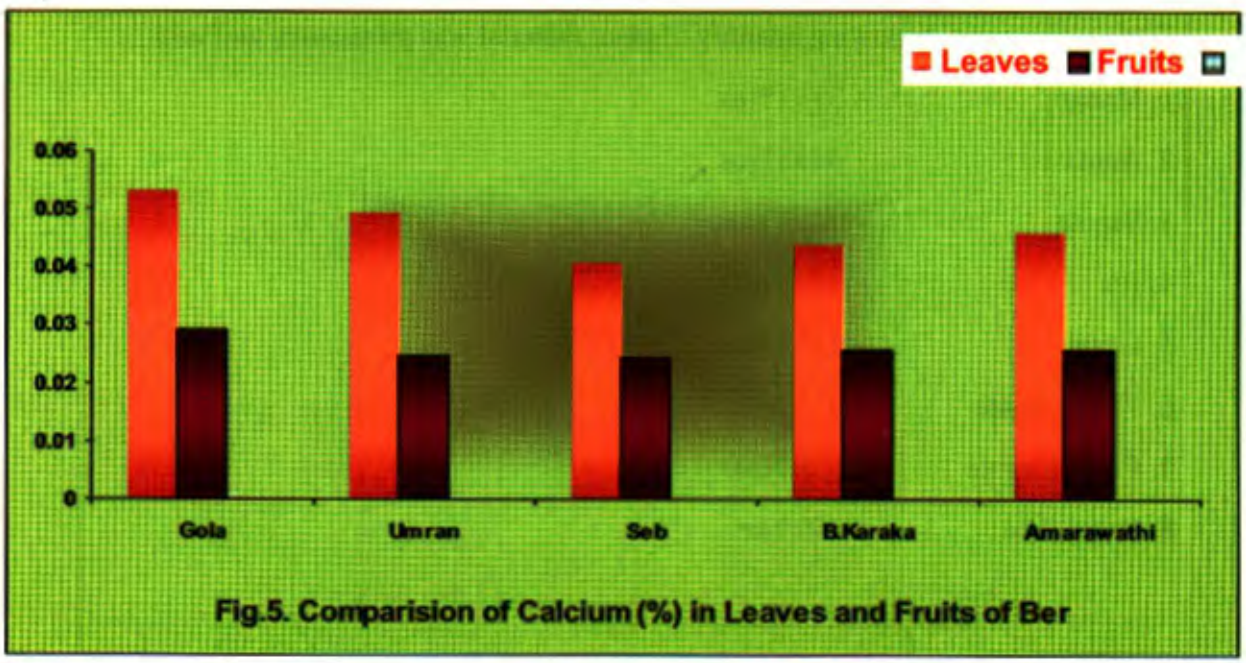


Fig.5. Comparision of Calcium (%) in Leaves and Fruits of Ber

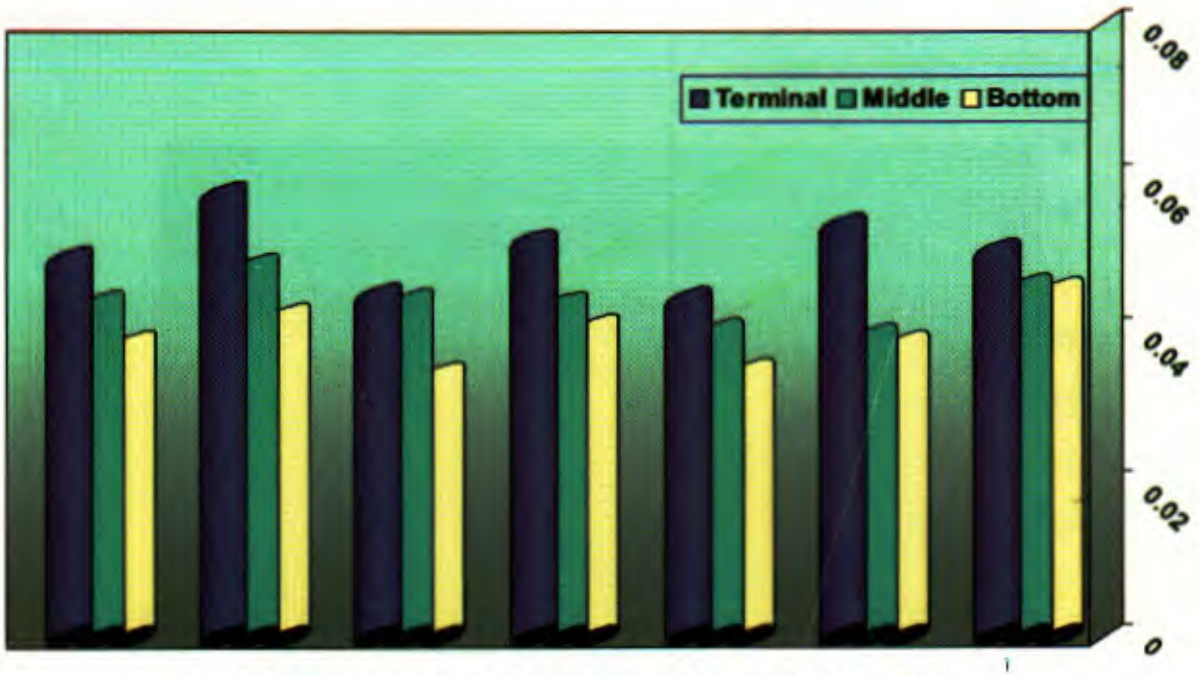


Fig.6 Percent Calcium(%) Content in Leaf Samples of Ber

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

Land Development and Utilization

Development and Management of CIAH, Farm

1. **Land development and utilization:** Up to March, 2002, 62 hectare farm land area has been completely developed for use in agri-horticultural at crop cultivation. Out of which seven hectare area marked for minor fruits, *bael* and *aonla* based farming system, where proper land leveling for the new plantation were taken on priority and resulted allotment of 2 hectare area for *aonla* based agro-forestry and three hectare for *ker* and *lasora*. Besides farm section provided service for maintenance of orchards for germplasm conservation, production-based crop experimental and seed production blocks covering *ber* (13), pomegranate (4), date palm (3), *aonla* (2), progeny block (2), vegetables (5), kinnow, *lasora, khejri*- one each.
2. **Seed production and revenue generation:** Seed production of cucurbitaceous crops released by the Institute during 1998, and also some advanced lines of important vegetable crops has been taken up on priority. During the period under report about 80 kg seeds have been produced. About Rs. 25,000/- were generated through sale of seeds, fresh fruits and vegetables.
3. **Irrigation system:** Irrigation water is the major factor deciding the expansion of research block in the farm. Therefore, complete plan for supplying irrigation water through close irrigation system has been plan and now the main structure of irrigation system has been laid out. The present net work for irrigating fields consists of IGNP water supply and tube well (2), inter connected with two diggi (25 and 10 lakh litre capacity), connected with storage tanks to supply water through 4" main pipe (3 km in length) line in more than 50 hectare areas either through open channel, controlled hose pipe, sprinklers (4 set), or drip system (11 ha) and were maintained properly for regular irrigation water supply to the experimental plots.

Management and development of lawn and other landscape and floricultural units.

One small unit of lawn and about 0.25 ha of area was brought under Chandni and Nerium ornamental plants for development of green belt near office building. About 100 potted collections of various ornamental plants were developed and maintained in office. Bougainvillea plants were planted around the lawn. Winter season annuals were planted in front of office building.

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 Bauganvillea.

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 31.03.2002:

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

Staff under A and B as on 31.03.2002

A. Headquarter

S.No.	Name	Designation/Discipline
	Research Management Position	
1.	Dr. G.B.Raturi	Director (upto 25.01.2002) (F/N)
2.	Dr. D.G.Dhandar	Director (from 25.01.2002)
	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. Scientist (Hort.)
6.	Dr. R.S. Singh	Scientist Sr. Scale (Hort.)
7.	Dr. D.B. Singh	Scientist Sr. Scale (Hort.)
8.	Dr. D.K. Samadia	Scientist Sr. Scale (Hort.)
9.	Dr. P. Nallathambi	Scientist (Plant Pathology)-on study leave
10.	Mrs. C. Umamaheswari	Scientist (Plant Pathology)
11.	Dr. Anil Kumar Shukla	Scientist (Hort.)
12.	Mr. Sumer Singh Meena	Scientist Hort. (Vegetable Science)
13.	Dr. Arun Kumar Shukla	Scientist Hort. (Fruit Science)
14.	Mr. A. Nagaraja	Scientist (Fruit Science)

15.	Dr. S.R. Meena	Scientist (Agril. Extension)
16.	Mr. I.S. Singh	Scientist (SWC)
	Administrative	
1.	Mr. Ayaz Ahmed	Asstt. Fin. and Accounts Officer
2.	Mr. V.K. Pandey	Asstt. Admn. Officer
	Technical	
1.	Sh. S.K.Pandey	T-5 (Technical Officer) Farm
2.	Mr. M.K.Jain	T-4 (Sr. Computer)
3.	Mr. P.P.Pareek	T-4 (Hindi Translator)
4.	Dr. U.V.Singh	T-4 (Field Technician)

B. Regional Station (CHES, Vejalpur)

S.No.	Name	Designation/Discipline
	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.	Mr. H.K. Joshi	Scientist Sel. Grade (Plant Pathology)
5.	Dr. V.V. Appa Rao	Scientist (Soil Science)
6.	Mr. V. Lenin	Scietnist (Agril.Extension)
7.	Dr. A.K. Singh	Scientist (Hort.)
8.	Mr. Raja Shankar	Scientist (Hort.)
9.	Mr. D.T. Meshram	Scientist (SWCE)
	Administrative	
1.	Mr. J.B. Saxena	Asstt. Admn. Officer
	Technical	
1.	Mr. D.K. Saraswat	T-8 (Technical Officer) Farm
2.	Mr. 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. G.R.Baria	T-4 (Field Technician)
6.	Sh. M.N.Makwana	T-4 (Hindi Translator)

Finances

Budget allocation and expenditure incurred during 2001-02 are given in table below.

Table 73. Budget allocation and expenditure incurred during 2001-02

S.No.	Head	Plan		Non-Plan	
		Allocation	Expenditure	Allocation	Expenditure
1.	Establishment Charges	4.85	4.75	137.00	136.63
2.	Wages (Temp. status)	-	-	34.58	34.58
3.	T.A.	5.00	4.87	1.25	1.25
4.	O.T.A.	0.35	0.27	-	-
5.	Works	95.80	95.79	12.00	11.98
6.	Other Charges	91.30	91.29	0.50	0.49
7.	One time catchup grant	8.80	8.55	-	-
	Total	206.10	205.52	185.33	184.93

Publications

A. Research papers

Bagle, B.G. (2001). Integrated Pest Management in Arid and Semi arid Horticultural crops. Lead Talk Abstract. Paper presented in National Symposium on Plant Protection Strategies for Sustainable Agri-Horticulture organized by Society of Plant Protection Sciences, held at Jammu, Oct. 12-13. P. 1-2.

Bhargava, R., Sharma, B.D., Vashishtha, B.B. and Raturi, G.B. (2001). Screening of ber cultivars on the basis of photosynthetic parameters. Paper presented in National Seminar on Role of Plant Physiology for Sustaining Quality and Quantity of Food Production in Relation to Environment, UAS, Dharwad, Dec. 5-7, 2001.

Bhargava, R., Vishal Nath and Pareek, O.P. (2000). Note on role of plant growth inhibitor in sprouting of *Capparis decidua* cuttings. *Curr. Agri.* 24(1): 131-133 (published in 2001).

Dhandar, D.G., Vashishtha B.B., Samadia D.K. and Singh R.S. (2002). Plant Genetic Resource Management in Arid Horticultural Crops (Status paper). In: Meeting on Plant Genetic Resources Management of Horticultural Crops, February 27-28, 2002, NBPGR, New Delhi.

Hiwale, S.S. (2001) Root distribution studies in *Ber (Zizyphus mauritiana* Lamk.). *Annals of Arid Zone* (Accepted).

Hiwale, S.S. (2002) '*Goma Kirti*' – A clonal selection in *Ber (Zizyphus mauritiana* Lamk.). *Indian Horti.* (Accepted).

Joshi, H.K. (2001) Disease management in horticultural crops of semi arid regions. In proceedings of National Symposium on Plant Protection Strategies for Sustainable Agri-Horticulture (Abstract) organized by Society of Plant Protection Sciences, held at Jammu, Oct. 12-13. P.14-15.

Nallathambi, P. and Umamaheswari C. (2001). A New Disease of Ber (*Ziziphus mauritiana* Lamk.) caused by *Torula herbarum* (Pers.) Limk. *J. Mycol. Plant Pathol.* 31(1): 72.

Nallathambi, P., Umamaheswari C., Vashishtha B.B. and Vishal Nath (2000). Fruit rot (*Alternaria alternata*) and sources of resistance in ber germplasm under arid conditions. *Ann. Arid Zone.* 39 (4): 471-478.

Raturi, G.B. and Saroj, P L. (2002). Production advances in arid horticulture. In: Proceeding of 'Indian Science Congress'. Pp. 14-15.

Samadia, D.K. and Vashishtha B.B. (2001). Genetic bio-diversity of *ker* (*Capparis decidua*) and *lasora* (*Cordia myxa*) in arid and semi arid regions of Rajasthan (Short communication). In: symposium on plant genetic resources management: Advances and challenges held at NBPGR, New Delhi, August 1-3, 2001.

Samadia, D.K., Umamaheswari C., Meena S.S. and Vashishtha B.B. (2001). Evaluation for the maintenance and conservation of *Cucumis* species under hot arid environment (short communication). In: Symposium on plant genetic resources management: Advances and challenges held at NBPGR, New Delhi, August 1-3, 2001.

Saroj, P L and Yadav, P.K.(2000). Marusthaliya kshetron ke badalate parivesh mein krishivaniki ke bhumika (hindi). In: Proceeding of National Symposium on 'Resource Management and Environment Conservation through Agroforestry'. Pp. 79-85.

Saroj, P L; Raturi, G.B., Vashishtha, B.B. and Vishal Nath (2001). Biodiversity and utilization of khejri (*Prosopis cineraria*) in arid ecosystem. In: Proceeding of conference on 'Resource Conservation and Watershed Management'. Pp. 121-129

Sharma, B.D. and Raturi, G.B. (2001). Improved Fertilizer Use Efficiency for fruit crops of Hort. Arid Ecosystem, IISS, Bhopal (Submitted).

Sharma, B.D., Vashishtha B.B.and Raturi G.B. (2001). Response of Pomegranate (*Punica granatum* L.) to Drip Irrigation and N- Fertigation in Arid Soils of western Rajasthan. In: National Seminar on Advances in Soil Science-2001, RCA, Udaipur, October, 2001.

शर्मा, बी.डी., वशिष्ठ बी.बी. एवं भार्गव आर. (2002). द्रप्स सिंचाई पोषण प्रणाली का बेर की फसल पर प्रभाव। राष्ट्रीय संगोष्ठी 'वर्षा आधारित कृषि क्षेत्रों में भूमि विकृतिकरण नियन्त्रण', केन्द्रीय बारानी कृषि अनुसंधान केन्द्र, हैदराबाद 5–7 मार्च, 2002.

शर्मा, बी.डी., वशिष्ठ बी.बी. एवं सिंह आर.एस. (2002). समेकित पोषक तत्व प्रबन्धन का अनार (प्यूनिका ग्रेनेटम एल.) की पौध वृद्धि, फल उपज, गुणवत्ता एवं मृदा नमी पर प्रभाव, राष्ट्रीय संगोष्ठी 'वर्षा आधारित कृषि क्षेत्रों में भूमि विकृतिकरण नियन्त्रण', केन्द्रीय बारानी कृषि अनुसंधान केन्द्र, हैदराबाद 5–7 मार्च, 2002.

Shukla, A.K. and Singh, A.K. (2001) Effect of various sources and levels of N on ber. *Annals Agri. Res.*,(Accepted)

Singh, D.B, Vashishtha B.B., Singh R.S. and Awasthi O.P.. 2001. Unexploited fruits of Arid ecosystem: Role in nutritional and ecological security, conservation and sustainable use. Proc." *Workshop on vegetation recovery in degraded land areas*" held at Kargoorlie Western Australia. 27th Oct. to 3rd Nov. 2001.

Umamaheswari, C. and Nallathambi P. (2001). Stem blight in ber (*Ziziphus* spp.) and its integrated management. *J. Mycol. Plant Pathol.* 31(1): 116.

Umamaheswari, C., Nallathambi P. and Samadia D.K. (2001). Reactions of pomegranate germplasm against leaf spots disease under arid conditions. *J. Mycol. Plant Pathol.* 31(1) : 115.

Vashishtha, B.B. and Samadia D.K. (2001). Conservation of fruit and vegetable crop germplasm in hot arid region of India (short communication). In. Symposium on plant genetic resources management: Advances and challenges held at NBPGR, New Delhi, August 1-3, 2001.

Vashishtha, B.B., Samadia D.K. and Nallathambi P. (2001). Genetic diversity in red pepper (*Capsicum annum*). Collecting pomegranate germplasm from arid regions. *Proc. on Impact of human activities on thar desert environment*. CARI, Jodhpur, p 73-74.

Vashishtha, B.B., Samadia D.K. and Nallathambi P. (2001). Collecting pomegranate germplasm from arid regions. *Proceedings* on impact of human activities on thar desert environment, CAZRI, Jodhpur, p 99.

B. Popular/Technical Extension Articles

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

समादिया, दिलीप कुमार एवं पारीक ओम प्रकाश (2001). शुष्क क्षेत्र में मतीरे की खेती। फल–फूल, 24(1): 9–12.

समादिया, दिलीप कुमार (2001). काचरी– खान पान के साथ आय भी। कृषक जगत पत्रिका, सितम्बर, 2001, 1(47): 6–7.

Singh. D.B, U.V.Singh and Singh R.S. (2001). Role of Plastics in Arid Horticulture. *Intensive Agric.*

C. Book Chapters

Awasthi, O.P., Shukla, A.K. and Singh, D.B. (2002) Problem and prospect of Aonla and Pomegranate production. Lecture delivered in National Training on "Management of Arid Horticulture". Directorate of Extension, RAU Bikaner, 5-12 Feb, 2002.

Bhargava, R. (2000). Physiological Adaption to water stress. National Training Programme on "Management of Arid Horticulture", held at RAU, Bikaner.

Samadia, D.K. (2002). Cultivation and management of cucurbit vegetables in arid region. In training manual on "Management of arid horticulture, February 8-12, 2002. Directorate of Extension Education, RAU, Bikaner.

Samadia, D.K., Singh D.B. and Singh R.S. (2001). Genetic resource management in less known arid horticultural fruit crops. Chapter in compendium "Winter School on exploitation of under utilized fruit crops, October 3-23, 2001, RCA, Udaipur, 22: 123-133.

Saroj, P L (2000). Genetic diversity of khejri (*Prosopis cineraria*). In: Proceeding of Winter School on 'Exploitation of underutilized fruit' at MPUAT, Udaipur. Pp. 134-137.

Saroj, P L. (2000). Nursery management in arid fruits. In: Proceeding of Winter School on 'Exploitation of underutilized fruit' at MPUAT, Udaipur. Pp. 218-226.

Singh, D.B, Singh R.S. and Samadia D.K. (2002). Production and post harvest utilization on under utilized fruit crops. Compedium on *National training on Management of Arid Horticulture*, organised by Directorate of Ext. Education RAU, Bikaner. 5-12 Feb. 2002.

Singh, D.B (2002). Role of Plant Growth Regulators in Horticultural Crops grown in Arid Zones. Compedium on National training on Management of Arid Horticulture, organised by Directorate of Ext. Education RAU, Bikaner. 5-12 Feb. 2002.

Singh, D.B. (2001) Tropical Underutilized fruits having potential for Exploitation" during. Compedium on Winter School on Exploitation of Under Utilized fruits from 3- 23rd Oct. 2001, organised by Deptt. of Horticulture, Rajasthan college of Agric. MP university of Agric. And Tech., Udaipur.

Sharma, B.D. (2001). Scope and Importance of Fertigation in Arid Ecosystem. In: Proc. of Management of Arid Horticulture, Directorate of Extension, RAU, Bikaner on 13-14 Feb., 2001.

D. Lecture delivered

Dr. R.S.Singh

"Scope and Importance of Exotic Fruit Plants in Arid Region" in National level course on Management of Arid Horticulture organized by Directorate of Extension Education, RAU, Bikaner, 5-12, February, 2002.

"Propagation Techniques and *Jojoba* Nursery Management" delivered in "Farmers Training Programme on *jojoba* cultivation" at College of Agriculture, RAU, Bikaner, 14th February, 2002.

Dr. P.L. Saroj

"Techniques on nursery management under arid conditions" in National Training on 'Management of Arid Horticulture' at RAU, Bikaner, February 8, 2002.

" Prospects of arid horticulture" in a training course of IFFCO officials at Bikaner, March 6, 2002.

Dr. D.K.Samadia

"Genetic Resource management in less known arid horticultural crops". In: Winter school on exploitation of under utilized fruits crops, RCA, Udaipur, Oct. 16, 2001.

"Cultivation and management of cucurbit vegetables in arid region". In: Training programme on management of arid horticulture. Directorate of Extension Education, RAU, Bikaner, Feb.08, 2002.

E. Radio Talk

Dr. Anil Kumar Shukla

"Phal vrikcho me kiye jane vale krishi karya" on dated 12.07.2001

"In dino phal vrikcho me kiye jane vale krishi karya" on dated 12.09.2001.

Dr. Arun Kumar Shukla

"Ber ke bageeche me keet niyantran" on dated 30.08.2001

Human Resource Development

A. Additional Qualification Acquired

Dr. P. Nallathambi awarded Ph. D. degree in Plant Pathology from Maharana Pratap Agricultural University, Udaipur (Rajasthan)

Dr. R. Bhargava awarded M.B.A. degree from Indira Gandhi National Open University, New Delhi.

B. Training programme attended

1. Dr. O.P.Awasthi

Attended seven day training programme from 25-30 June on "Agricultural Research Prioritization techniques" at National Academy of Agricultural Research Management, Rajendranagar, Hyderabad-500030.

Attended twenty one days winter school from 3-23 Oct. 2001 on "Exploitation of Underutilised fruits" organized by Department of Horticulture, Mahrana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

2. Dr. P.L.Saroj

Participated in a training on " Intellectual Property Rights and World Trade Organizations" at IARI, New Delhi, June 20-22, 2001.

Participated in a training on" Prioritization and Impact Assessment" at TNAU, Coimbatore, October 8-12, 2001.

C. Teaching

Dr. D.K.Samadia involved in Teaching and Guiding of M.Sc. (Ag.) Horticulture, College of Agriculture, RAU, Bikaner.

a) Teaching: 1. Summer vegetable production, I Semester Course- 2001-02

2. Breeding vegetable crops, II Semester Course- 2001-02

b) Guided as a Co-advisor M.Sc. (Ag.) Horticulture students Mr. Bhoop Singh (2001) Thesis entitled " Genetic variability and character association in chilli (*Capsicum annuum* L.).

Dr. Anil Kumar Shukla, Scientist (Hort.) acted as a faculty member/course leader for the teaching of "Post harvest technology of horticultural crops" to the Post Graduate Student.

Dr. O.P.Awasthi taught a PG. Course entitle, "Production of Tropical and Temperate Fruits" (Horts. 613) to M.Sc Ag. (Hort.).

Meeting /Seminars/Symposium

Name of Meeting/Seminar/Symposium	Scientiest participated	
1. XIth Research Workers Group Meeting of AICRP on AZF held at RAU, Bikaner from 13-15 March, 2002	Dr. D.G.Dhandar, Director Dr. B.B.Vashishtha, PS Dr. B.D.Sharma, Sr. Sci. Dr. P.L.Saroj, Sr. Sci. Dr. R. Bhargava, Sr. Sci. Dr. O.P.Awasthi, Sr. Sci. Dr. R.S.Singh, Sci. (S.S.) Dr. D.K.Samadia, Sci. (S.S.)	Dr. D.B.Singh, Sci. (S.S.) Dr. P.Nallathambi, Sci. Mrs. C. Umamaheswari, Sci. Dr. Anil Kumar Shukla, Sci. Mr. S.S.Meena, Sci. Dr. Arun Kumar Shukla,Sci. Dr. S.R.Meena, Sci. Mr. A. Nagraja, Sci.
2.Management and Utilization of *Prosopis* sp., jointly organized by CAZRI, Jodhpur from May 2-5, 2001.	Dr. R.S.Singh, Sci. Sr. Scale	
3.NATP Interaction Workshop on Agri-Silvi Horticultural System under Micro Irrigation System at CAZRI, RRS,Bikaner on 24th October, 2001	Dr. R.S.Singh, Sci. Sr. Scale Dr. P.L.Saroj, Sr. Sci.	
4. National Training Programme on "Advances in Arid and Semi Arid Fruit Crops" held at Centre for Advance Studies, MPKV, Rahuri from Feb. 20 to March 12, 2002.	Dr. R.S.Singh, Sci. Sr. Scale	
5. Third National Workshop on NATP on plant bio diversity, NBPGR, New Delhi, 18-20 April, 2001	Dr. D.K.Samadia, Sci. Sr. Scale	
6. One day group meeting cum orientation training under NATP on plant bio-diversity, NBPGR, RS, Jodhpur, Sept. 7, 2001.	Dr. D.K.Samadia, Sci. Sr. Scale	
7. Field day of *Kharif* crop germplasm for plant breeders under NATP on plant bio-diversity, NBPGR, RS, Jodhpur, Sept. 28, 2001.	Dr. D.K.Samadia, Sci. Sr. Scale	
8. Impact of Vegetable Production in India, IIVR, Varanasi, March 1-2, 2002	Dr. D.K.Samadia, Sci. Sr. Scale	
9.National Symposium on Biodiversity vis-à-vis Resource exploitation: An introspection, held at Port Blair, Andman and Nicobar Island, 23-24 April, 2001.	Dr. B.B.Vashishtha, PS Dr. D.B.Singh, Sci. Sr. Scale	
10. Resource person for finalising " Descriptor for Arid and Semi-arid fruit crops for conservation of Bio diversity" at NBPGR, New Delhi, 19-20 June, 2001.	Dr. D.B.Singh, Sci. Sr. Scale	
11. District task force and advisory committee on 21.06.2001 organised by Deptt. of Science and Technology Project Enterpreneurship Development Project, Bikaner	Dr. D.B.Singh, Sci. Sr. Scale	
12. Indian Science Congress at University of Lucknow, 2-7 January, 2002.	Dr. P.L.Saroj, Sr. Scientist	
13. National Conference on Resource Conservation and Wasteshed Management at CSWCRTI, Dehradun, 23-25 May, 2001.	Dr. P.L.Saroj, Sr. Scientist	
14. NATP Workshop of Agri-silvi-horti system project at CHES, Godhra, 27-28 August, 2001.	Dr. P.L.Saroj, Sr. Scientist	
15. Peer Review Committee Meeting of NATP at CAZRI, Jodhpur, March 20-21, 2002.	Dr. P.L.Saroj, Sr. Scientist	
16. Eco-restoration of field firing ranges organized by Army Officers Unit at Bikaner, June 7, 2001.	Dr. P.L.Saroj, Sr. Scientist	
17. NATP site committee meeting at RAU, Bikaner, September 21-22, 2001.	Dr. P.L.Saroj, Sr. Scientist	
18. ZREAC meeting of Zone IC at ARS, RAU, Bikaner, 25-26 February, 2002.		

Awards

Dr. R. Bhargava

Awarded Fellow of Indian Society of Plant Physiology.

Awarded Fellow of Indian Society of Agricultural Biochemistry.

Dr. P.Nallathambi

Silver Medal: by Sugarcane Technologists Association of India, New Delhi, during 62nd Annual Conviction held at Agra, 2000 for research work on "Plant Growth Promoter Regulators by Fluorescent Pseudomonas in Sugarcane Crop".

Award of Merit for the first position in the order of merit in Ph.D. (Plant Pathology) by Rajasthan College of Agriculture, Udaipur, 2000.

Promotions

Scientific staff

Dr. B.G.Bagle, Sr. Scientist (Ento.) & I/c Head promoted to Principal Scientist w.e.f. 27.7.1998.

Dr. S.S.Hiwale, Scientist (Hort.) promoted to Scientist (Sel. Grade) w.e.f. 27.07.1998 and Sr. Scientist w.e.f. 9.3.2000.

Technical Staff

Sh. G.U.Trivedi, Lib. Asstt. (T-4) promoted to T-5 w.e.f. 01.01.2000.

Sh. Nihal Singh, T-5 (Tech. Officer) promoted to T-6 (T.O.) w.e.f. 24.4.2001

Sh. P.P.Pareek, H.T. promoted to T-4 w.e.f. 29.06.2001

Sh. M.N.Makwana, T-II-3 (H.T.) promoted to T-4 (H.T.) w.e.f. 29.6.2001

Sh. U.V.Singh, T-II-3 (F.T.) promoted to T-4 w.e.f. 04.05.2001

Sh. G.R.Baria, T-II-3 (F.T.) promoted to T-4 (F.T.) w.e.f. 20.7.2001

Sh. P.R.Singh, T-1 (F.T.) promoted to T-2 w.e.f. 07.12.2000

Sh. Vinod Kumar, T-1 (F.T.) promoted to T-2 w.e.f. 10.02.2000

Sh. Satpal, Gypsy Driver (T-1) promoted to T-2 w.e.f. 29.6.2001.

Sh. Ashok Kumar, Tractor Driver (T-1) promoted to T-2 w.e.f. 29.6.2001

Sh. I.A.Pathan, T-1 (Bus Driver) promoted to T-2 w.e.f. 29.6.2001.

Sh. H.B.Patel, T-1 (Driver) promoted to T-2 w.e.f. 29.6.2001.

Sh. T.S.Dakiya, Tractor Driver (T-1) promoted to T-2 w.e.f. 29.6.2001

Sh. A.S.Bilvar, T-1 (Pump House Operator) promoted to T-2 w.e.f. 29.6.2001.

Sh. P.J.Jadav, T-1 (Tractor Driver) promoted to T-2 w.e.f. 29.06.2001.

Administrative Staff

Sh. K.F. Kharkhariwala, U.D.C promoted to Assistant w.e.f. 29.10.2001.

Sh. N.A. Patel, U.D.C. promoted to Assistant w.e.f. 03.12.2001.

Sh. H.S. Patel, L.D.C. promoted to U.D.C. w.e.f. 12.11.2001.

Sh. P.V.Solanki, L.D.C. promoted to U.D.C. w.e.f. 03.12.2001.

Sh. K.D.Vankar, L.D.C. promoted to U.D.C. w.e.f. 14.12.2001

Joining

Dr. D.G.Dhandar, Director, CIAH, Bikaner joined on 25.01.2002 from NRC Oil Palm, Pedavegi (A.P.).

Sh. I.S.Singh, Scientist (SWC) joined on 01.12.2001.

Transfer

Sh. G.K.Tripathi, T-1 (Lab. Tech.) transferred from CIAH, Bikaner to NRC on Seed Spices, Ajmer w.e.f. 03.08.2001

Superannuation

Dr. G.B.Raturi, Director, CIAH, Bikaner retired from Council's service on 31.07.2001.

Mr. M.B. Baria, SSG-I (Watchman) retired from CHES, Godhra on 31.12.2001

Re-employment

Dr. G.B.Raturi re-employed as Director, CIAH, Bikaner from 01.08.2001 to 24.01.2002 and relieved from Council's service on 25.01.2002.

Visitors

At CIAH, Bikaner

Dr. G. Kalloo, Dy. Director General (Hort.), Indian Council for Agricultural Research, New Delhi on dated 15.03.2002

At CHES, Godhra

- Shri Gopalsinghji G. Solanki, M.P. (Rajaya sabha), Godhra, Gujarat visited on 21.04.2001
- Shri Natvarsinh F. Thakor, M.L.A. (Mahudha), Sanali, Tal:Mahudha, Distt.: Kheda, Gujarat visited on 10.09.2001.
- Dr. G. Kalloo, Dy. Director General (Hort.), Indian Council for Agricultural Research, New Delhi visited on 11.11.2001.
- Dr. Satayabrato Maiti, Dirctor, NRC on MAP, Boriavi, Anand, Gujarad visited on 11.11.2001

Dr. G.Kallo, DDG (Hort.) visiting Nursery of CIAH

Dr. G.Kallo, DDG (Hort.) visiting CIAH Farm

Farewell of Dr. G.B. Raturi, Ex-Director, CIAH, Bikaner and taking oyer of Dr. D.G. Dhandar, as Director, CIAH, Bikaner on 25.01.2002.

Dr. D.G. Dhandar, Director, CIAH, Bikaner visiting CHES, Vejalpur (Godhra) Farm on 01.02.2002

वार्षिक प्रतिवेदन सारांश

प्रस्तावना

कृषि के वर्तमान परिदृश्य में जहां बढ़ते हुए शहरीकरण के कारण कृषि योग्य भूमि का आकार सिकुड़ता दृष्टिगत होता जा रहा है, वहां उष्मीय शुष्क क्षेत्र में कृषि उत्पादन को विकसित करने के बहुत विकल्प हैं। 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 हैं वरन् 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 राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान की स्थापना 1993 में की गई जो बाद में केन्द्रीय शुष्क बागवानी संस्थान में क्रमोन्नत कर दिया गया।

मुख्य ध्येय

शुष्क पारिस्थितिकी में उद्यानिकी फसलों का उत्पादन बढ़ाने के लिए योजनाबद्ध अनुसंधान कार्य करना तथा शुष्क क्षेत्र उद्यानिकी से संबद्ध सूचनाओं के प्रमुख केन्द्र के रूप में कार्य करना।

उद्देश्य

1. शुष्क परिस्थितियों में उद्यानिकी 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 उद्यानिकी 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 उद्यानिकी फसलों की शुष्क जलवायु के अनुरूप उत्पादकता बढ़ाने के लिए समुचित उपयोग करने की कृषि तकनीकीयों का विकास कर उनका मानकीकरण करना।
5. उच्चताप एवं विकिरण संसाधनों के उपयोग हेतु उद्यानिकी फसल–चक्र पद्धतियों के पारिस्थितिजन्य परिमापकों का अध्ययन करना।
6. शुष्क क्षेत्रीय उद्यानिकी फसलों के उत्पादों की सर्वउपलब्धता हेतु कटाई उपरान्त तकनीकियों का विकास करना।
7. शुष्क परिस्थितियों में उद्यानिकी फसलों हेतु समाकलित कीट एवं व्याधि प्रबन्ध की तकनीकियों का विकास करना।

उपलब्धियां

वर्ष 2001–2002 के मध्य अनुसंधान क्षेत्र में अर्जित महत्वपूर्ण उपलब्धियों का संक्षिप्त विवरण :

1. प्रतिवेदन की अवधि में निम्नलिखित जननद्रव्यों के संग्रह से संस्थान की संचित जननद्रव्य निधि में बढ़ोतरी दर्ज की गई। संस्थान की कुल संचित निधि बढ़कर इस प्रकार है– हिमाचल प्रदेश से पाला सहिष्णु आंवले की 18 कलमें, अनारदाना के दो संग्रह जिनमें एक हिमाचल प्रदेश तथा दूसरा आई.आई.एच.आर., बैगलौर से, बेल के 7 जननप्रकार अण्डमान निकोबार द्वीप से तथा राजस्थान व गुजरात से तीन फालसे के तथा चार करोंदा के जननद्रव्य संग्रह किए गए। इस प्रकार कुल जनन द्रव्य संग्रह बढ़कर बेर में 318, अनार में 150, आंवला में 22, कैक्टस पीअर में 107, खजूर में 52, काचरी में 558, मतीरा में 193, स्नेपमेलन में 90, मिर्ची में 132, खरबूजे में 55 एवं 60 किस्में अन्य विभिन्न फलों की जो तालिका क्रमांक 38 में दिये गए हैं।

2. बेर में 'पाला से बचाव' अध्ययन में छुआरा, टिकड़ी, काठाफल, खारकी–1, बादामी, ग्लोरी, सफेदा रोहतक प्रजातियाँ पाले से अप्रभावित पाई गई।

3. शुष्क क्षेत्र के स्थानीय एवं एक्जोटिक अवप्रयोगी फलों को चिन्हित कर चयनित करने का कार्य आरम्भ किया गया है।

4. अनार में फल–फटने वाले रोग पर नियंत्रण हेतु 'बोरोन' का प्रयोग किया गया। बोरोन का 0.2 प्रतिशत का घोल इस समस्या के निराकरण हेतु प्रभावी पाया गया।

5. खजूर में प्रकाश संश्लेषक परिमापकों के अध्ययन में नेट प्रकाश संश्लेषण दर फूल आने के समय अधिक दर्ज की गई।

6. बेर की गोला व सन्दूरा किस्मों के साथ सी.आई.ए.एच. चयन 1 व सी.आई.ए.एच. संकर 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 ए.एच.डब्ल्यू. 19 मतीरे की एफ 5 प्रोगेनी को तरबूज की 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. शुष्क क्षेत्रीय सब्जियों में लोकी की ए.एच.एल.एस. लोंग–1 व ए.एच.एल.एस. गोल–1 तथा टिण्डा के ए.एच.आर. एम.–1 चयनों को चिन्हित कर उनका प्रायोगिक चक्र लगाया गया। इन चयनों में उत्तम गुणवत्ता व अधिक उपज दर्ज की गई।

10. लसोड़ा में बडिंग समय मानकीकरण में 15 अगस्त के आस–पास की गई बडिंग सर्वोत्तम दर्ज की गई।

11. मतीरा व तरबूज में प्रकाश संश्लेषण अध्ययन में देखा गया कि न्यून जलापूर्ति की स्थिति में मतीरे में प्रकाश संश्लेषण दबाव कम जबकि तरबूज में यह पचास प्रतिशत तक हो जाता है।

12. खीरावर्गीय फसलों में सूखे के परिमापकों को निश्चित करने में पौध वृद्धि दबाव सूची तथा शुष्क तत्व दबाव सूची को जननद्रव्य छांटने में प्रयोग किया जा सकता है।

13. अनार में अकार्बनिक उर्वरक एवं कार्बनिक खाद 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. ट्राइकोडरमा के विकास व बढ़वार पर कार्बोहाइड्रेट के प्रभाव को जॉचने के कम में गेहूँ व फिंगर मिलेट कार्बोहाइड्रेट रूप में वर्मीकम्पोस्ट, मींगनी व गोबर खाद के साथ मिलाया गया। इसस ट्राइकोडरमा का आश्चर्यजनक विकास दर्ज किया गया।

15. संस्थान के वैज्ञानिकों एवं तकनीकी तथा प्रशासनिक अधिकारियों ने अन्य सहयोगी व रचनात्मक कार्य कलापों में सहयोग किया। संस्थान के वैज्ञानिकों ने विभिन्न किसान मेलों व अन्य विस्तार गतिविधियों में सक्रिय भाग लेकर किसानों को नई प्रौद्योगिकियों 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।


250
200
150
100