Annual Report
2012-13

Central Institute for Arid Horticulture
(Indian Council of Agricultural Research)
Bikaner- 334006 (Rajasthan)

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PREFACE

It gives me immense pleasure in bringing out the Annual Report 2012-2013 of the Central Institute for Arid Horticulture (CIAH), Bikaner. The Institute was established as National Research Centre for Arid Horticulture (NRCAH) in 1993 and grew over a period to a fullfledged institute in the year 2000 with a Regional Research Station at Godhra, Gujarat. CIAH is a premier Institute involved in conducting research on arid horticultural crops.

Owing to their strength such as vast area, ample solar radiation, low incidence of disease and pest and low population arid and semi arid regions have potential to become the horticultural bowl of India provided adequate technologies are developed. In view of this, Central Institute for Arid Horticulture, Bikaner is dedicated to develop technologies for production of horticultural crops under low water input, value addition of the horticultural produce, introduction of crops from iso-climatic conditions and development of quality planting material for farmers, etc.

The present report highlights glimpses of 4 mega research projects and 9 externally funded projects, new methodologies developed, significant advisory services provided, dissemination of knowledge acquired, human resource development, linkages cultivated/nurtured with various ICAR institutes, SAUs and other research organization of India. I take this opportunity to place on record my appreciation to all the members of the Institute Research Committee (IRC) who have discussed all the activities at length and come out with well laid out plan of action within a definite time frame. I also thank technical personnel, administrative, finance and other staff of the Institute who have put their lot of efforts to take policies and programmes of the Institute forward.

I take this opportunity to place on record my sincere thanks and deep sanse of gratitude to Dr. S. Ayyapan, Secretary, DARE and D. G., ICAR for his constant support in executing the mandate of the Institute. I also express my gratitude to Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture) for their ciritcal remarks and valuable suggestion.

This Annual Report is the culmination of dedicated and sustained efforts by our Scientists and other staff of the institute. I wish to express my sincere appreciation to Dr. R. Bhargava and Dr. R. S. Singh for their sincere and whole-hearted support in bringing out the Annual Report. The technical support in terms of computerization by Sh. Bhoj Raj Khatri is appreciated.

Date : June, 2013, Bikaner

(S. K. Sharma)
Director

CONTENTS

		Page
	Preface	iii
	Executive Summary	vii
1.	Introduction	1
2.	Research Achievements	4
3.	Education, Training and Technological Intervention	76
4.	Women Empowerment	81
5.	Awards and Recognitions	82
6.	Linkages and Collaborations	84
7.	Externally Funded Projects	85
8.	Publications	98
9.	Research Programmes and Projects	109
10.	RAC, IMC, IRC	113
11.	Conferences, Training, Lectures, Meetings, etc.	115
12.	Distinguished Visitors	121
13.	Rajbhasha	124
14.	Personnel	127
15.	Budget	131
16.	Meteorological Data	132

EXECUTIVE SUMMARY

Plant Genetic Resources and Crop Improvement

Fruits

The institute is maintaining a rich germplasm of mandate crops in the field gene bank. During the period under report, 2 new accessions of ber, 7 of date palm, 1 each of ker, wood apple & khirni, 5 of mulberry, 7 of bael, 3 each of bottle gourd, long melon, brinjal & 4 of ridge gourd were collected and added to the germplasm gene bank.

A physiological disorder 'brown tip' was noted in ber cv. Chhuhara for second consecutive year. The disorder appears during late harvesting period. The disorder fruits were found to have less TSS, reducing and total sugar.

Varietal trial consisting of cvs. Halawy, Khalas, Zahidi, Medjool and Khadawy were carried out and it was recordd that Halawy recorded maximum height. Evaluation of tissue culture plants showed that spathe emergence was recorded in Barhee within three years of planting.

Evaluation of beal germplasm showed 3 elite types viz. CHES-B-5, CHES-B-8, CHES-B11 which were having short structure, early fruiting, less spine and high yield.

Exotic fruit species (Marula nut, Argan, Carob, Chinese jujube) were maintained and evaluated for growth and flowering/ fruiting.Marula nut plants were susceptible to frost.

Under utilized fruits such as Manila tamarind, mulberry, wood apple, sapota, jamun etc were also evaluated and are elite type of jamun (GJ-8) was identified.

Vegetables

During the period, monitoring of dessertic melons (125), non-dessertic melons (161) and gourds (60) lines of cucurbitaceous crops was done for safe conservation in gene bank (-20°C) at the institute. As per maintenance and seed enhancement work plan, snapmelon (65) germplasm was undertaken during 2012. Sufficient quantity of seeds of 65 lines was produced and deposited for conservation both at CIAH and NBPGR, RS, Jodhpur.

During summer season of 2012, sixteen advanced lines of round melon progenies were evaluated. A good amount of variations were recorded and potential individuals were identified for advancement of generation.

Based on the screening of brinjal lines, CIAH-1, CIAH-2, CIAH-12, CIAH-16, CIAH-21, CIAH-22 and CIAH-67 were selected which showed earliness, reduced infestation of fruit and shoot border, high marketable yield and consistent fruit quality under high temperature.

In ridge gourd, two superior genotypes viz., AHRG-29 and AHRG-41 were selected which were able to set fruit at high temperature during May-June.

In pumpkin, six breeding lines performed better and yielded higher number of fruits in summer season.

Crop Management and Agrotechniques

The growth, yield, physiological and fruit quality parameters were recorded in eight years old established plants of ber, bael, khejri and drumstick grown in association with aonla in the various

cropping models. The study revealed that the fruit crops exerted no negative allelopathic effect on germination of ground storey crops like cluster bean, mustard, dill, coriander and ajowain. The highest yield of aonla was recorded in aonla-kinnow (52.3 kg per plant) system followed by aonla- mulberry (49.6 kg/plant), aonla-ber (54.1 kg/plant) and aonla-khejri (39.2 kg/plan), while the lowest was recorded in aonla- moringa (36.7 kg/plant).

Attempts were made to develop green house based propagation technology. It was recorded that efficiency of propagation can be increased under greenhouse conditions. The feasibility of growing tomato and capsicum under protected cultivation during offseason was demonstrated.

In order to study the khejri based cropping system, an area of 2 hectare was developed through in situ establishment of khejri variety 'That Shobha'.

Integrated Nutrient and Water Management

Analysis of microbial population of 0-0.15 and 0.15-0.30 m depth revealed that total microbial population was minimum in absolute control and maximum in treatment recommended dose of N, P, K + FYM and consortium of biofertilizer. Similarly, in kinnow the best fruit weight, fruit yield, TSS, acidity and juice recovery was also observed in above treatment.

Studies on high density planting systems revealed that different planting systems significantly affected the vegetative growth, yield and quality of aonla under rainfed conditions of hot semi-arid environment

Application of different mulches in aonla demonstrated the bacterial population in basin soil was highest in paddy straw mulch.

Application of organic fertilizer in vegetables (pumpkin and bitter gourd) demonstrated that treatment receiving neem compost gave better yield (5.5 kg/ plant), followed by subabul and lowest yield were observed in control.

Organic farming

Application of biofertilizers showed that soil properties in terms of organic carbon available N & K, pH and EC were improved.

In mango, application of FYM + standrad dose of NPK+ Azotobactor+ PSB showed best growth and development. In an experiment conducted to study the effect of different forms of compost revealed that in tomato and cluster bean compost made from neem gave the highest yield.

Crop Physiology and Biotechnology

The effect of water stress on soluble sugar, starch content and sugar/starch ratio was assessed in drought tolerant (mateera) and drought susceptible (muskmelon) in shoot & root. It was observed that in drought tolerant plants, the soluble sugar accumulates in root as soon as the water stress in applied.

In order to accelerate the growth of shoot & root in zygotic embryos, the bioreactor parameters were studied. It was observed that better shoot growth was recorded at 23°C whereas root growth was maximum at 28°C.

The primers for characterization of khejri cv. Thar Shobha was standardized. It was recorded that Thar Shobha had specific bands 200 bp with OPBA-13; 350 bp with OPBE-05; 550 bp with OPA12 & 300 bp with OPA-14.

Post Harvest Technology

RTS from bael pulp powder was prepared . The bael pulp powder was dried and stored at room temperature and it was observed that bael pulp powder can be stored upto 5 months at room temperature and RTS had high acceptability.

Aonla shreds were prepared by solar drying after treatment with salt. Similarly, oil less pickle of aonla was prepared with 10-15% salt.

Crop Protection

Integrated disease management of powdery mildew in ber and leaf spot of pomegranate, fruit rot of aonla and cercospora leaf spot of bottle gourd were worked out. The major diseases affecting bael, chilli, tomato and cucurbits were also identified.

The incidence and morphomatric analysis of coried bug affecting khejri was worked out and it was found that incidence was maximum in winter months. Similarly, muskmelon varieties/genotypes were evaluated for fruit fly and it was recorded that AHMM/BR-1, RM-50 and AHMM/BR-8 were highly resistant. Biochemical analysis of plants with respect to pest incidence revealed that total alkaloid and pH explained 97.96% of variation in fruit fly infestation.

Agricultural Extension

The information on traditional vegetables grown, their use and marketing system, change in cropping patterns and socio-economic characteristics of farmers, ITKs were investigated. The major constraints faced by farmers in adopting the technologies were also collected. A large number of students, farmers and farm women visited the farm at Bikaner and Godhra during 2012-13.

Externally funded projects

At CIAH, Bikaner and its regional station CHES, Vejalpur (Godhra) nine externally funded projects were in operation.

Under project" Bioprospecting of genes and allele mining for abiotic stress tolerance" core collection of *Z. mauritiana* was developed. Similarly, on the basis of physiological parameters *Z. nummularia* from Jaiselmer and Bikaner were more tolerant to water stress.

Under the project "Validation of DUS testing guidelines for cucurbits i.e. watermelon and muskmelon" in depth studies on the morphological parameters of watermelon and muskmelon were undertaken to develop the DUS characters.

Under DUS project on date palm, detailed morphological data of different varieties were collected and analyzed. Similarly, the morphological & quality parameters were recorded under DUS project on bael, DUS project on aonla and DUS project on jamun.

Survey in Gujarat was undertaken to access genetic variability in genus *Morinda* under the project "Identification, collection, characterization, evaluation and conservation of Noni (*Morinda* spp.) of western India (Gujarat and M.P.). In this project the characterization and evaluation of collected material was undertaken and conserved at Vejalpur, Godhra.

1

INTRODUCTION

As a result of urbanization, the fertile agricultural land is shrinking and the land available for production is not sufficient to feed the population of the country. In a situation such as this, the attention of agriculturists and policy planners is shifting towards areas which were till date not considered ideal for agricultural production due to climatic, edaphic and other adverse conditions. Among such areas, arid region which occupies about 12% of country's geographical area has shown potential to be ideal for agricultural production provided adequate technologies are developed.

In view of this and to achieve income and nutrition security for the people of arid region and develop the horticultural scenario in this region, the National Research Centre for Arid Horticulture came into existence on 1st April 1993. This was later upgraded to Central Institute for Arid Horticulture on 27th September 2000 and CHES, Godhra (earlier Regional Station of IIHR, Bangalore) was merged with it as its Regional Station on 1st October, 2000.

Mandate

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

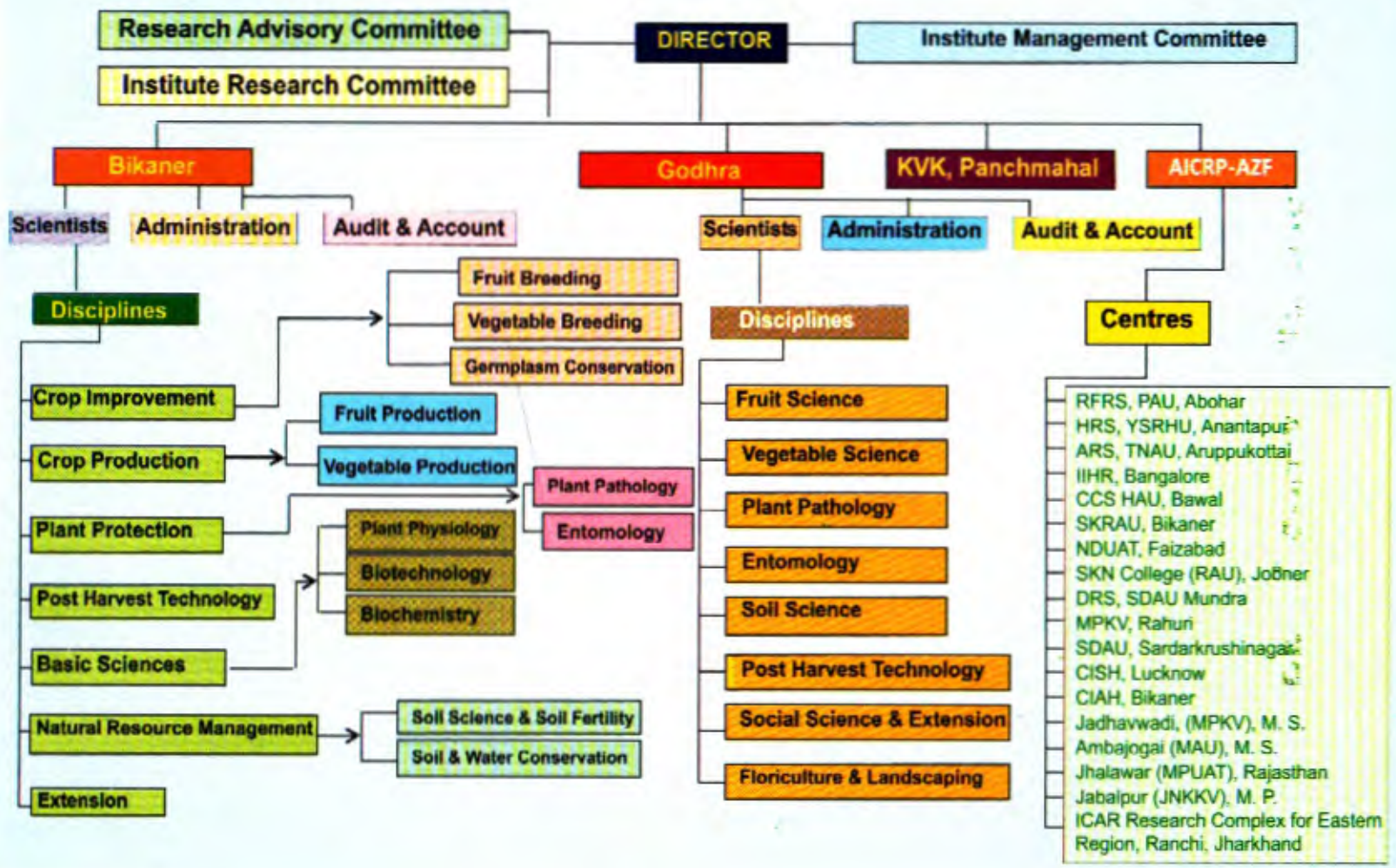
Mission/objectives

- To introduce, collect, characterize, conserve and evaluate the biodiversity of horticultural crops under arid and semi arid environment.
- To utilize the available biodiversity and improve the target fruit crops such as ber, pomegranate, aonla, date palm, sapota, custard apple, tamarind, fig and cucurbitaceous, leguminous and solanaceous vegetable crops to develop high quality and productive types having tolerance to biotic and abiotic stresses.
- To study the factors related to rapid multiplication of propagules in case of established as well as new crops and the problems related to their growth and fruit development.
- To standardize agrotechniques with respect to efficient use of soil, water and nutrients for increased horticultural productivity involving water harvesting and conservation techniques under rainfed conditions, efficient use of the scarce irrigation water and nutrient management.
- To study the eco-physiological parameters of cropping system models for utilization of high temperature and radiation resources.

- To develop post harvest technology package for extended use of the horticultural produce of arid region.
- To develop integrated pest and disease management technologies for horticultural crops under arid environment.
- To transfer the innovative technologies generated on the above aspects to farmer's field for effective horticultural development and socio-economic upliftment of the farmers.
- To carry out the impact assessment of the technologies and constraint analysis.
- To serve as a repository of information related to arid and semi arid horticulture.
- To collaborate with relevant national and international agencies for achieving the above.

Keeping in view the above mandate and objectives, the research and extension works were carried out during 2012-13 and the significant results obtained in different projects are presented hereunder.

ORGANIZATIONAL SETUP



2

RESEARCH ACHIEVEMENTS

Genetic Resources

Introduction, collection, characterization, conservation and evaluation under hot arid environment

Fruits

Ber (*Ziziphus mauritiana* Lamk)

Screening of ber species for drought-tolerance

Some ber species were screened for drought tolerance for their use as drought-tolerant rootstocks. The parameters chosen for screening were leaf proline contents and membrane stability index (MSI). The results are being presented in the Table1. Based on the *in vitro* tests, it can be concluded that bordi (*Ziziphus rotundifolia*) would be most tolerant to drought followed by Tikadi, *Z. nummularia*, while the least was recorded in *Z. spinachristi*.

A physiological disorder 'brown tip' was noted in ber cv. Chhuhara for the second consecutive year.

Table 1. Screening of ber species of resistance to drought

Sr. No.	Species/ genotypes	Membrane Stability Index	proline (mg/g FW)
1	*Ziziphus rotundifolia*	93.05	14.18
2	*Ziziphus mummularia*	89.43	09.62
3	*Ziziphus spinachristi*	80.46	05.87
4	*Ziziphus species*	82.51	05.63
5	Tikadi	91.60	10.31

The disorder has been found to aggravate with the progress in the maturity. Further, this disorder appears during late harvesting period, when atmospheric temperature is well above 25°C i.e. last week of February to first fortnight of March. In order to ascertain the etiology of the disorder biochemical estimations were made and it was fount that these fruits had less TSS, reducing and total sugars; besides reduced ascorbic acid. In addition, the secondary metabolites like polyphenols and enzymes like polyphenol oxidase (PPO) and peroxidase, which are primarily associated with stress in plant system, have been found to be significantly higher in affected fruits.

It is amply clear that browning of stylar end of ber fruits is due to accumulation of secondary metabolites and higher activity of enzymes, which are largely responsible for browning of plant tissues (Fig.1). These secondary metabolites play an important role in plant defense and may also constitute a physical barrier against biotic and abiotic stresses. The higher level of these compounds in fruits shows that affected fruits are under some kind of environmental stress.

Fig. 1. Stylar end browning in ber.

Date palm (*Phoenix dactylifera* L.)

Collection and conservation

Sixty date palm varieties/genotypes including exotics were maintained in the field gene bank. Exotic cultivars Siwi and Amhat introduced from Egypt, are growing well and 3-4 new suckers were emerged out. The offshoots of cv. Mejnaz, Sopari, Anand tissue culture plant, Sel.-9, MDP-01, 07 and MDP-12 collections were made from DRS, Mundra and Zagloul from DRS, Bikaner and planted for evaluation.

Evaluation of germplasm

The maximum palm height 6.90 m and plant spread observed in cv. Muscat followed by Halawy and Tayer.The spathe emergence started from second week of February and completed in second week of March. Delayed emergence of spathe was observed among germplsam during the year due to climatic conditions and genetic characters. The spathe emergence/opening and fruiting were observed in 26 genotypes out of 60 germplasm.

The number of bunch 1-12 per palm and fruit's yield varied from 1-52 kg/plant among germplasm. Better fruiting was observed in cvs. Halawy (52kg), Chip-chap (44kg), Shamran (38kg). However, low fruiting (1kg per palm) was in cv. Sedami. The maximum number of bunch/ plant was observed in Halawy (12) followed by Muscat, Chip-chap, (11) and others. The number of berries (21 per strand) was observed in cvs. Zahidi followed by Khuneizi (18). The early doka stage was observed in cv. Tayer and harvested in last week of June 2012. However, cvs. Halawy, Muscat and Khuneizi during third week of July and Bintaisha, Saidy, Khalas were harvested in last week of July. Maximum fruit drop was observed in cv. Sedami, Muscat, Tayer, Sayer and Khalas. The maturity of fruits (doka stage) was recorded in maximum varieties in third week of July. Late fruit maturity was observed in Medjool and Hayani. Maximum berry weight (24.3 g) and size (4.7x2.9cm) was observed in Medjool and minimum fruit weight 4.0g was in Sedami. Maximum stone weight 1.9g was recorded in Medini followed by Punjab Red 1.6g and minimum was in Tayer (0.7g). TSS of doka fruits varied from 20° to 43o brix among evaluated germplasm. During the year, pind (Tamer) stage was not observed in any genotypes.

Varietal evaluation

Varietal trial consisting of cvs. Halawy, Khalas, Zahidi, Medjool and Khadrawy were carried out for plant growth, fruiting, yield and fruit quality under drip system of irrigation. Maximum plant height was observed in cv. Halawy (5.10m) while minimum palm height (2.50m) was observed in cv. Medjool. Halawy, Khalas, Medjool and Zahidi varieties yielded five to seven bunches/palm after nine years of planting.

Evaluation of tissue culture plants

Tissue culture plants of cv. Barhee and KCS-143 were evaluated for growth and flowering under arid environment. Vegetative growth in respect of height of plant (1.70 m), spread (2.60 x 2.80m) and number of leaves (10-12per plant) was observed after three year of planting. However, spathe emergence was observed in Barhee plant within three years of planting and two bunch of small size (1 kg) was harvested in the first week of August. The growth of Barhee plant was better than KCS-143 (1.35m height) and eight plants of cv. Barhee was also planted during Feb., 2013 for evaluation.

Treatment of suckers with IBA for rooting

The effect of 5000ppm IBA treatment in lanoline paste on rooting in arial suckers was observed during October, 2012. For treatment, cuts near sucker's joint were made and pasted with IBA and then covered with soil mixture (Fig. 2). Further, in three plants, cut mark was pasted with IBA and tie up with wire and regular watering was given to maintain moisture for rooting. However, the results were not encouraging to initiate roots in arial suckers.

Fig. 2. Application of IBA for rooting

Bael (*Aegle marmelas Correa.*)

At Bikaner

Bael germplasm (17) were maintained in the field repository at CIAH, Bikaner and evaluated for growth, flowering and effect of frost/low temperature. The vegetative growth of plants varied under hot arid conditions. The maximum plant height 4.25 m and spread (3.40m N-S and 3.60m E-W) was recorded after 10 years of planting in a collection from Pushkar (Ajmer). Flowering and fruit set was observed in three genotypes but flowers and immature fruits dropped due to poor soil moisture conditions during summer. During the year, effect of frost on bael germplasm was very less. One elite type, late maturing seedling was identified whose average fruits weight was 400-500g, with yellow flesh, thin shell and good taste.

For development of varietal block of NB-5, NB-9, CISHB-1, CISHB-2, Pant Sujata, CIAH Bael Sel-2, Bael Sel. -1 and Goma Yashi bael, *in situ* budding was done but success percentage varied from 40-50 per cent during mid August, 2012. However, slow initial growth in young plants and effect of frost was also observed in new establishing plants during winter season, 2012.

Bael rootstocks were planted at 6x6, 6x4, 4x4 and 8x8m spacing during August 2012 and survival rate was 57% and 70% under 4x6m and 8x8 m spacing, respectively. However, plant height varied from 19 to 26 cm and also affected by frost.

At Godhra

Varieties of bael viz, CISHB-1, CISHB-2, NB-5, NB-7, NB-9, NB-16, NB-17 Pant Aparna, Pant Sujata, Pant Urvashi, Pant Shivani and Goma Yashi were evaluated for vegetative growth, flowering, fruiting behaviour and quality attributes under rain fed conditions of hot semi-arid ecosystem during the year 2012-13. Yield per plant among different evaluated varieties of bael varied from 40.00 -98.00 kg during 2012-13. Fruit weight varied from 0.79-4.00 kg, fruit length 11.50-18.00 cm, fruit width 11.00 - 19.50 cm, shell thickness 1.60-3.40 mm, number of seeds 68-205, pulp TSS 32.00 - 39.50 0brix, mucilage TSS 43- 48.50 0brix total sugar 15.00 - 21.00 per cent, vitamin C 15.50-21 mg /100 fruit pulp in all the evaluated varieties of bael. The pulp content was found maximum in Goma Yashi followed by NB-5, Pant Aparna, Pant Sujata, and CISHB-1. The seed content was recorded maximum in NB-17 followed by CISHB-1 whereas the mucilage was found to be the maximum in Pant Aparna and NB-16.

Ripening

Fruit attained maximum size up to September and then remained more or less stationary phase until the fruits were harvested. Almost all varieties exhibited similar pattern of fruit growth. Varieties CISHB-1, Pant Shivani and Goma Yashi started ripening from the second fortnight of February, varieties Pant Aparna and Pant Sujata in the second fortnight of March, varieties NB-16, NB-17 and Pant Urvashi in first fortnight of April, varieties NB-9 in second fortnight of April, varieties NB-7, NB-5 and CISHB-2 in first fortnight of May under rain fed conditions of hot semi-arid ecosystem.

Evaluation of bael genotypes

Apart from the 12 varieties, 40 germplarm of bael have been evaluated for growth parameters which were established through *in-situ* patch budding. Vegetative parameters of these genotypes

are being recorded under rain fed conditions of semi-arid ecosystem. All the genotypes showed wide variation in growth characters. Flowering was noticed in eight genotypes during the year 2012-13. Annual growth extension in terms of plant height was recorded maximum in CHESB-5 (50.20cm) and minimum in CHESB-27 (32.12cm), whereas girth of stem (3.32cm) was recorded maximum in CHESB-31 and it was minimum in CHESB-19 (3.15cm), among the genotypes evaluated for growth under rainfed conditions of semi-arid ecosystem.

Salient Features of Identified Elite Genotypes of Bael

CHESB-5

An identified promising genotype CHESB-5 was collected from Badalpatti village of Jaunpur district of Uttar Pradesh State and *in-situ* budding was performed during 2006. It is superior genotype with desirable characters like earliness, compact growth, medium height, very less spine, better yield with quality fruits having pleasant flavour with attractive colour of pulp. It started flowering and fruiting from 4th year of budding. Plant height, stem girth, plant spread was recorded 5.25 m, 43.42cm and 5.10 m, respectively during 6thyear of orchard life. Average yield 52.11 kg in 6th year, fruit weight 1.68 kg, fruit size 21.80 cm x 15.30 cm, fruit girth 45.79 cm, shell thickness 2mm, total number of seed 138, seed weight 0.15g, total seed weight 33.15g, fibre weight 65 g, shell weight 265g, locules in cross section 13-16, pulp 69.50%, TSS pulp 340B, TSS mucilage 48.500B, acidity (0.28%) and vitamin C 19.80 mg / 100 g pulp were recorded. It is an early maturing variety (1st week of March).The fruits of this genotype is less affected by sun scald owing to compact and luxuriant growth of plant.

CHESB-8

An identified promising genotype CHESB-8 was collected from Mera village of Jaunpur district of Uttar Pradesh State and in-situ budding was performed during 2008. It is superior genotype with desirable characters like earliness, compact growth, medium height, spiny, better yield with quality fruits having pleasant flavour with attractive colour of pulp. It started flowering and fruiting from 3rd year of budding. Plant height, stem girth and plant spread were recorded 3.95 m, 34.42 cm and 3.8 m, respectively during 4thyear of orchard life. Average yield per plant 15.23 kg in 4th year, fruit weight 2.65 kg, fruit size 17.12 cm x 16.20 cm, fruit girth 51.50 cm, shell thickness 0.19cm, total number of seed 72, seed weight 0.25g, total seed weight 22.15g, fibre weight 120.18 g, shell weight 365.12g, locules in cross section 13-16, pulp 69.50%, TSS pulp 390B, TSS mucilage 49.900B, acidity (0.28%) and vitamin C 19.80 mg / 100 g pulp were recorded. It is an early maturing variety (1st week of March).The fruits of this genotype is having good flavour and aroma. It is highly suitable for sherbet and squash making.

CHESB-11

An identified promising genotype CHESB-11 was collected in 2009 from Baharipur village of Jaunpur district of Uttar Pradesh State and in-situ budding was performed during 2009. It is superior genotype with desirable characters like compact growth, medium height, spiny, better quality fruits having very excellent flavour with attractive yellowish orange colour of pulp. It started flowering and fruiting from 3rd year of budding. Plant height, stem girth, plant spread was recorded 3.30 m, 31.12cm and 3.20 m, respectively during 2012. Average yield per plant 5.00 kg in 3th year, fruit weight 1.60 kg, fruit size 15.15 cm x 15.55 cm, fruit girth 46.50 cm, shell thickness 0.24cm, total number of seed 82, seed weight 0.22g, total seed weight 25.45g, fibre weight 140.68 g, shell weight 250.12g, locules in cross section 14-17, TSS pulp 380B, TSS mucilage 48.800B, acidity (0.27%) and vitamin C 21.80 mg / 100 g pulp were recorded. It is medium maturing variety (1st week of April).The fruits of

this genotype is having good flavour and aroma. It is highly suitable for sherbet and murabba making.

Aonla (*Emblica officianalis*)

Maintenance of aonla germplasm is challenging due to incidence of frost/chilling injury. During this year, an experiment was carried out on frost management by spray of chemicals @0.1% such as Sulphuric acid, Potassium nitrate, Salicylic acid , Thiourea and Calcium nitrate @0.1%) during middle of December month and first week of January. Four plants under each treatment were sprayed twice. Visual observations on damage of shoots/plants were recorded. However, chemical spray was not effective to minimize the damage of plants caused by frost.

Further, defoliation of aonla through chemical spray of Potassium iodide @ 0.3% and Ethephon @ 0.1% was also tried but the results were not encouraging.

Pomegranate (*Punica granatum* L.)

Maintenance of 150 germplasm at CIAH, Bikaner and 45 at CHES, Vejalpur, Godhra was done during the year.

All germplasm were affected by low temperature/frost under arid conditions during winter season 2013. Sprouting and growth in plants started after employing management practices which were varied among germplasm. Variation in sprouting in plants after frost effect was observed from 50 to 100% which may be due to genetic features of varieties. In 65 germplasm sprouting was not observed up to 15th Feb, 2013 while 100 per cent sprouting was observed in 32 genotypes and 50 % in rest genotypes. Deblossoming was done to avoid ambe bahar during summer-2013.

Evaluation of Anardana type

Twelve collections started flowering and fruiting. Average plant height varied from 1.5-3.5 m. Upper top portion of plants was affected by frost/ low temperature during winter season. The size of fruits was small having below 100g weight and number of fruits/plant varied from 10 to 30. The aril was small and hard in all anardana types and further evaluation is in progress.

Cactus pear (*Opuntia ficus indica*)

Genotypes were maintained in the nursery mother block. Three clones 1308, 1269 and Mount Abu collection including 30 tissue culture plant of vegetable type were planted during August in field at 3x1m and evaluated for survival and growth. The clone 1308 sprouted earlier than other clones. Average 2 to 5 cladodes were formed after four months of planting. Survival of plant was 80-90% and sprouting started after15-20days and growth of clones was good in all three genotypes.

Manila tamarind (*Pithecelobium dulce*)

Three genotypes were evaluated under field conditions and it was noted that plants were susceptible to frost/ low temperature.

Mulberry (*Morus alba*)

Among mulberry genotypes, CIAH Selection 1 & CIAH Sel. 2 was found superior to other genotypes of mulberry available in field repository in terms of growth and yield characteristics. CIAH Sel. 1 was found to be earliest with respect to maturity period. It took 30-35 days to mature and has been found to be around 10-day earlier than any other variety available in mulberry germplasm block. Besides, a new accession of mulberry genotype Delhi Collection has also been shown to be promising in terms of fruit length (5-9 cm), width (1-1.2 cm), weight (4-6 g), attractive colour (reddish to maroon), organoleptic attributes and consumers acceptability.

Fruits of two promising genotypes CIAH Sel. 1 & 2 were subjected to quality analyses. The red

fruited mulberry genotypes was found to be superior to the green fruited genotypes; hence, indicating towards its higher nutritive value. The variations in the antioxidant attributes of genotypes used may be due to the variation in their genetic makeup and difference in the plant physiology.

Wood Apple *(Feronia limonia)*

Five elite wood apple types were planted in field during August 2012 for evaluation. The initial growth of plant was slow in all genotypes and susceptible to frost.

At CHES, Godhra, growth parameters of wood apple recorded in different lines indicated that there were significant differences in respect of all the growth parameters viz. plant height, stock, scion diameter and plant spread. Plant height, stock, scion diameter and plant spread (EW) were maximum in line CHES 7 (6.38 m, 25.20 cm, 21.46 cm, 5.76 m and 5.16 m respectively). Fruiting and yield parameters for the year revealed significant differences between the lines. Number of fruit set per plant ranged from 7 to 139, resulting in the yield per plant of 2.74 to 45.53 kg. Highest number of fruits per plant were observed in line CHES -5 (139 no.), However yield per plant was maximum in CHES-2.The Physico-chemical characters of fruit along with TSS, acidity, reducing and total sugar, vitamin C content and composition of minerals like Ca, Mg and K were studied during the year . Data on fruit weight indicated that it varied from 193.00 g to 470.0 g with maximum in line CHES 3 (470.0 g). Smaller fruit weight (193.0 g.) was recorded in line CHES 8. Percent pulp weight per fruit was maximum in line CHES 3 (53.82 %.) and least in line CHES-8 (32.75 %). Per cent skull to fruit weight was maximum in line-7, closely followed by line-3. Maximum TSS was recorded in line -6 (15.0° Brix) and was least in line-4 (8.0° Brix).Total and reducing sugar was highest in line-8 (22.43% and 10.09%, respectively). It was least in line-7(16.89% and 4.79%, respectively). As regards mineral composition maximum Ca was observed in line-3 (0.68 %).Mg was maximum in line 4(0.72%). Per cent K was maximum in line-7 (2.14%), followed by line-2 and 3 (1.84, 1.85%).There was not much variation in Ascorbic acid content in different lines.

Sapota *(Manilkara sapota)*

Vegetative growth parameters recorded during the year indicated that cv. PKM-2 was most vigorous in respect of all the growth parameters followed by PKM-1.Least growth was recorded in DSH-2. The PKM series plants have started flowering and fruiting. Data recorded indicated that maximum number of flower clusters per shoot were recorded in cv. PKM-1 (11.75), while it was least in PKM-3, (4.75).However maximum no. of fruit set per shoot was in PKM-2 (63.25) and least in PKM-3 (18.25).Maximum no of fruits set per plant was recorded in cv.PKM-2 (780) and least in PKM-3,(81).

Mango *(Mangifera indica)*

Efforts were continued to collect the variability in mango cv. Kesar to identify superior types particularly in respect of fruit size and colour. Total five collections were planted in the field and were evaluated for growth parameters. There were significant differences in respect of plant height, stock and scion diameter of the collections.

Jamun *(Syzigium cuminii)*

Promising genotypes (26 no.) of jamun were evaluated for growth, flowering, fruiting and fruit quality attributes. Peak period of panicle emergence was recorded in the month of February. Peak period of flowering and fruit set was recorded in the month of March in all genotypes. Maximum panicle length and fruit set per panicle was recorded in GJ-2, closely followed by GJ-8. Time taken for complete development of flower bud ranged from 22-28 days in different genotypes. Peak period of ripening was recorded in the month of June. Maximum fruit yield per plant was recorded (50.00 kg) in Goma Priyanka.

Fruit weight (20.10 g),pulp weight (17.10 g), pulp percent (85.07 %) and TSS (17.00 0 Brix) was also recorded maximum in Goma Priyanka, closely followed by GJ-8 under rainfed conditions of hot semi-arid ecosystem.

Further, 40 genotypes have been evaluated for growth, flowering, fruiting and fruit quality attributes. Maximum fruit weight (18.00 g) and TSS (16.00 0 Brix) was recorded in GJ-30.

Brief characters of promising genotype of jamun

GJ-8

It was collected from Ode village of Anand district of Gujarat. Peak period of flowering was recorded in the month of March. It ripens in the second week of June and recorded 20.00 g fruit weight, pulp weight 17.00g, 85.00 % pulp, 15.70 0 Brix TSS, 0.36 % acidity, 10.70 % total sugar and 47.00 mg/100g vitamin C.

Studies on anti oxidant and protein content of jamun genotypes

Thirteen genotypes were evaluated. Maximum antioxidant value (0.65 mM TE/g) was recorded in CHESJ-8, while maximum protein content was found in CHESJ-7 (8.09 mg/g).

Tamarind *(Tamarindus indica)*

Promising genotypes (24 no.) of tamarind were evaluated for growth, flowering, fruiting and fruit quality attributes. The maximum number of fruits per panicle was recorded in Pratisthan (4.00), closely followed by Goma Prateek (3.50), Sweet Type (3.20) and T-263 (3.00).

Peak period of ripening time in majority of genotypes was March. Maximum fruit yield per plant (80.00 kg) was recorded in Goma Prateek during 11th year of orchard life under rainfed conditions of hot semi-arid ecosystem, closely followed by T-10 (45.00 kg/plant), while minimum was recorded in PKM-1 (15.00kg/plant). Goma Prateek also recorded maximum pod weight (25.20 g), pulp percent (52.00 %) and TSS (72.50oBrix). Developmental pattern and maturity standards in tamarind were studied. Separation of peel from the pulp at the time of ripening was one of easiest methods for assessment of ripening in tamarind. Further, 3 genotypes of tamarind collected from Aruppukotai, Tamil Nadu have been established in the field.

Brief characteristics of tamarind

CHEST-10

It has semi-spreading growth habit, thick trunk and drooping branches. Peak period of ripening time was first week of April. It recorded 45 kg fruit yield per plant, pulp percent (51.00 %) and TSS (71.10oBrix).

CHEST-11

It has semi-spreading growth habit, thick trunk and drooping branches. Peak period of ripening time was last week of March. It recorded 18 kg fruit yield per plant, pulp percent (53.00 %) and TSS (70.00° Brix).

Chironji *(Buchanania lanzan)*

Thirty promising genotypes of chironji were evaluated for growth, flowering, fruiting and fruit quality attributes. The average plant height ranged between 1.60m 3.45 m, plant spread i.e. N-S 1.40m 2.45 m and E-W 1.50 m -2.50m and stem girth 23.50 cm- 53.50 cm in different genotypes. The peak period of flowering and fruit set in chironji was recorded in the month of February and March respectively. Maximum panicle length (25.00cm) and fruit set per panicle was recorded in CHESC-7, closely followed by CHESC-2. After evaluation,CHES-7 and CHESC-2 were found promising.

Characteristics of Chironji (CHESC-7, CHESC-2)

CHESC-7

It has semi-spreading growth habit, thick trunk, dense foliage and drooping branches. Peak period of ripening time was May. It recorded 1.15 g fruit weight, 24.50° Brix TSS, 13.20 % total sugar and 50.00 mg/100g vitamin C, 0.15g kernel weight and 31.00 % kernel protein.

CHESC-2

It is having up right growth habit. Peak period of ripening time was May. It recorded 1.20 g fruit weight, 23.20° Brix TSS, 12.20 % total sugar and 48.00 mg/100g vitamin C. Kernel protein was recorded 32.00 %.

Mahua *(Bassis latifolia)*

Promising genotypes (30 No.) of mahua were evaluated for growth, flowering, fruiting and fruit quality attributes. The highest total soluble solids, total sugar and vitamin C content was recorded in flowers of MH-10, however juice content was found to be highest in MH-18. Maximum fruit weight (28.00 g) and seed weight (12.50 g) was found in MH-10., while MH-14 recorded 27.20 g fruit weight and 11.30 g seed weight.

Karonda *(Carisa carandus)*

Seven genotypes of karonda were evaluated for growth, flowering and fruiting under arid conditions. Flowering was observed but fruit set was very less due to poor soil moisture condition. It was observed that none of the genotypes were found tolerant to frost. The growth features of germplasm were of bushy type.

At CHES, Godhra total 40 genotypes were evaluated in karonda. Peak period of maturity of different genotypes of karonda was recorded in the month of September. Konkan Bold recorded maximum fruit weight (14.00g) and TSS (10.20° Brix) but fruit yield was 5 kg per plant only. Minimum acidity (0.40 %) was recorded in Konkan Bold during ripening. Maximum fruit yield (12.00 kg/ plant), fruit weight (5.00 g) and TSS (10.20° Brix) was recorded in CHESK-2, closely followed by CHESK-3. CHESK-1 recorded 4.90 g fruit weight, 9 kg yield/ plant . The fruit colour of CHESK-2 and CHESK-3 was recorded red and purple respectively at the time of maturity.

Fig. 3. Fruting in Karonda

Khirni *(Manilkara hexandra)*

Thirty genotypes were evaluated for flowering, fruiting and fruit quality attributes. The peak period of flowering and fruit set was recorded in the month of November-December and December-January, respectively in majority of the genotypes. Number of flowers per cluster ranged from 3.00-4.10 in different genotypes being highest in CHESK-10. Fruit set per cluster ranged from 2.50 to 4.00 being highest in CHESK-10.

Peak period of ripening was recorded from last week of April and May in all the genotypes. Maximum fruit weight (5.00 g) and TSS (25.00° Brix) was recorded in CHESK-10, closely followed by CHESK-1, CHESK-6, CHESK-11, CHESK-12 and CHESK-16.

Fig. 4. Khirni-CHESK 10

Characters of CHESK-10

It was collected from Parwadi village of Panchamahal district, Gujarat. It has spreading growth habit, thick trunk, dense foliage and drooping branches The peak period of flowering was recorded in the month of December. Fruit set per cluster was noted 4.00 It ripens in third week of May and recorded 5.00g fruit weight, 25.00° Brix TSS, 28.00mg/100 vitamin C (Fig. 4).

Moringa *(Moringa oleifera)*

Characterization of moringa germplasm

Among the 55 germplasm lines maintained and characterized during the season indicated wider variation for leaf, floral and fruiting parameters. As Moringa is a multipurpose tree, leaf characters are equally important for commercial exploitation. The primary leaflet pairs arises (pinnae) from rachis ranged from 7-10 (M17/4) with mean of 8.18, which are arranged in descending order from the base invariably in all genotypes (Fig. 5). However, the genotypic specificity was observed for number of leaflets in primary (pinne) and secondary (pinnule) leaflet pairs, as it did not show uniformity among the order of leaf pair. (Fig. 6) But in general the 2nd leaflet pair has more leaves over the other order. Similarly, the number of leaflets in a tripinnate leaf showed range from 236 to 888 with mean value of 508.

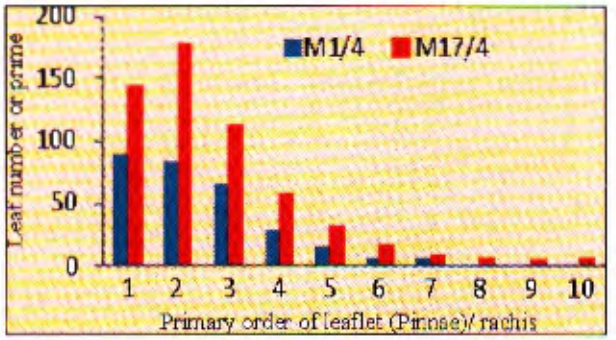


Fig. 5. Variation on leaflets in each pinnae

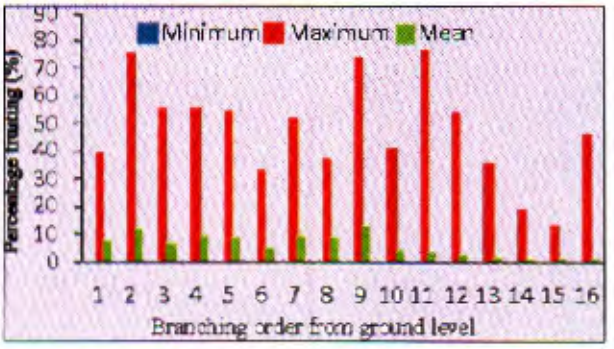


Fig. 6. Genotypic variation on brancing order wise proportion of fruiting in Moringa

Genotype specific variation was found for edible and non edible leaf portions, which revealed that the total leaf weight ranging from 6.7 to 47.5g with mean value of 19.32g in which the edible portion ranging from 3.59 to 30.8g and non edible portion ranging from 3.12 to 16.4g. Hence, genotypes have wider variation on edible proportion of leaf ranging from 48.6 (M21/2) to 68.29 (M14/15) over whole leaf. Despite of highest leaf weight in M14/1 (47.2g), the edible portion proportion was 68.29 per cent which was at par with M14/15 (65.20%) having 11.2g leaf weight. Hence specific genotype could be identified for leaf purpose (Fig. 7)

Considering the branching order wise fruiting behavior of moringa, indicated that fruiting branches observed per tree ranged from 1 to 16 (M14/9). In

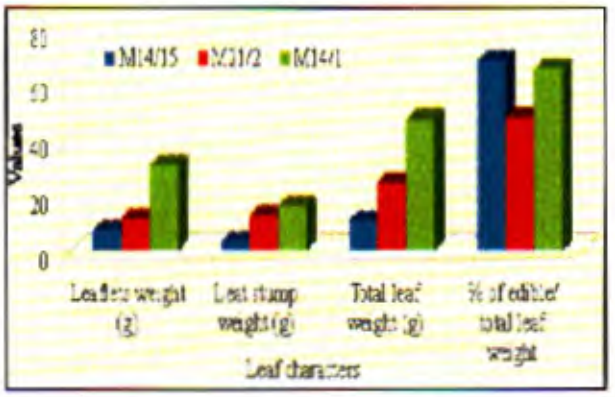


Fig. 7. Phenotype of moringa depitcs variation on edible proportion of leaf

general, the proportion of fruiting on total yield per tree was found in descending order of branching from ground level with few exceptions (M14/9), where the higher proportion of setting occurred at top order branches. Further, the fruiting was found significantly higher in alternate order branches as compared to branches in sequence. Considering the mean genotypic performance, 2nd, 9th and 11th order branches had significantly higher fruiting and thereafter gradual reduction of fruiting.

Under on farm trial, the genotype M23/3 was selected from population of PKM-1. The fruits are long with dark green colour having length of 100.0 cm shape weighing about 155g. It is medium sized tree having larger sized dark green leaves. Each plant produces about 314 fruits, weighing each at 155.3g. Fruits are long and dark green colour. Fruits mature during April May and yields highly marketable fruits in 160-180 days. It is superior in fruit size yield (185.6%) over PKM-1 (Table 2)

Vegetable

Realizing the importance of cucurbit vegetables in the arid region, the germplasm collection was started since 1994 at CIAH and a large number of

Table 2. Characterization of superior Moringa genotypes under on farm trial

Sl.No.	Characters	M23/3	M23-1	M21/2	M21/2-1	M4/2	M4/2-1
1	Branching type	Vertical branching type	Vertical branching type	Vertical branching type	Vertical branching type	Vertical branching type	Vertical branching type
2	Growth type	Medium	Medium	Medium	Medium	Medium	Medium
3	Annual growth (m)	1.753	2.504	1.706	1.502	1.702	2.1
4	Leaves	Tripinnate	Tripinnate	Tripinnate	Tripinnate	Tripinnate	Tripinnate
5	Inflorescence length (cm)	34	16	20.4	15.5	23.4	33
6	Peduncle length	20-25.3	24-26.3	15-16.3	14-15	22-26.3	27-30.6
7	Fruit length (cm)	95-100.5	65-68.3	52-53.3	60-63.2	88-90.3	73-77.1
8	Fruit girth (cm)	6	6.5	5	5.5	6	5
9	Fruit colour	Light green	Green	Light green	Light green	Dark green	Light green
10	Number of seed per fruit	20-21	17-18	18-19	15-16	18-19	17
11	Fruit type	Straight	Straight	Straight	Struight	Curling	Straight
12	Number of fruits per tree	218	214	238	128	150	446
13	Average fruit weight (g)	155.3	142.3	106.7	75	121.2	126.8
14	Yield per tree (kg)	33.85	30.45	25.3	9.6	18.18	56.5

cultivars, landraces, semi-domesticated and wild forms of mateera / watermelon (*Citrullus lanatus*), round melon (*Praecitrullus fistulosus*), kachri (*Cucumis melo* var. *callosus / agrestis*), snap melon (*Cucumis melo* var. *momordica*), muskmelon (*Cucumis melo*), kakdi (*Cucumis melo* var. *utilissimus / fluxuosus / acidulus*), bottle gourd (*Lagenaria siceraria*) and Luffa gourds were collected, evaluated and maintained for conservation and utilization in breeding programme.

Monitoring and maintenance of dessertic melons (125), non-dessertic melons (161) and gourds (60) germplasm lines of cucurbitaceous crops was done for safe conservation in gene bank (-20° C) at the institute. As per maintenance and seed enhancement work plan, snap melon (65) germplasm was taken during rainy season of 2012 and also evaluated for identification of trait specific lines under abiotic stresses and rainfed conditions. On the basis of germination and seed vigour studies, the seed storage study revealed that the snap melon germplasm can be stored for five years under ambient conditions and about 10 years under deep freeze conditions (-20° C) for utilization as active material. Sufficient quantity of seeds of 65 germplasm lines was produced under seed enhancement work during the rainy season of 2012 and deposited for safe conservation both at CIAH and NBPGR, RS, Jodhpur. This snap melon conserved material has to be regenerated after 2022 through seed enhancement for safe conservation.

Maintenance of snap melon germplasm

Snap melon, a nondessertic form of *Cucumis melo* var. *momordica* is the most popular and underexploited arid zone cucurbit vegetable. As a result of intensive surveys and explorations in arid and semi-arid regions of Rajasthan from 1994 to 2001, about 120 accessions were collected at CIAH and evaluated in phase manner as well all together in 2002 for seed enhancement and conservation. Out of them, 65 germplasm lines maintained at the institute were evaluated during rainy season of 2012 for trait specific characterization and seed enhancement for conservation (Fig. 8). A wide range of variations were recorded for days to appearance of first male flower (25.32 36.24 DAS), node number to first male flower (1.61 3.13), days to appearance of first female flower (29.82 43.45 DAS), node number to first female flower (2.63 3.81), days to first harvest (52.72 70.35 DAS), number of fruits/plant (3.47 6.52), fruit yield/ plant (0.951 5.312 kg), fruit weight (0.195 1.251 kg), fruit length (9.51 25.22 cm), fruit diameter (19.53 36.14 cm), fruit flash thickness (0.92 2.53 cm), fruit seed cavity (3.24 7.61 cm), number of seeds/fruit (287.55 705.25), weight of seeds/fruit (2.948 12.729 g), seed yield/plant (15.25 61.85 g), weight of 100 seeds (0.958 1.948 g), seed length (0.53 1.08 cm) and seed width (0.31 0.52 cm). The data on variability components are presented in table-3.

The snap melon germplasm exhibited variations for ovary length (1.51 2.72 cm), ovary diameter (0.59 1.02 cm), male flower size (1.71 3.28 cm x 2.79 4.49 cm), female flower size (2.49 3.82 cm x 2.88 4.21 cm) and leaf size (9.48 13.32 cm x 13.69 16.82 cm). The plant growth was recorded from very less to vigorous (1.75 3.25 m) with medium to

Fig. 8. Filed view of snap melon germplasm lines under evaluation

good number of branches (3.5-8.2). A wide range of variations were also observed for fruit size (very small to very large), shape (oval, round, oblong, oblong-obovate and long) and skin colour (saffron-yellow, greenish-yellow, whitish-yellow, yellowish-

green, yellowish and saffron) with or without spots (Fig. 9). Besides, the fruit quality characters such as TSS (2.2- 8.5° Brix), pulp colour and taste was also studied. The germplasm were screened for incidence of diseases and variable intensity was recorded (0.0-80.0%) under field conditions. Similarly, screening of lines against infestation of fruit fly was recorded at fruit maturity stages considering the total number of marketable fruits per plant and the infestation was from 7.5- 38.5 percent. Based on maturity, fruit size, shape, yield potentials and over all performance the snap melon germplasm lines namely AHS 6 , AHS 10, AHS 23, AHS 50, AHS 56, AHS 82, DPY 216 and DKS/AHS 2011/2 were found to be most potential for utilization in breeding programme.

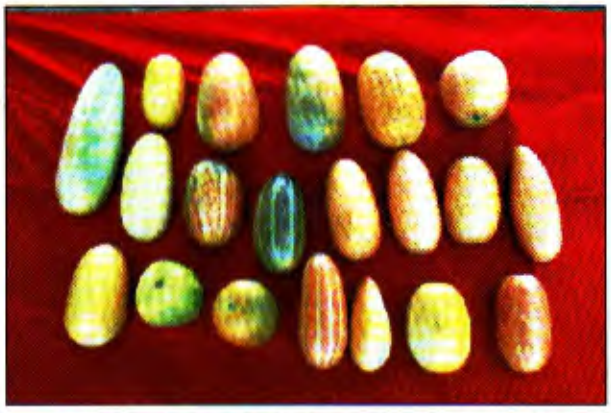


Fig. 9. Fruit variability in evaluated snap melon germplasm lines

Table 3. Genetic variability components of snap melon germplasm lines evaluated during rainy season of 2012.

Characters	Min.	Max.	Mean	CD at 5%	ECV %	GCV %	PCV %	h^2 % (broad sense)	Genetic advance	Genetic gain (5% SI)
Days to male flower (DAS)	25.32	36.24	29.25	1.38	2.92	8.52	8.69	96.23	5.04	17.23
Node to male flower	1.61	3.13	2.26	0.13	3.73	11.06	11.27	96.25	0.51	22.37
Days to female flower (DAS)	29.82	43.45	35.21	1.41	2.48	7.48	7.62	96.45	5.33	15.15
Node to female flower	2.63	3.81	3.24	0.12	2.46	7.07	7.21	96.09	0.46	14.27
Days to first harvest (DAS)	52.72	70.35	61.25	1.36	1.37	6.30	6.35	98.44	7.88	12.87
Number of fruits/plant	3.47	6.52	4.91	0.37	4.75	12.96	13.24	95.70	1.28	26.11
Fruit yield/plant (kg)	0.951	5.312	2.834	0.36	7.89	27.16	27.54	97.26	1.56	55.19
Fruit weight (kg)	0.195	1.251	0.593	0.18	19.15	27.32	29.47	85.93	0.31	52.17
Fruit length (cm)	9.51	25.22	16.97	2.38	8.68	17.02	17.74	92.02	5.71	33.64
Fruit girth (cm)	19.53	36.14	26.69	3.41	7.91	9.49	10.53	81.20	4.70	17.62
Fruit flash thickness (cm)	0.92	2.53	1.74	0.33	11.81	10.81	12.77	71.50	0.32	18.82
Fruit seed cavity (cm)	3.24	7.61	4.93	0.66	8.36	11.48	12.45	84.97	1.07	21.81
Number of seeds/fruit	287.55	705.25	504.33	28.73	3.52	20.04	20.14	98.98	207.15	41.07
Weight of seeds/fruit (g)	2.948	12.729	6.844	0.43	3.92	26.71	26.81	99.29	3.75	54.83
Seed yield/ plant (g)	15.25	61.85	34.32	0.52	0.95	27.22	27.23	99.96	19.25	56.07
Weight of 100 seeds (g)	0.958	1.948	1.397	0.05	2.57	14.11	14.18	98.90	0.40	28.90
Seed length (cm)	0.53	1.08	0.77	0.16	13.38	8.89	11.78	56.97	0.11	13.83
Seed width (cm)	0.31	0.52	0.37	0.09	14.98	3.97	9.52	17.39	0.01	3.41

Evaluation of bottle gourd genotypes

During the summer season of 2012, eight bottle gourd genotypes were studied for their performance as AVTI of AICRP (VC) trial under high temperature conditions of arid agro-climate. The high temperature and dry conditions during peak summers in the months of May and June affected the fruit quality and yield potential drastically in all long fruited eight new entries (Table 4). The genotype took 75-95 days for harvesting of first marketable fruits and recorded low yield potential (62- 124 q/ha). A very high number of fruits in all the entries were of non-marketable quality due to deformed shape at early growth stages of fruit development and this might be due to extremeness of high temperature and aridity conditions. This exhibited that the genotypes from favourable agro-climate failed to express their potentiality under hot arid conditions and thus, this indicated the susceptibility of genotypes towards abiotic stresses of arid region.

Conservation of arid vegetable germplasm

Landraces and local cultivars are source of genes for stresses, adaptability, quality and yield. The systematic collection of vegetable germplasm was started since 1994 at CIAH, Bikaner under mission mode and institutional programmes. During last one and half decade (1994 to 2008), several crop specific and multi-crop explorations were made for survey and collection of vegetable germplasm from parts of arid, semi-arid and tribal areas of Rajasthan and Gujarat. Besides, augmentation of germplasm from national net-work was also taken up at CIAH. A data base has been developed for compilation of work on genetic resource management in arid vegetables at the institute and up to 2008, a total 1725 germplasm accessions were collected and evaluated and of them 1059 has been deposited in NGB at NBPGR for long term conservation. Presently, 500 lines of potential vegetables are being maintained as active germplasm at CIAH, Bikaner. These comprised of mateera (65), kachri (68), snap melon (65), muskmelon (60), round melon (10), kakdi (18), bottle gourd (20), ridge gourd (20), sponge gourd (15), bitter gourd (4), chillies (45), brinjal (30), tomato (14), khejri (14), India bean (30), sword bean (01), cluster bean (02) and other (15) vegetables.

Germplasm monitoring for maintenance and exchange

During 2012-13, the monitoring of conserved germplasm (-20° C deep freeze conditions) was done periodically and it is observed that the

Table 4. Growth and yield component characters of bottle gourd lines during summer season of 2012.

Entries	Days to first harvest (DAS)	Fruit weight at marketable stage (g)	Fruit length at marketable stage (cm)	Fruit diameter at marketable stage (cm)	Fruit yield (q/ha)	Fruit shape
10/BOGVAR-1	93.3	396.3	23.6	5.5	62.37	Necked, crooked
10/BOGVAR-2	75.2	440.4	20.7	6.3	79.45	Necked, crooked
10/BOGVAR-3	84.4	388.1	15.5	6.4	62.72	Necked, crooked
10/BOGVAR-4	95.1	538.2	25.3	6.6	70.07	Necked, crooked
10/BOGVAR-5	87.3	351.8	17.4	6.1	70.21	Necked, crooked
NDBG-104 (C)	76.2	461.2	25.2	6.4	124.53	Necked
Pusa Naveen (C)	77.3	356.6	16.4	6.3	77.77	Crooked
Pusa Samridhi (C)	77.4	449.5	20.7	6.6	93.03	Crooked

germplasm of mateera, Indian bean, cowpea and methi lines needs regeneration for safe maintenance and seed enhancement between 2014-2015. During the period under report, potential breeding lines/ varieties (>35) of arid zone vegetable crops such as kachri, snap melon, mateera, bottle gourd, brinjal, Moringa, cluster bean and beans were supplied to national institutes, SAU's and state agencies covering the states such as Karnataka, Gujarat, Maharashtra, Odisha, Uttar Pradesh, Tamil Nadu and Rajasthan for performance studies as new crop varieties or use in breeding programmes as genes for drought hardiness and tolerance to high temperature conditions.

Watermelon

During 2012 a total of 20 genotypes of watermelon were evaluated, maintained and characterized for different morphological traits. Among the genotypes, significant variation was observed for days to first female flower (37.13-58.73), fruit diameter (13.73-22.32cm), fruit weight (2.19-5.70kg), marketable fruits/ plant (2.13-3.27), rind thickness (0.50-2.70cm), TSS (6.00-12.40%) and flesh hardness (110.20-718.42g/cm^2). Wide variation in morphological traits was also observed for leaf shape (non-lobed, pentalobate), sex form (monoecious, andromonoecious), ovary shape (long, oval), fruit shape (round, oblong, oval, elliptical), rind colour (green, grey, yellow), rind pattern (stripped, non-stripped, solid) and flesh colour (red, yellow) (Table 5).

Selection of superior lines

Among red fleshed genotypes of watermelon, AHW/BR-16 was found to be promising and selected for further evaluation. This line produced round fruits with fruit weight (3.15-4.0kg), fruit diameter (17.8-20.1cm), rind thickness (1.0-1.5cm), TSS (10.8-12.0%) and flesh hardness (321-434g/ cm2). Fruits harvested in 72.27-76.53 days after sowing and produced 3.60-4.00 fruits/ plant free from cracking (Fig. 10).

Table 5. Variability among watermelon genotypes

Characters	Range	Mean
Inter-nodal length (cm)	6.59-13.20	9.07
Days to 1st female flower	37.13-58.73	50.38
Node on which 1st female flower appeared	4.93-28.00	8.76
Days to 1st fruit harvest	67.20-84.53	80.63
Fruit diameter (cm)	13.73-22.32	18.05
Fruit weight (kg)	2.19-5.70	3.08
Marketable fruits/ plant	2.13-3.27	2.76
Marketable fruit yield/ plant (kg)	6.38-12.54	8.48
TSS (%)	6.00-12.40	10.50
pH of fruit juice	4.88-5.41	5.12
Flesh hardness (g/cm^2)	110.20-718.42	511.63
Rind thickness (cm)	0.50-2.70	1.30
100 seed weight (g)	3.77-10.44	6.78

Fig. 10. Fruit of AHW/BR-16

Muskmelon

Assessment of genetic variability

Twenty genotypes of muskmelon were studied during 2012 for genetic variability, heritability and genetic advance and the analysis of variance showed sufficient variability for all the characters studied. The heritability estimates in broad sense were higher for rind thickness (67.49), TSS (65.15) and marketable fruits/ plant (59.11) along with high genetic advance 55.98, 18.32 and 40.68 per cent, respectively (Table 6).

Table 6. Variability and genetic parameters in muskmelon

Characters	Mean	Range	GCV (%)	PCV (%)	h^2 (%)	Genetic advance (GA)
Days to 1st female flower	45.13	39.87-50.20	5.01	10.13	24.50	2.31
Days to 1st fruit harvest	76.19	68.40-80.67	3.14	5.33	34.73	2.90
Fruit diameter (cm)	10.93	8.90-14.69	10.43	15.94	42.82	1.54
Width of seed cavity (cm)	6.04	4.69-7.21	8.28	17.42	22.61	0.49
Flesh thickness (cm)	2.56	1.54-3.39	16.28	23.62	47.50	0.59
Rind thickness (cm)	0.20	0.12-0.41	33.08	40.26	67.49	0.11
100 seed weight	3.02	1.61-4.03	22.28	22.46	98.42	1.37
TSS (%)	11.45	9.56-13.90	10.02	13.65	65.15	2.10
Flesh pH	5.95	4.64-6.57	7.90	7.98	97.91	0.96
Marketable fruits/ plant	3.49	3.00-4.20	8.07	13.41	36.26	0.35
Fruit weight (kg)	0.76	0.36-1.22	22.58	31.07	52.82	0.26
Marketable fruit yield/ plant (kg)	2.67	1.20-3.90	25.69	33.41	59.11	1.08

Identification of monoecious line

Among the evaluated genotypes of muskmelon, a monoecious land race (AHMM/BR-8) was identified from the available genetic stock. Single plant selection was exercised based on earliness, fruit size, flesh colour and TSS. Plants of this line produced round fruits with salmon orange coloured flesh of 3.2-4.0cm thickness, 10.8-11.3% TSS and 478-570g/cm^2 hardness. Plants started to produce female flowers in 45-48 days after sowing. The number of fruits/ plant was found to be 3.47-4.27 weighing 0.8-1.10 kg which developed full slip at ripening. The presence of stable monoecious sex form in this line could be utilized in F1 hybrid seed production of muskmelon.

Sponge gourd

Enhancement, maintenance and evaluation

During the year 2012 collected 16 genotypes and evaluated in rainy season for horticulturally desirable traits and maintained the seed of all lines. The evaluated genotypes showed variability for days to first flower (41.33-53.20), days to first harvesting (50.53-64.87), ovary length (1.4-4.0cm), fruit length (14.30-31.39cm), fruit diameter (2.12-4.10cm), fruit weight (69.25-190.54g), number of marketable fruits/ plant (22.8-37.2). The maximum number of marketable fruits/ plant (37.2) was recorded in AHSG-28.

Crop Improvement

Vegetable

Bikaner

Round melon

Breeding for high temperature tolerance and fruit quality

Round melon commonly known as tinda is potential arid zone cucurbits. In general, dark-green

and whitish-green colour fruit type landraces are found growing in traditional cropping of arid region as rainfed crop. The tender fruit quality of dark green colour type (popularly known as Bikaneri Green) is very poor but it is adapted to drought and abiotic stresses including high temperature conditions (44^0 C) of arid region. The tender fruit quality of whitish-green colour type is good for vegetable use but it is highly susceptible to high temperature (40-42^0 C) and abiotic stresses, in addition, the plants exhibited slow initial growth, susceptible to mites, viral diseases and high level of fruit fly infestation. Therefore, systematic breeding work was initiated at CIAH. During the summer season of 2012, sixteen advanced round melon progenies (F3 generation) developed through hybridization between the lines of AHRM-1 and AHRM-2 were evaluated for growth, flowering and fruiting behaviour, fruit and seed characters. A good amount of variations were recorded in the developed progenies (Table 7) and potential individuals were identified for advancement of generation and further selection breeding for better fruit quality and marketable yield under abiotic and high temperature conditions. In F3 generation, the progenies namely AHRM - 2b x AHRM - 1b, AHRM - 2a x AHRM - 1a and AHRM - 1a x AHRM - 2a exhibited maximum variations for fruit and other desirable characters and presented in picture forms.

A wide range of variations were recorded for leaf characters such as size, lobbing pattern and colour. Most of progenies exhibited variable leaf size (length 10.7- 11.3 cm, width 11.3-14.3 cm and total number of lobs (6.2 9.1). The length of leaf stalk was ranged between 10.8-13.2 cm (Fig. 11 (a-d)). Two individual plants from a progeny (AHRM - 2b x AHRM - 1b) recorded non-lobbed leaves (length 10.2 cm and width 14.9 cm) with leaf stalk length (9.75 cm). The progenies were studied for heat tolerance and potential individuals were identified based on field performance for advancement of generation. Most of the progenies recorded high range of fruit fly incidence and susceptibility to high temperature conditions (above 42^0 C). Seeds of selfed fruits of identified progenies were harvested for advancement of generation.

Table 7. Performance of F_3 progenies of round melon during summer season of 2012

Characters	Range
Days to appearance of first male flower (DAS)	42.2 – 59.5
Node number to first male flower	1.6 – 2.8
Days to appearance of first female flower (DAS)	47.5 – 69.2
Node number to first female flower	2.6 – 3.6
Days to first harvest, tender fruits (DAS)	54.5 – 76.2
Mature fruit weight (g)	117.2 – 719.6
Mature fruit length (cm)	4.8 – 8.9
Mature fruit girth (cm)	22.5 – 38.5
Number of seeds/fruit	82.5 – 353.5
Mature fruit shape	Flat, round, oblong
Mature fruit colour	Whitish-green, green, dark-green
Leaf size and lobbing pattern	Small to very large and non lobbed, less to highly lobbed

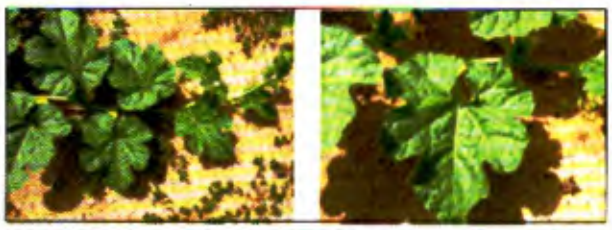


Fig. 11a. Large sized multi lobbed leaves observed in breeding line of round melon.

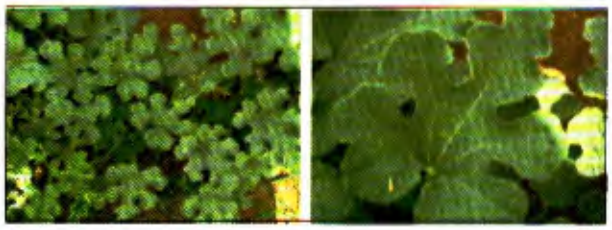


Fig. 11c. Small sized multi-lobbed leaves observed in breeding lines of round melon

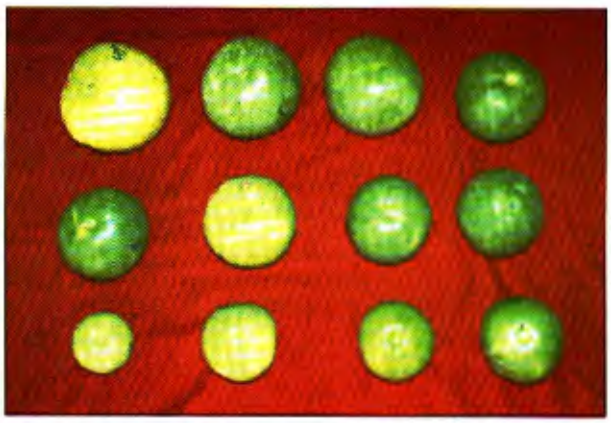


Fig. 11d. Variations recorded for fruit size, shape and colour from breeding lines of round melon (F_3 generation) during summer season of 2012

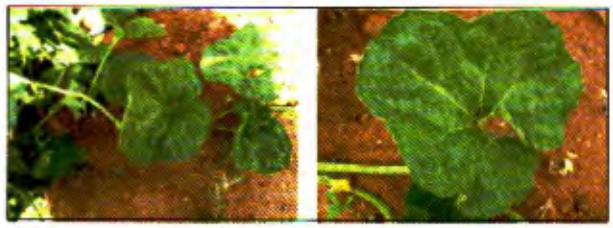


Fig. 11b. Big size non-lobbed leaves observed in individuals of breeding lines of round melon.

Bottle gourd

Breeding for high temperature tolerance and marketable yield in long fruited bottle gourd

During the rainy-winter season of 2012, twelve long fruited advanced progenies developed at the institute were evaluated for growth, flowering, fruit set, fruit quality and yield component characters. Detailed observations were recorded to screen the material under high temperature and abiotic stresses, and also advancement of generation. The performance of progenies of cross combination of AHLS24 x BOGVAR3 is given in Table 8. The phenological characters of bottle gourd progenies (F4) exhibited variations such as length of male flower stalk (13.92-17.23 cm), male flower size (3.12-4.89 cm x 4.31 6.23 cm), length of female flower stalk (3.67-6.92 cm), female flower size (2.11-2.92 cm x 3.76-5.78 cm), ovary length (2.98 - 4.32 cm), ovary girth (3.78-4.87 cm), leaf petiole length (12.69-15.32 cm) and leaf size (13.51-17.43 cm x 18.12- 22.88 cm).

A wide range of variations were observed in bottle gourd progenies for days to appearance of first male flower (48.2-55.3 DAS), node number to first male flower (2.7-3.3), days to appearance of first female flower (55.1-62.1 DAS), node number to first female flower (3.4-4.3), days to first harvest (61.3 -71.3 DAS), fruit weight (353-697 g), fruit

Table 8. Performance of bottle gourd progenies (F_4) during rainy-winter season of 2012.

Characters	Range
Days to appearance of first male flower (DAS)	48.2 – 55.3
Node number to first male flower	2.7 – 3.3
Days to appearance of first female flower (DAS)	55.1 – 62.1
Node number to first female flower	3.4 – 4.3
Days to first harvest (DAS)	61.3 – 71.3
Fruit weight at marketable stage (g)	353 – 697
Fruit length at marketable stage (cm)	19.1 – 29.2
Fruit diameter at marketable stage (cm)	5.5 – 8.1

length (19.1-29.2 cm) and fruit diameter (5.5-8.1 cm) at marketable stages. The variations were also recorded for fruit colour (greenish and whitish green) and fruit shape (necked, crooked, straight). The line F4-9 produces straight and better quality fruit yield whereas the line F_4-7 and F_4-12 were high yielding.

Mateera

Breeding for high seed content in mateera

To assess the uniformity and stability of the developed breeding material, the advanced progenies of mateera AHW RSS1 was tested during summer season of 2012. The mateera line AHW RSS-1 was found to be uniform and purified for higher seed yield. On pooled basis, it took about 80 days from sowing for first fruit harvesting. The number of seeds in a fruit ranged from 950 to 1120 with average seed yield of 295 to 335 g/plant under varying situations over the seasons.

Muskmelon

Breeding for high temperature tolerance and fruit quality

As a result of evaluation of 115 genotypes of muskmelon under high temperature conditions of arid region over the period (1997-2008) at CIAH, Bikaner, some potential lines were identified for use in breeding programme and purification work is still in progress (Table 9). During the summer season of 2012, twelve advanced progenies were tested for growth and fruit characters, and screening under abiotic stresses and high temperature conditions. The purification and advancement of breeding lines in muskmelon at CIAH, Bikaner from 2007 to 2012 resulted to stabilization of CIAH-1 for uniform and better quality fruit yield potential under hot arid agro-climate (Fig. 12). The developed genotype CIAH-1 is early in maturing and took 85 - 90 days from sowing for first harvesting. It is high yielding and marketable fruit yield potential ranged from 2.75-4.35 kg/plant over the seasons.

Table 9. Performance of advanced muskmelon progenies during summer season of 2012

Characters	Range
Days to appearance of first male flower (DAS)	42.5 – 44.2
Node number to first male flower	2.2 – 3.2
Days to appearance of first female flower (DAS)	52.4 – 58.3
Node number to first female flower	3.1 – 3.8
Days to first harvest (DAS)	82.5 – 90.1
Number of fruits/plant	0.650 – 6.55
Fruit weight (kg)	0.547 – 1.189
Fruit length (cm)	8.95 – 14.55
Fruit girth (cm)	31.7 – 45.5
Flesh thickness (cm)	2.4 – 3.6
Seed cavity (cm)	4.4 – 7.2
TSS (%)	6.2 – 11.4
Fruit shape	Oval, round, flat-round, oblong and long
Flesh colour	Light-orange, orange , greenish

Fig. 12. Fruits of muskmelon genotype CIAH-1 in bearing

Brinjal

Screening of brinjal lines for biotic and abiotic stresses and evaluation for performance studies

On the basis of evaluation, selection and advancement for five generations, seven elite lines were found promising and these were studied during summer season of 2012 for growth and fruit yield performance. These lines having different fruit shape, size, colour, harvesting period, level of fruit and shoot borer (FSB) infestation and yield potential and are CIAH-1, CIAH-2, CIAH-12, CIAH-16, CIAH-21, CIAH-22 and CIAH-67. These were selected based on earliness, reduced infestation of FSB, high marketable yield and consistent fruit quality under high temperature conditions. No infestation of FSB was observed under spring-summer season, however loss of lusture in fruits was observed during month of June in CIAH-2, CIAH-22 and CIAH-67. All the lines were homogenous and did not show any segregation for major morphological traits. During the rainy-winter season of 2012-13, the brinjal line CIAH-22 was tested under replication for large scale testing.

Performance of brinjal genotype CIAH-22

As a result of intensive germplasm evaluation and selection breeding at CIAH, a high yielding brinjal genotype CIAH-22 has been developed from original germplasm line AHB-03. After four successive cycles of selfing, selections and advancement for better plant structure, fruit shape, fruit set and yield under high temperature conditions, it was uniform and stable during testing seasons of 2012. Plants are semi-erect and medium stature in growth. First flowering and harvesting starts 32.3 and 51.2 days after transplanting, respectively. Medium sized (50-60 g) fruits are bluish purple in colour having soft textured flesh of better cooking quality. On an average, a plant bears 60-80 fruits in a season with a yield potential of about 3.65 kg over the varying environment and seasons under hot arid agro-climate.

Fig. 13. Flower leaf and fruits of brinjal genotype CIAH-22

Tomato

Breeding for high quality tomato yield under hot arid environment

During spring-summer season of 2012, fifteen

advanced breeding lines of tomato (developed through mutation breeding) were evaluated for uniformity, stability, quality and yield characters under high temperature conditions. Out of 15 breeding lines, six lines exhibited uniformity for desired characters and a bulk material was developed and named as AHSL 1 for large scale testing. During rainy-winter season of 2012 -13, F2 progenies (AHSL-1 x Himshikhar) was evaluated for growth, flowering and fruit set, maturity, fruit quality and yield component characters. A good number of individuals were identified for the desirable traits and seed was collected for the advancement of generation.

Indian bean

Varietal trial of Indian bean

During the rainywinter season of 2012-13, two varietal trials (AVT-II) of Indian bean (pole and bush type) were conducted under AICRP on vegetable crops at CIAH, Bikaner (Table 10-13). Among ten entries of pole type, two were from CIAH such as AHDB03 (Thar Maghi) and AHDB16 (Thar Kartiki) and were tested alongwith checks (Pusa Early Prolific and Swarna Utkrist). During the crop period, the minimum low temperature dips down below 2^0 C in last week of December 2012 at the experimental site of the farm and at the same time the mild frost conditions resulted to a high level of damages in flower, tender pods and plants. Therefore, the data on experimental trial up to 31 December 2012 harvest were compiled for the presentation. Among the pole type, very low pod harvest was recorded in most of the entries due to late maturing group where first pod harvesting started from second or third week of December 2012. The early maturing entries (second or third week of October to first week of November) recorded good pod harvest till the onset of low temperature and frost injuries. The institute varieties 'Thar Maghi' and 'Thar Kartiki' recorded the superiority for pod yield 103.15 q/ha and 103.46 q/ha, respectively under extremes of arid environmental conditions.

Table 10. Performance of pole type Indian bean genotypes during rainy-winter season of 2012-13

Variety	Days to flower (DAS)	Days to first harvest (DAS)	Pod length at tender (cm)	Pod width at tender (cm)	Tender pod weight (g)	Pod yield (q/ha)
10/ DOLPVAR - 1	83.4	107.1	11.88	3.01	11.67	83.98
10/ DOLPVAR - 2	109.9	134.7	7.87	1.92	5.32	19.47
10/ DOLPVAR - 3	105.5	129.5	8.31	2.15	4.74	23.69
10/ DOLPVAR - 4	108.1	131.6	14.32	1.48	7.85	19.44
10/ DOLPVAR - 5	85.1	108.8	14.31	1.42	9.04	90.16
10/ DOLPVAR - 6	88.2	113.5	14.27	1.27	8.30	103.15
10/ DOLPVAR - 7	113.3	142.3	12.81	2.42	9.86	15.75
10/ DOLPVAR - 8	113.6	136.4	8.84	1.61	6.12	30.74
10/ DOLPVAR - 9	74.9	87.7	10.11	1.64	5.12	103.46
10/ DOLPVAR – 10	126.7	144.4	14.84	3.06	11.63	0.93
Swarna Utkrist (C)	117.7	140.1	10.89	1.94	5.65	19.34
Pusa Early Prolific (C)	79.3	95.3	9.85	1.25	4.47	32.31

Eight bush type entries including Arka Jay (check) were evaluated under arid environment. The overall crop performance and pod quality of entries were found to be poor and not acceptable by the consumers. During the crop period of 2012-13, the performance of bush type varieties was affected due to high temperature conditions even as rainy season crop resulted to low pod setting in early flowering varieties. The bush type entries depicted low temperature injury (<5°C) observed from fourth week of December, 2012 and more low temperature injury was recorded from last week of December at the production site. Therefore, the data on experimental trial up to December, 2012 were compiled.

Table 11. Seed characters of pole type Indian bean genotypes.

Variety	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	Weight of 100 seeds (g)	Seed colour
10/ DOLPVAR - 1	1.32	0.82	0.58	27.33	Brownish
10/ DOLPVAR – 2	1.16	0.88	0.61	27.17	Creamy
10/ DOLPVAR – 3	1.16	0.81	0.64	24.40	Creamy
10/ DOLPVAR – 4	1.32	0.98	0.66	36.30	Dark brown
10/ DOLPVAR – 5	1.36	0.94	0.59	33.67	Blackish
10/ DOLPVAR - 6	1.32	0.88	0.76	54.60	Brownish mottled
10/ DOLPVAR – 7	1.34	0.98	0.64	52.43	Blackish
10/ DOLPVAR – 8	1.02	0.82	0.56	26.10	Dark brown
10/ DOLPVAR – 9	1.16	0.83	0.62	37.73	Creamy
10/ DOLPVAR - 10	1.21	0.92	0.66	37.19	Dark brown
Swarna Utkrist (C)	1.08	0.76	0.61	23.42	Brownish
Pusa Early Prolific (C)	1.22	0.72	0.64	36.21	Dark brown

Table 12. Performance of bush type Indian bean genotypes during rainy-winter season of 2012-13

Variety	Days to flower (DAS)	Days to first harvest (DAS)	Pod length at tender (cm)	Pod width at tender (cm)	Tender pod weight (g)	Pod yield (q/ha)
10/ DOLBVAR - 1	40.3	78.8	10.02	1.39	3.23	38.91
10/ DOLBVAR - 2	44.3	90.4	6.22	1.69	2.17	36.65
10/ DOLBVAR - 3	55.1	81.5	8.55	1.28	2.99	54.67
10/ DOLBVAR - 4	76.4	89.3	6.68	1.57	1.81	52.48
10/ DOLBVAR - 5	70.6	92.3	12.64	1.07	3.31	28.12
10/ DOLBVAR - 6	109.6	122.9	10.96	1.38	4.82	18.84
10/ DOLBVAR - 7	105.9	121.8	9.21	1.47	3.66	19.01
Arka Jay (Check)	65.4	82.8	9.31	1.33	3.39	22.87

Table 13. Seed characters of bush type Indian bean genotypes

Variety	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	Weight of 100 seeds (g)	Seed colour
10/ DOLBVAR - 1	0.94	0.74	0.51	25.86	Dark brown
10/ DOLBVAR - 2	0.79	0.71	0.46	12.32	Light orange
10/ DOLBVAR - 3	1.12	0.74	0.56	22.23	Brownish
10/ DOLBVAR - 4	0.86	0.69	0.46	24.33	Dark orange
10/ DOLBVAR - 5	1.18	0.72	0.56	23.33	Creamy
10/ DOLBVAR - 6	1.21	0.84	0.64	40.53	Dark brown
10/ DOLBVAR - 7	0.96	0.78	0.54	16.36	Dark brown
Arka Jay (Check)	0.96	0.74	0.56	12.93	Dark orange

Khejri

Characterization of khejri genotypes

Fourteen elite genotypes maintained clonally in khejri germplasm plot for *ex situ* conservation. These fourteen genotypes alongwith three additional types were characterized over the seasons from the year 2009 to 2012 for generation of information of khejri for horticultural exploitation and summarized range values of the characters are presented in Table 14 & Fig. 14&15. For harvesting of both products (sangri and loong) annually from the plantations these were also studied in response to crop regulation by pruning the trees in the month of June. The khejri variety Thar Shobha out yielded for tender pod, loong and total bio-mass production. The variety Thar Shobha was also characterized for growth, flowering, pod set, pod quality and yield components under the varying situations of production to assess the performance over the years.

Fig. 14. Variations recorded in ripen pods of characterized khejri genotypes

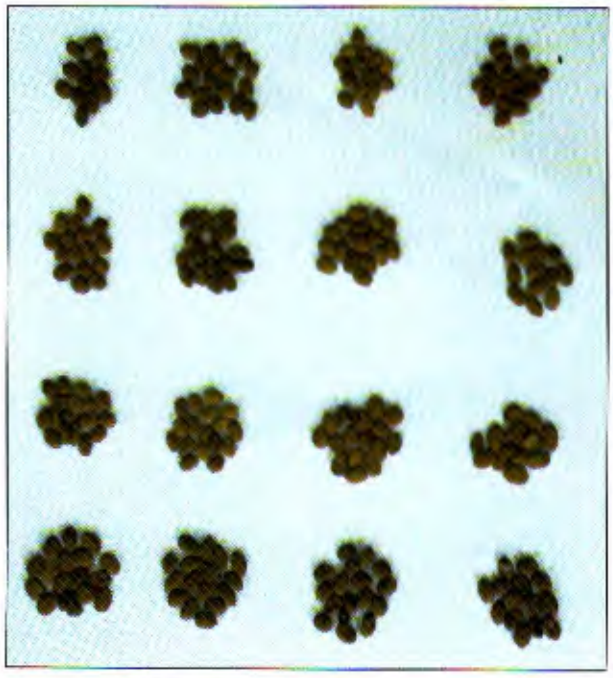


Fig. 15. Seed variations in characterized khejri genotype

Table 14. Characterization of horticultural potential khejri genotypes over the years (2009 to 2012) under varying situations at CIAH, Bikaner.

Characters	Range
Leaf length (cm)	0.9 – 2.6
Leaf width (cm)	0.29 – 0.86
Number of leaflets/ pinnae	12.5 – 30.2
Length of pinnae (cm)	2.9 – 11.3
Number of pinnae/ composite leaflet	2.1 – 6.2
Number of leaflets/ composite leaflet	26.4 – 139.8
Inter nodal length between composite leaflets (cm)	2.1 – 5.3
Length of floral spike (cm)	5.5 – 21.8
Number of buds/floral spike	45.5 – 142.4
Number of open flowers/spike	15.7 – 78.1
Number of floral spikes/cluster	2.2 – 10.6
Number of clusters/panicle	2.1 – 6.4
Number of tender pods/spike	2.2 – 6.8
Number of tender pods/panicle	6.6 – 54.5
Tender pod length for sangri (cm)	9.8 – 25.3
Tender pod width for sangri (cm)	0.21 – 0.52
Tender pod weight for sangri (g)	1.073 – 3.405
Tender pod colour for sangri	LG, G, DG
Tender pod type	S, W; R, RF, F
Number of mature pods/spike	1.9 – 6.9
Number of mature pods/panicle	6.5 – 55.2
Mature pod length of khokha (cm)	13.5 – 30.2
Mature pod width of khokha (cm)	0.28 – 0.65
Mature pod weight of khokha (g)	1.268 – 3.253
Mature pod colour of khokha	Y, YB, C, CB, B
Mature pod type	S, W; R, RF, F
Number of seeds/pod	11.8 – 19.8
Weight of seeds/pod (g)	0.421 – 0.948
Weight of pulp/pod (g)	0.697 – 2.182
Mature seed length (cm)	0.49 – 0.92
Mature seed width (cm)	0.35 – 0.63
Mature seed thickness (cm)	0.16 – 0.32
Weight of 100 seeds (g)	4.394 – 6.662
Seed colour	LB, B, GB
Seed size	M, L

*Where = LG – light-green, G – green, DG – dark-green, Y – yellowish, YB – yellowish-brown, C – creamish, CB – creamish-brown, B – brown ; S – straight, W – wrinkle; R – round, RF – roundish-flat, F – flat; LB – light-brown, B – brown, GB – greenish-brown; M – medium and L – large.

Ridge gourd

Enhance maintenance and evaluation

Collected 04 new genotypes of ridgegourd from Baran and Sikar districts of Rajasthan. Evaluated 20 genotypes during summer season of 2012 for vegetative growth, yield and yield related traits. The seed of all the lines were maintained through inbreeding for further utilization. The analysis of variance showed highly significant mean sum of square estimates for all traits under study which indicate a wide range of variability.

Characterization of genotypes

Characterized 06 genotypes for growth, flowering and yield traits and observed significant differences among ridge gourd genotypes for fruit length, fruit diameter, days to first fruit harvest, marketable fruits/ plant, fruit weight and marketable yield/ plant (Table 15). The average fruit length was maximum in AHRG-27 (27.26cm) which had significant difference over all genotypes. The genotype AHRG-29 was the earliest in terms of harvesting which took 51.85 days for first fruit harvest from sowing. The maximum marketable fruit yield/ plant was observed in AHRG-29 (2.13kg) followed by AHRG-41 (2.00kg).

Selection of promising genotypes

The genotypes best performed during 2011-12 were again evaluated and based on over all phenotypic performance selected two superior genotypes viz., AHRG-29 and AHRG-41. Both the lines were found to set fruit at high temperature during May-June. AHRG 29, a selection from a land race was found to be promising in respect of days to first female flower (46.40-52.27), number of fruits per plant (16.40-20.13), fruit length (20.80-24.10 cm), fruit diameter (2.91-3.52 cm), fruit weight (94.62-115.20 g) and fibre content on dry weight basis (25.1-25.8 %).

Fig. 16. AHRG 29-1

Table 15. Analysis of variance for yield and yield related traits in ridge gourd

Characters	Mean	Range	GCV (%)	PCV (%)	h^2 (%)	Genetic advance (GA)
No. of branches/ plant	4.53	3.47-6.33	12.88	21.86	34.71	0.71
Vine length (m)	3.50	2.16-4.69	15.05	20.87	51.98	0.78
Internodal length (cm)	14.08	6.47-16.85	15.08	21.13	50.91	3.12
Days to 1st female flower	48.60	42.27-53.60	4.85	8.78	30.56	2.69
Node at which 1st female flower appeared	14.59	2.93-20.27	29.40	32.29	82.91	8.04
Ovary length (cm)	4.92	1.53-8.27	22.20	29.04	58.43	1.72
Fruit length (cm)	20.85	3.67-26.93	22.74	24.88	83.60	8.93
Fruit diameter (cm)	4.70	3.47-7.10	21.67	26.13	68.78	1.74
Days to 1st fruit harvest	54.60	48.27-61.13	5.00	8.03	38.81	3.51
Marketable fruits/ plant	21.40	16.67-42.80	25.48	28.12	82.05	10.17
Fruit weight (g)	84.16	18.25-112.16	23.28	24.67	89.09	38.12
Marketable fruit yield/ plant (kg)	1.72	0.77-2.21	19.94	24.76	64.86	0.57

At CHES, Godhra

Brinjal

Evaluation of brinjal collections

During this year, 62 germplasm lines of brinjal were evaluated for yield and quality. The germplasm lines are both erect, spreading and semi spreading types with very larger and very smaller leaf size. The plant height ranges from 50 to100.7 cm with mean value of 73.47cm. The flowers are found in purple to white in colours as that of fruits, purple, white, green in round and long types. The highest fruits per plant were observed in B-6-11(53 fruits). The fruit weight ranging from 40g to 435g was observed with mean value of 110g. The plant yield potential was found ranging 560g to 7.45kg (Baina-1-2).

Under this condition, there are two promising selection (B-6-12-1-3 and Baina-1-2) were made from B-6-12 and Baina collection). Baina-1-2 is a vigorous plant having dense foliage with larger leaf size. Plant produces 7-8 white flowers in a cluster against their parent, which produced 5-6 purple flowers in each cluster. The immature fruits are milky white in colour and turns green strips with white back ground. Each plant produces 49 long fruits weighing 158g each. The yield potential is about 7.45kg. It withstands moisture stress (Table 16).

Table 16. Characterization of superior genotypes of brinjal for yield under semiarid condition

Sl. No	Parameters	B6-12	B-6-12-1-3	BAINA-1-1	BAINA-1-2	CIAH round
1	Plant growth type	Erect	Erect	Erect	Erect	Semi spread
2	Plant height (cm)	70.10	76.5	76.60	100.70	54.20
3	Plant spread (E-W)	97.00	108.50	80.10	90.20	67.20
4	Plant spread (N-S)	94.20	100.30	110.20	125.60	78.30
5	Days to flowering (DAS)	90	86	98	93	79
6	No of primary branches per plant	12.00	10.00	7.00	12.00	11
7	Days to first harvest (DAS)	112	106	114	105	101
8	Fruit colour (immature)	Green	Green	White	White	Deep purple
9	Fruit color(matured stage)	Green	Green	Green strips at blossom end	Green strips at blossom end	Deep purple
10	Fruit shape	Round	Obovate	Long	Oblong	Round
11	No.of fruits per plant	14	13	42	49	19
12	Peduncle length (cm)	5.00	7.30	8.00	6.70	3.30
13	Fruit length (cm)	15.00	21.00	16.00	22.00	8.50
14	Fruit girth(cm)	34.00	35.50	10.00	10.20	16.20
15	Fruit sape index	0.44	0.59	1.60	2.16	0.50
16	Fruit shape	Round	Obovate	Long	Oblong	Round
17	Average fruit weight (kg)	0.302	0.436	0.071	0.152	0.065
18	Average yield per plant (kg)	4.23	5.67	2.99	7.45	1.237
19	Per cent yield increment over parent (%)	-	134.0%	-	249.1%	

A selection (B-6-12-1-3) was made from B-6-12, which is highly vigorous plant with larger leaf size. Plants produces 4-5 purple color flowers per cluster. Each plant produces 13 long fruits with uniformly green colour, weighing 436g each. The yield potential of the plant is 5.67kg, whereas, selection B-6-12-1 is an attractive purple colored oblong fruit type each fruit weighing about 380-400g with yield potential of 5.38kg.

Under MLT, CIAH round was tested under Gujarat condition, which was found to be the earliest genotype. Plants are less vigorous and semi spreading type, having purplish green leaves with smaller leaf size. Plants produce small round deep purple fruits weighing each 65g. Each plant yields is 1.237kg.

Breeding for yield, quality, biotic and abiotic stress resistance in cucurbitaceous crops

Evaluation of segregation population of pumpkin

In advancement of superior breeding lines, 58 and 54 promising types of pumpkin were raised during rainy and summer season, respectively. Significant variation among the breeding line was found for vegetative, floral and fruiting parameters. During summer season, plant length was recorded from 1.45m to 3.70m with mean value of 2.63m. The node to first female flower appeared from 10 to 24 with mean of 16. The number of male and female flowers produced per plant was 38-289 and 1-23 respectively. The average female flower emerged in each plant was 5. The fruits were found in globular, oblong, obovate and cylindrical in shapes. The yield potential of each plant ranged from 0.400g to 9.40kg with mean of 3.00kg. The fruits were deformed during the season was found to be 0-37 per cent. The TSS content of the fruit ranged from 6-14.5 Brix.

Out of 54 breeding lines, tested 6 breeding lines significantly performed better and yielded higher number of fruits, which may suit for summer season. The pumpkin yellow mosaic virus incidence was also assessed among the breeding lines, in which 14 lines were highly susceptible and was infested in very early vegetative growth stage itself. 25 breeding lines were moderately resistant and showed no yield reduction despite of disease symptom at flowering stage and beyond. Three lines were free from mosaic symptom at field level. During advancement a distinctive plant having silvery or white leaf with unserration on margins was observed. This plant is less vigourous and grows up to 2.35m with medium sized leaves (11.5x15.5cm). It produces male and female flower at 10th and 27th node of the plant respectively. Each plant produced 49 and 5 male and female flowers respectively. Each fruit weighs about 0.700 to 0.850g. No symptom of pumpkin mosaic virus was observed at field condition.

Advancement of promising hybrids derivatives of pumpkin for high yield and quality (F6 and F7 generation)

The five superior derivatives of CM16xCM19,CM16 x CM17, CM19xCM12, CM13x CM15 and CM4 x CM22 were advanced to F6 and F7 generation under replicated yield trial. Considering the variation, the lowest node at first female flower appeared (3) and the lowest fruit size (0.850g) was also recorded in CM16xCM19 against the largest fruit size CM13xCM15 (5.98kg). The higher number of female flowers per plant (11-16) was recorded in CM16x19 as against the check variety Arka Chandan and Arka Suryamuki (5 and 7 respectively). The TSS was recorded highest (14.52brix) in CM16x CM19 as against the CM13 x CM15, which recorded the lowest value (9.92brix) (Table 17).

A mini box type was found in CM16xCM19 consistently performed better over the season. It is a medium vigour plant having sturdy medium sized leaves (12.0x13.5cm) having long petiole (21.0cm)

Table 17. Varietal descriptor of Pumpkin var CHES-1 with check

Parameters	CHES-1 (CM-16xCM-19)	ARKA SURYAMUKHI	ARKA CHANDAN
Days to germination	3	4	4
Plant vigour	Medium Vigor	Medium Vigor	Vigour
Leaf colour	Whitish green	Pale green	Whitish green
leaf size	Small	Medium	Medium
Plant length (cm)	280.0	245.0	220.0
No of primary branches per plant	9	6	9
Leaf length (cm)	12.0	10.5	14.5
Leaf width (cm)	13.5	13.5	20.0
Petiole length (cm)	21.0	14.0	24.5
Node to first male flower appeared	3	4	4
Days to male flower anthesis	70	60	72
Node to first female flower appeared	12-13	10-12	18-20
Days to female anthesis	70 days	62 days	76 days
No of male flower/plant	189.00	67.00	156.00
No of female flower/plant	11.00	6.00	6.00
No of fruits /plant	7-8	5-7	3-4
Days to fruit harvest	115-120 days	100-110 days	120-125 days
Average fruit weight (Kg)	0.80-0.90	0.40	1.70
Unmarketable fruits percent (%)	1.90	1.00	5.60
Fruit flesh thickness (cm)	4.0	1.5-2.0	3.3
Flesh colour	Deep orange	Yellowish	Deep yellow
Fruit size	Small	Very small	Medium
TSS ((Brix)	8.5	7.8	8.0
Yield per plant	7.2-7.8	2.5-3.2	5.5-6
Yield increment over check	130%	-	-
Percent fruit size over check	-50 %	-	-

with prominent white spots over the surface. Leaf margin is distinctly serrated. Plant grows up to 2.8m and compact growth. It starts flowering at about 65-70 days and female flowers appears at 12-13th node of the plant. It sets 14-16 female flowers per plant and attains 7-9 marketable fruits. The fruits are flat round having distinctive yellow patches over dark green surface. Each fruit weighs about 800-900g and yield potential is about 7.0 to 7.5kg per plant. The flesh thickness is 3.3cm with deep orange flesh colour. It recorded TSS of 8.5 brix. It is moderately resistant to pumpkin mosaic virus.

Advancement of hybrids derivatives of bottle gourd for high yield and quality (F5 and F6 generation)

The promising derivatives of bottle gourd viz. LS-4xLS3-2, LS-20-1xLS14-1, LS-28-1x LS20-2, LS-3xLS2 and LS-42-xLS32-2 were raised under replicated trial to assess the vegetative, flowering, fruit and yield related parameters. Significant differences were observed among the derivatives for majority of the parameters. LS3xLS2 was found to show vigorous growth and earliness. Fruits are attractive green and cylindrical in shape. Fruit size is 600-700g at optimum edible stage attained at 55-63 days after sowing. Considering the fruiting parameters, the highest number of fruits per plant (18.1) was recorded in LS4xLS3-2, which is round shaped. The LS20-1xLS14-1 recorded the lowest value for number of fruits per plant (13.11), which bears thump bell shaped fruits. Each fruit weighs 850-920g at harvestable stage (65-68 days after sowing). Among the derivatives, the lengthiest fruit having cylindrical shape was recorded in LS28-1xLS20-2 (43.80cm), fruits reaches marketable stage at 55 to 60 days itself. Each plant bears 15-16 fruits weighing 800-850g. The highest protein and crude fiber was recorded in LS4xLS3-2 as compared to other derivatives.

Isolation and characterization of mutant with high lycopene under heat stress condition in tomato

During this year, 83 single plant progenies identified in CO-3 (45), Arka Meghali (17), EC-24296(11) and EC-531038 mutant population were raised for assessing yield and quality along with superior mutant of tomato under replicated trial. Significant difference were observed among the progenies for vegetative, floral and fruiting characters. The progenies exhibited from determinate to indeterminate growth type with height range from 42.5cm to 244.3cm (CO-3), 67.3cm to 133.5cm. A distinct flowering mutant from CO-3-153 exhibited 100-125 flowers in a panicle having length of 18.7cm and produced 100 to 456 fruits per plant.

Among the single plant progenies, the extra large fruit mutant progenies were found in CO-3 (15), Arka Meghali (4), EC-24296(1) and EC-531038 (2), which fruit size ranged from 100-125g each as compared to their parents. Similarly, very small fruit size mutant progenies were also observed (1 and 3) in CO-3 and Arka Meghali respectively, where fruit size ranged from 5.0 to 10.3g each. The very smaller fruit mutant plants produced 350-785 fruits each.

Under replicated trial, the mutant CO-3-237-3 exhibited consistently superior performance for growth and yield characters. It is an indeterminate mutant growing upto160.3cm. Plants produce dark green leaves and dense foliage. The fruits are whitish green at immature stage and deep red colour at ripening. Each plant bears 40 fruits, round in shape, on an average weighing 125g. Yield potential of each plant is 4.97kg. It has high lycopene content 7.9mg/100g with acidity of 0.38 per cent. Crop duration is 110-130 days. It is field resistant to TLCV. An attractive rose colored fruit mutant AM-10 was identified from Arka Meghali, which consistently performed superior in yield. Plants are semi determinate growing up to 137.8cm. The inflorescence length is 13.2cm and produces 2-3 fruits per cluster. Each plant produces 100-105 flat round shaped fruits, rose in colour. Each fruit weighing about 50-55.5g with plant yield potential of 5.49kg. The crop duration is 105-115days.

In addition, the yellow mutants of CO-3(1), Arka Meghali (2) and EC-521038 (1) was also advanced and characterized. An attractive yellow colour fruit mutant AM-47 was isolated from Arka Meghali. It consistently showed superior performance for yield and quality. This mutant is semi determinate type, grows up to 123.5cm. Each plant bears 30-35 fruits weighing 105-110g each. Fruits are at dark green color at immature stage and turns attractive yellow colour. This extra large fruits

are flat round in shape and yield 3.27kg per plant. It yields lycopene content 043mg/100g with acidity 0.41%. Crop duration is 105-123days. It exhibited field resistant to TCLV.

A mutant (AM-10-1) is recorded the highest TSS content. Plants are indeterminate type. Each plant bears 117 fruiting cluster per plant with 6-8 fruits each. Fruits are round in shape and very smaller in size weighing 3.0-5.0g. Each plant bears 700-735 fruits having yield potential up to 3.3-4.2kg. The TSS content is 10.2brix. It is field resistant to TCLV. Crop duration is 145-150 days.

Crop Management and Agrotechniques

Planting models

At Bikaner

Development of khejri based cropping models

Khejri (*Prosopis cineraria*) is an important multipurpose tree species and lifeline of Indian desert. It is most potential perennial component compatible to almost any companion crop in the traditional farming systems in the hot arid region. With the development of bud grafting techniques at CIAH, Bikaner, the institute has developed and recommended variety Thar Shobha for establishing uniform plantations. This would result into development of systematic cultivation as orchards of horticultural significances (sangri) and to develop farming systems of crop production with khejri as a perennial base crop. Now, the long term strategic objective is to develop khejri based crop production models and to understand the impact of cropping systems both under rainfed and irrigated situations for sustainable resource utilization and maximize income under resource constraints arid region.

The research work on khejri based crop production site management approach as technological interventions could be an innovative tool to break-up the yield gaps in crops over the traditional or intensive crop production systems and to enhance productivity of resources under hot arid environment. For this, some principles have been suggested and these are fencing of production site for protection, development of multi-tier row plantations of native species around the production site for creation of micro-climate and fellow fields from April - June or October-November for soil health security. The perennial native species such as lasora, rohida, bordi and khejri seedling plantation alongwith native desertic flora all around the block fencing has to be taken in to consideration for the development of micro-climate in the production site.

The khejri based planting models under studies are KM-1 (4 x 4 m), KM-2 (6 x 6 m), KM-3 (8 x 8 m), KM-4 (8 x 4 m), KM-5 (8 x 4 x 4 m), KM-6 (16 x 4 m), KM-7 (16 x 4 x 4 m), KM-8 (24 x 4 m), KM-9 (24 x 4 x 4 m), KM-10 (48 x 4 m), KM-11 (48 x 4 x 4 m) and KM-12 (c).

Growth and development studies

To develop khejri based cropping system adopting Horticulture Based Crop Production Site Management Approaches (HBCPSMA), an area of two hectare was developed through *in situ* establishment of khejri variety 'Thar Shobha' by planting the seedling in 2007 and budding in 2009 under absolute rainfed situations. During 2012-13, the observation on plant growth and development were recorded through out the year and no significant differences were observed in growth characters of khejri variety 'Thar Shobha' under varying planting models. During the period, intensive studies on khejri, ker and jharber were undertaken for germination and growth characters under nursery conditions (Fig. 17 & 18). and also for field establishment under wide spaced khejri planting model as intercropping crops.

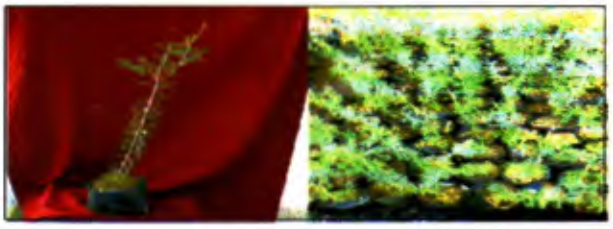


Fig. 17. Raising of seedling of Khejri in nursery and sapling ready for field planting

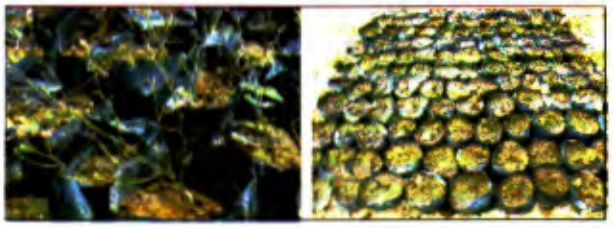


Fig. 18. Studies on germination growth and development of ker under nursery conditions

Evaluation of fruit based diversified cropping models for arid region

The experiment comprises of eight different cropping models viz., Aonla-Ber-Cluster bean-Fennel (M-1), Aonla-Bael-Cluster bean-Coriander (M-2), Aonla-Khejri-Cluster bean-Ajowain (M-3), Aonla-Drumstick-Cluster bean-Dill (M-4), Aonla-Khejri-Grass (L. sindicus) (M-5), Aonla-Mosambi-Cluster bean-Mateera (M-6), Aonla-Kinnow-Cluster bean-Chick pea (M-7) and Aonla-Mulberry-Kachari-Mustard (M-8). Observations on growth and development was recorded in already eight year old established plants of aonla, ber, bael, khejri and drumstick grown in association with aonla in the different cropping models. Ground storey crops were sown as per the treatments during kharif and rabi season.

Impact of canopy on over, under and ground storey crops

During the period under report, no negative allelopathic effects of over storey crops (aonla, ber, khejri, karonda, moringa) on growth and production potential of ground storey crops (ajowain, coriander, dill, mustard, fennel and cluster bean) was observed under field conditions, which was later confirmed by laboratory assays.

Intercropping and yield assessment of over storey and ground storey crops

The average yield of aonla varied considerably in different cropping model systems with highest being recorded in aonla-ber (54.1), aonla-kinnow (52.3 kg per plant) followed by aonla-mulberry (49.6 kg/plant) and aonla-khejri (39.2), (Fig. 19 a-f) while the lowest was recorded in aonla-moringa (36.7 kg/plant). The highest yield in aonla involving ber could be due to synergistic crop interaction. The higher yield of aonla in models involving kinnow and mulberry could be attributed to less competition, for natural resources, exerted by these crops as kinnow and mulberry plants in the respective cropping models are in young stage. The average yield of bael was recorded to be 18-20 kg per tree, while a single fruit weighed around 1.5 kg with maximum and minimum fruit weights recorded to be 2.4 and 0.6 kg, respectively (Fig. 19 d). The average yield of

Fig. 19a. Fruting in aonla in aonla-ber-Cluster bean-Fennel (M-1) cropping

Fig. 19b. Fruting in aonla in aonla-khejri-Cluster bean-ajowain (M-3)

Fig. 19c. Bearing in khejri in aonla-khejri-Cluster bean-Ajowain 3) cropping model

Fig. 19d. Bael fruits harvested from different cropping models

Fig. 19e. Bearing in khejri in aonla-khejri-Cluster bean-Ajowain (M-3) cropping model

Fig. 19f. Flowering and fruiting in moringa in Aonla-Drumstick-Cluster bean-Dill M-4) cropping model

karonda was recorded up to 11 kg/plant planted in between aonla plants. Likewise, the yield of ber cv. Seb was recorded to be 38.9 kg/plant in model M-1. The yield of sewan grass was recorded to be an average of 1.66 kg/m2 on dry weight basis.

Eco-physiological interaction studies

The trend of eco-physiological parameter like canopy interception of light (Photosynthetic Active Radiation) for different fruit crops over the seasons is being presented hereunder;

April: Bael > Moringa > Karonda > Khejri > Aonla. May: Moringa > Bael > Aonla > Khejri > Karonda. June: Moringa > Bael > Ber > Karonda > Aonla > Khejri. July: Moringa > Bael > Ber > Karonda > Aonla > Khejri. August: Aonla > Moringa > Bael > Karonda > Ber > Khejri. September: Aonla > Khejri > Karonda > Moringa > Ber > Bael. October: Aonla > Moringa > Bael > Karonda > Khejri > Ber. November: Moringa > Karonda > Bael > Aonla > Ber > Khejri. December: Moringa > Karonda > Aonla > Bael > Khejri > Ber. January: Bael > Moringa > Khejri > Karonda > Aonla > Ber.

February: Aonla > Moringa > Bael > Karonda > Khejri > Ber. March: Karonda > Aonla > Bael > Khejri > Moringa > Ber.

Photosynthetically active radiation was recorded to be the maximum with moringa followed by bael and ber during extreme summer season. However, least was noted in ber and khejri for most of period under study.

Physiological Studies

Monthly relative water contents (%)

Fruit Trees

April: Karonda (90.48) > Khejri (87.52) > Bael (84.93) > Moringa (82.70) > Ber (78.96)

May: Khejri (94.64) > Aonla (85.90) > Karonda (82.41) > Bael (74.62) > Moringa (70.60) June: Karonda (96.09) > Khejri (87.94) > Aonla (86.75) > Bael (83.79) > Moringa (64.02) July: Bael (92.77) > Aonla (88.71) > Karonda (87.52) > Khejri (81.59) > Moringa (71.12) > Ber (56.49). August: Bael (89.46) > Khejri (89.27) > Moringa > Aonla (84.18) > Ber (83.90) > Karonda (81.83). September: Bael (88.46) > Aonla (82.83) > Karonda (81.93) > Khejri (80.89) > Moringa (78.91) > Ber (73.54). October: Aonla (83.22) > Karonda (82.77) > Khejri (81.45) > Moringa (74.95)> Bael (66.80) > Ber (51.96). November: Aonla (88.63) > Moringa (81.88) > Bael (81.19) > Khejri (80.59) > Karonda (79.39) > Ber (46.53). December: Aonla (94.90) > Bael (94.57) > Khejri (93.75) > Karonda (89.27) > Moringa (86.86) > Ber (57.04). January: Aonla (92.58) > Bael (90.72) > Karonda (90.04) > Moringa (87.00) > Khejri (82.07) > Ber (55.83). February: Karonda (93.10)> Khejri (91.68)> Bael (89.05)> Aonla (83.21)> Moringa (82.91) > Ber (57.83). March: Karonda (91.07)> Bael (88.47)> Aonla (88.24)> Khejri (86.12)> Moringa (83.15) > Ber (54.31).

Karonda and aonla leaves were observed to maintain the comparitively higher relative water

content throughout the period under study followed by bael, khejri and moringa while the lowest was noticed with ber. Likewise, with regards to the leaf water content, drumstick tree was observed to be highest while ber tree the lowest.

Pruning in karonda and its impact on yield and harvesting season

Adoption of proper canopy management practices is of utmost importance for sustainable fruit production. Seven years old plants of karonda, under diversified fruit based cropping system, were pruned with different pruning intensities viz., mild pruning (involving thinning of criss-crossed and dried branches), medium pruning (by retaining 4-6 scaffold branches) and severe pruning (heading back at 45 cm height from ground) during the month of February, 2012. The unpruned plants yielded 8-9 kg fruits per plant. Similarly, mild pruned plants recorded 10-11 kg fruits per tree, while medium pruned registered 5-6 kg fruits per tree. The severe pruned plants put forth only vegetative growth and no fruiting was recorded. As a result of medium pruning, the yield was reduced; however, the harvesting period was hastened to the month of (July), while in mild pruned plants the harvesting period remained unaffected (August). The findings highlights the need of adopting suitable pruning strategies for the regulation of yield and harvesting season, keeping in view the market demand.

Mango based cropping system under rain fed condition of semi-arid ecosystem

Experiment was set up in randomized block design which was replicated four times. Inter crops (bottle gourd, pumpkin, bitter gourd, sponge gourd, cucumber excluding control) were sown during rainy season between spaces of two rows of mango, planted at 10 x10 m distance. Economic analysis of mango based cropping system revealed that maximum yield per plot was recorded with mango + bottle gourd combination followed by mango + pumpkin among the different combinations under rain fed conditions of semi-arid ecosystem. Growth pattern of the mango plants is satisfactory.

Sweet orange based cropping system under rain fed condition of semi-arid ecosystem.
Experiment was set up in randomized block design which was replicated four times. Inter crops (bottle gourd, pumpkin, bitter gourd, sponge gourd, cucumber excluding control) were sown during rainy season between spaces of two rows of sweet orange, planted at 5 m x 5 m distance. Maximum yield per plot was recorded with sweet orange + bottle gourd combination followed by sweet orange + pumpkin among the different combinations.

Canopy Management

At Godhra

Effect of planting system cum high density in aonla

Results of study on high density planting systems revealed that different planting systems significantly affected the vegetative growth, yield and quality of aonla under rainfed conditions of hot semi-arid environment.

Vegetative growth

Plant height was recorded significantly maximum (7.63 m) in double hedgerow planting system while it was recorded minimum in square system of planting (7.10m). However, maximum values for rootstock girth (59.35cm), scion girth (55.00) and plant spread (6.87 m) were recorded in square system of planting and it was recorded minimum in hedgerow planting system.

Yield

Yield per plant (98.00 kg) was recorded highest in square system of planting followed by paired (93.47 kg), cluster (91.00 kg), hedgerow

(89.95 kg) and double hedgerow planting system (88.50 kg), while yield per plot (17.70q) was recorded maximum in double hedgerow planting system followed by cluster (14.56q), hedgerow (13.49q), paired (11.21q) and square (8.82q). On the basis of area of plant population in the area of each plot, yield per ha (196.47q) was recorded the maximum in double hedgerow planting system followed by cluster (161.07q), hedgerow (149.31q), paired (124.31q) and square (98.00q) whereas, for commercial exploitation of various planting geometries, the actual yield per hectare was computed 98.00, 121.51, 179.90, 153.79 and 230.10q in square, paired, hedgerow, cluster and double hedgerow system of planting, respectively. Yield per plot and hectare was recorded significantly highest in double hedgerow planting over rest of the systems.

Quality attributes

Planting systems had pronounced influence on the fruit qualities (Table 18). Fruit weight (48.00 g), fruit length (4.15 cm), fruit breadth (4.27 cm) were recorded the maximum in the fruits of square system followed by paired, hedgerow and cluster, whereas it was recorded the minimum in double hedgerow planting system. The quality in terms of TSS (9.500 brix), total sugar (5.97 %) and vitamin C (508.00 mg/ 100g) were recorded highest in double hedgerow system in all the evaluated planting systems.

Pruning trial in mango

For conducting the pruning trial in mango, planting of 200 plants of Kesar mango under high density (5x5 m) has been done in 0.5 ha area. Plants are growing well.

Organic and Biodynamic Farming

Organic farming in fruits

Effect of organic manure and fertilizers on mango cv. Kesar

A field experiment was conducted in mango cv. Kesar, planted in the year 2008 at 10x10m distance. Soil properties and growth of the mango plants were considerably influenced by the application of different types of cakes, FYM, fertilizers and biofertilizers in different combinations under rainfed conditions of hot semi-arid ecosystem of western India. Maximum plant height (2.3 m) was recorded in T6-FYM + std. dose of NPK + Azotobactor + PSB closely followed by T8-Castor cake + standard dose of NPK+ Azotobactor + PSB. Maximum TSS (20.60 0 Brix) was also recorded in T-6, closely followed by T-8.

Effect of organic manure and fertilizers on sweet orange cv Sathgudi

Maximum plant height (1.80 m), plant spread East- West (1.30 m), north-south (1.50m) and scion

Table 18. Effect of planting systems on fruit quality

Treatments	Seed weight (g)	Specific gravity	TSS (%)	Total sugar (%)	Acidity (%)	Total phenol (mg/100g)	Vitamin C (mg/100g
Square	2.07	1.03	8.00	5.49	2.15	167.50	488.50
Hedgerow	2.03	1.02	9.00	5.62	2.05	169.75	496.20
Double hedgerow	2.01	1.02	9.50	5.97	2.01	173.17	508.80
Cluster	2.04	1.02	8.50	5.68	2.07	170.20	492.25
Paired	2.06	1.01	8.00	5.51	2.10	168.72	490.00
C.D. at (5%)	NS	NS	0.50	0.21	NS	5.89	15.52

girth (10.00 cm) was recorded in T6-FYM + std. dose of NPK + Azotobactor + PSB closely followed by T8-Castor cake + standard dose of NPK+ Azotobactor + PSB.

Effect of biofertilizers on aonla

Soil properties

Soil properties were influenced significantly by different combination of FYM, biofertlizers and NPK. The results of the study of various organic and inorganic sources of nutrients on soil reaction (pH) revealed that the treated basin soil declined from its initial value of 7.60 to 6.48, 6.59, 6.60 and 6.62 during 2012-13 with T5, T3, T6 and T4, respectively while pH of the basin soil was not influenced with the application of NPK alone (T1). The EC of the soil decreased from its initial value 0.13 dS m^{-1} to 0.10dS m^{-1} being lowest in T6. In the tree basin, addition of FYM and biofertlizers decreased the bulk density from its initial value1.39 Mg m-3 to 1.22, 1.23, 1.25,1.27 Mg m^{-3} in 2012-13 with T5, T3,T4 and T6, respectively, while it was recorded maximum in T1(1.35 Mg m^{-3}). The organic carbon increased from its initial value 4.30 g kg^{-1} to 6.78, 6.62, 6.49, 6.35, 6.31 and 5.65 g kg^{-1} in the treatment T6, T3, T4, T5, T2 and T1, respectively, which were found to be 31.39 to 57.67 per cent increment from their initial value. Available N was recorded maximum with the application of standard dose of NPK (T1) followed by FYM+ 50 % of the standard dose of NPK (T2), FYM + Azotobactor + VAM (T6) and FYM + Azotobactor + PSB (T3). Available P concentration increased from its initial value 11.00 kg per ha to 20.28, 19.05, 18.90, 17.72, 16.98 and 16.00 kg per ha with the treatments T1, T2, T5, T3, T4, and T6, respectively. The average increase in available K was observed the maximum in standard dose of NPK (T1), whereas it increased from initial value 117.60 to 132.53, 127.55 and 124.67 kg per ha in T1, T2 and T5, respectively.

Plant growth

The average annual extension of plant height (55.21 cm), rootstock girth (3.10 cm), scion girth (2.79 cm) and plant spread (51.12 cm) were recorded with T1 followed by T2, T5 and T3.The plant height (41.00cm), was recorded minimum in T6, while root stock girth (2.75 cm), scion girth (2.27 cm)and plant spread (39.17 cm) were the minimum in T4.

Yield

The mean yield per plant (80.12kg), fruit weight (47.10 g), fruit length (4.05cm) and fruit width (4.10 cm) were recorded maximum with standard dose of NPK (T1) followed by FYM + 50 % of standard dose of N P K (75.70 kg/ha, T2) and FYM + Azotobactor +VAM (71.12 kg/ha,T5-), while yield was recorded the minimum with T4 (63.00kg) followed by T6 (67.29 kg). Similar trend was also observed with respect to fruit pulp and seed weight.

Fruit quality

The results obtained from the study revealed that the maximum total soluble solid were recorded 9.500 Brix with the application of FYM + Azotobactor + VAM (T5) followed by T3, T6 and T4. However, treatments T1, T2, T3 and T6 showed parity with respect to TSS. Total sugar, vitamin C, total phenols were also in similar trends as the TSS. However, the maximum reduction in acidity was noted with the application of FYM + Azotobactor + VAM (2.00 %) followed by T3 (FYM + Azotobactor + PSB) among the different treatment combination. Different treatment combinations of organic and inorganic sources of nutrients could not exert significant effect on the acidity of the fruit.

Effect of organic manures and fertilizers on growth, yield and quality of aonla

Soil properties

There was significant reduction in bulk density by the application of manure, cakes and CPP.

Addition of farm yard manure, cakes and CPP decreased the bulk density of the basin soil of the tree. The maximum hydraulic conductivity (0.46cm /hr) was observed in neem cake + FYM +CPP (T1), which was at par with T3 (groundnut cake + FYM + CPP), while T2, T4,T5 and T6 showed parity with respect to hydraulic conductivity. The bulk density reduced from its initial value 1.40 Mg m-1 to 1.25, 1.29, 1.33 and 1.33 Mg m-1 in T1, T3, T2, and T4, respectively. Organic carbon content of basin soil was increased from its initial value 4.4 g kg-1 to 6.9, 6.6, 6.4, 6.3, 6.0 and 5.8 g kg-1 in the treatment T1, T3, T4, T2, T5 and T6, respectively. However, maximum build up of organic carbon was observed in neem cake + FYM +CPP (T1) treatment i.e. from 4.4 to 6.9g kg-1.

Application of organic manures and inorganic fertilizers significantly increased the build up of available N in the soil. The available N content in the soil increased with the application of manures and fertilizers in the soil. Nitrogen content was recorded highest in the soil which was treated with FYM + standard dose of NPK (T5) and FYM + half of the standard dose of NPK (T6). Available N in soil among the various combinations of organic sources was recorded the maximum with neem cake+ FYM + CPP (T1) and groundnut cake + FYM + CPP (T3). Available P concentration increased to 26.10, 24.53, 24.00 and 22.98 kg per ha from the initial value 17.00 kg per ha in T5, T1, T6 and T3, respectively. The maximum increase in available K was observed in Farm Yard Manure + standard dose of NPK, whereas it increased from initial value 116.60 to 129.00, 126.30, 125.79 and 124.20 kg per ha in T5, T6,T1 and T3, respectively.

Vegetative growth

Results of study revealed that organic manure and inorganic fertilizers affected plant growth significantly. Plants received FYM + standard dose of NPK (T5) had the maximum annual growth extension followed by FYM + half of the standard dose of NPK (T6). Vegetative growth in terms of plant height, rootstock girth, stem girth and plant spread was recorded significantly highest from the plants treated with FYM + standard dose of NPK (T5) followed by FYM + half standard dose of NPK (T6) and neem cake + FYM + CPP (T1) while minimum growth was recorded with mahua cake + FYM + CPP (T4). The growth was recorded intermediate in the plants which were treated with FYM + half standard dose of NPK, FYM + neem cake + CPP, FYM + castor cake + CPP and FYM + ground nut cake + CPP.

Yield

The yield per plant (81.90 kg), fruit weight (45.40 g), fruit pulp (43.30 g), fruit length (4.00cm) and fruit width (4.10 cm) were recorded maximum with FYM along with standard dose of N P K (T5) followed by FYM + half standard dose of NPK (T6) and FYM + neem cake +CPP (T1), while yield (65.43 kg / tree) was recorded the minimum in T4 (FYM + mahua cake + CPP).

Fruit quality

Total soluble solids (9.500 brix), total sugar (6.5 %) were recorded maximum in T1. The acidity of the fruit was minimum (2.03%) in T1, followed by T2 (2.07%), while it was maximum T6 (2.18%). Among the different treatment combinations, vitamin C (498.95 mg /100g) and total phenols content (178 mg/ 100g)) were recorded maximum in T1 and minimum in mahua cake + FYM + CPP (T4).

Organic farming in vegetables

Various leaf composts from various leaves namely aonla, eucalyptus, jamun, mahuva, mango, neem, *P. dulce*, sapota, subabul and tamarind were prepared in summer season. and were applied in the field @ 25 t/ha in pumpkin and bitter gourd taking 3 replications and observations like yield per plant, number of fruits per plant, number of leaves per plant, leaf weight per plant, average leaf weight per plant, twine weight per plant were taken. The

treatment which received neem compost was giving better yield (5.5 kg/plant), followed by subabul, Pithacellobium dulce and lowest yield (2.1kg/plant) were observed in control. In the same way in bitter gourd also more yield (1.25 kg/plant) was observed in treatment received neem compost followed by subabul and Pithacellobium dulce and lowest yield (0.45kg/plant) was observed in control.

The leaf analysis of pumpkin reveals that the nitrogen, phosphorous, potassium, calcium, magnesium and sulphur varied from 2.5-4.3, 0.12-0.15, 0.6-1.2, 0.76-2.69, 1.85-2.26 and 0.12-0.16 per cent, respectively. In bitter gourd the leaf analysis revealed that nitrogen, phosphorous, potassium, calcium, magnesium and sulphur varied from 3.20-5.25, 0.13-0.16, 1.56-1.88, 3.2-6.8, 4.18-7.17 and 0.13-0.18 per cent, respectively. The fruit analysis of pumpkin reveals that the nitrogen, phosphorous, potassium, calcium, magnesium and sulphur varied from 3.63-4.83, 0.24-0.56, 1.4-3.49, 1.12-1.68, 2.04-2.29, 0.12-0.25 percent respectively. In karela the fruit analysis revealed that nitrogen, phosphorous, potassium, calcium, magnesium and sulphur varied from 4.2-5.75,0.25-0.28,2.314-2.66,1.28-1.63,1.95-2.24,0.143-0.165 per cent, respectively.

Integrated soil, water and nutrient management

Standardization of integrated nutrient management practices in arid horticultural crops

Effect of different INM treatments on microbial population

Monitoring of microbial population at two depths (0.00-0.15 and 0.15 -0.30 m) during 2012-2013 was carried out in bael and kinnow field experiments of integrated nutrient management. The bacterial population in different treatments ranged from 100 to 160 x104 cfu g^{-1} soil, fungal from 55 to 150 x104 cfu g^{-1} soil and actinomycetes from 50-85 cfu g^{-1} soil in different INM treatments in kinnow orchard. Total microbial population was minimum in the absolute control and maximum in the treatment where recommended dose of N, P and K was associated with FYM and consortium of bifertilizers at both the depths. (Table19). Total population as well as individual population of different micro-organism increased with involvement of FYM and consortium of biofertilizers. This is because most of the soil micro-organisms are chemoheterotrophs which require organic source of carbon as food and oxidation for organic substances provides energy. Under different INM treatments, the total and individual population of different micro-organisms was higher where nutrients were provided by RDF of N, P, K + FYM + PSB + Azotobactor + VAM combinations followed by RDF of N, P, K +FYM + Azotobactor treatment and minimum population of micro-organism was observed in control treatment. In FYM treated plants, C: N ratio was wide which proved more carbon and low rate of mineralization, this might have resulted in increased total population as well as individual microbial population. Total as well as individual microbial population was higher in the surface than subsurface soil.

The data presented in Table 20 revealed that total microbial population was less in bael orchard in all INM treatments in comparison to kinnow orchard. The bael orchard was only 5 year old and added only small amount of FYM and biofertilizers. In different treatment of INM in bael, bacterial population ranged from 70 to 110 cfu g^{-1} soil, fungal 55 to 90 cfu g^{-1} soil and actinomycetes 65 to 120 cfu g^{-1} soil. In this crop also, addition of organic matter and biofertilizers increased the total microbial population in the bael orchard.

Effect of different INM treatments on morphological parameters of kinnow

The data presented in table 21 revealed that maximum plant height (2.90 m) was recorded in RDF of N, P, K + FYM + PSB + Azotobactor + VAM treatment and minimum was in control (2.55

Table 19. Effect of different INM treatments on microbial population (cfu x10⁴ g⁻¹ soil) in kinnow orchard (12year old plants)

Treatments	0-15 cm depth (Bacterial population)				15-30 cm depth (Bacterial population)			
	B	F	A	Total	B	F	A	Total
Control	100	55	50	205	90	50	50	190
RDF of N, P and K	115	60	55	230	100	60	50	210
RDF of N, P, K + FYM	125	85	70	280	115	80	70	265
RDF of N, P, K +Azotobactor	120	65	55	240	120	60	50	230
RDF of N, P, K + PSB	125	70	60	255	125	70	50	245
RDF of N, P, K + VAM	110	100	75	285	110	110	75	295
RDF of N, P, K +FYM + Azotobactor	135	130	80	345	130	125	80	335
RDF of N, P, K + FYM + PSB	130	125	80	335	125	120	75	320
RDF of N, P, K + FYM + VAM	130	135	80	345	120	130	85	335
RDF of N, P, K +FYM +PSB + Azotobactor	140	145	85	370	135	140	80	355
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	140	150	85	375	135	140	80	355
SEM±	10.2	9.5	8.0	15.0	10.0	12.0	10.0	15.0
CD (5%)	26.0	25.0	22	34.0	22.5	26.0	22.5	35.0

Table 20. Effect of different INM treatments on microbial population (cfu x10⁴ g⁻¹ soil) in bael orchard

Treatments	0-15 cm depth (Bacterial population)				15-30 cm depth (Bacterial population)			
	B	F	A	Total	B	F	A	Total
Control	60	40	35	135	50	35	35	120
RDF of N, P and K	75	45	40	160	70	40	40	150
RDF of N, P, K + FYM	85	50	30	165	75	40	30	145
RDF of N, P, K +Azotobactor	90	50	35	175	80	40	30	150
RDF of N, P, K + PSB	95	65	30	180	85	50	30	165
RDF of N, P, K + VAM	80	70	40	190	70	60	30	160
RDF of N, P, K +FYM + Azotobactor	100	70	40	210	90	60	40	190
RDF of N, P, K + FYM + PSB	100	60	40	200	90	50	30	170
RDF of N, P, K + FYM + VAM	80	80	40	200	80	60	40	180
RDF of N, P, K +FYM +PSB + Azotobactor	100	100	50	250	90	70	40	200
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	110	90	90	290	90	80	40	210
SEm±	8.0	6.5	8.0	18.0	10.2	6.5	10.0	12.0
CD (5%	19.5	15.0	20.6	40.2	25.6	16.2	NS	32.0

B: Bacteria, F: Fungal, A: Actinomycetes

Table 21. Effect of different INM treatments on morphological parameter of kinnow orchard (Average age of plant: 12 years)

Treatment	Tree height (m)	Tree Spread		Stem diameter (cm)
		N-S (m)	E-W (m)	
Control	2.55	2.10	2.00	45
RDF of N, P and K	2.55	2.20	2.10	50
RDF of N, P, K + FYM	2.60	2.30	2.30	50
RDF of N, P, K +Azotobactor	2.55	2.10	2.20	45
RDF of N, P, K + PSB	2.50	2.20	2.30	45
RDF of N, P, K + VAM	2.60	2.20	2.30	50
RDF of N, P, K +FYM + Azotobactor	2.85	2.30	2.30	65
RDF of N, P, K + FYM + PSB	2.65	2.25	2.20	60
RDF of N, P, K + FYM + VAM	2.75	2.30	2.20	60
RDF of N, P, K +FYM +PSB + Azotobactor	2.80	2.30	2.30	65
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	2.90	2.30	2.30	65
SEm±	0.09	0.07	0.12	6.0
CD (5%)	0.22	0.19	NS	16.0

Table 22. Effect of different INM treatments on yield and fruit quality paramenters of kinnow orchard (Average age of plant: 12 years)

Treatment	Fruit weight (g)	Fruit yield (t/ha)	TSS (° Brix)	Acidity (%)	Juice (%)
Control	125	65.00	10.50	0.80	40.00
RDF of N, P and K	185	85.00	11.00	0.75	48.00
RDF of N, P, K + FYM	230	125.00	11.00	0.75	50.00
RDF of N, P, K +Azotobactor	195	90.00	1050	0.70	48.00
RDF of N, P, K + PSB	195	90.00	11.00	0.75	45.00
RDF of N, P, K + VAM	185	90.00	10.50	0.75	46.00
RDF of N, P, K +FYM + Azotobactor	225	95.00	11.00	0.70	50.00
RDF of N, P, K + FYM + PSB	230	95.00	11.00	0.70	52.00
RDF of N, P, K + FYM + VAM	225	100.00	11.00	0.70	52.00
RDF of N, P, K +FYM +PSB + Azotobactor	235	130.00	11.50	0.65	52.00
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	235	135.00	12.00	0.65	52.00
SEm±	15.00	9.05	1.06	0.15	3.52
CD (%)	40.15	22.06	NS	NS	8.62

m). The pattern in plant height revealed that addition of RDF along with FYM and consortium of biofertilizers has the highest increment in plant growth. Likewise plant spread in both the directions was also more in the same INM treatment. The data on stem diameter was not significantly differed among INM treatments.

Effect of INM treatments on yield and fruit quality paramenters of kinnow

The fruit weight, fruit yield, TSS, acidity and juice recovery were measured in different INM treatment and data given in Table 22 revealed that maximum fruit weight (235 g) was recorded in RDF of N, P, K + FYM + PSB + Azotobactor + VAM which was significantly at par with RDF of N, P, K +FYM + Azotobactor treatment. The minimum fruit weight (125 g) was recorded in control treatment. The fruit yield was estimated and maximum fruit yield (135 t/ha) was recorded in RDF of N, P, K + FYM + PSB + Azotobactor + VAM treatment and minimum (65 t/ha) yield was estimated in control treatment. The TSS was measured in mature fruits from all treatment and recorded in the range of 10.50 to 12.00 ° brix and data revealed that addition of FYM, inorganic fertilizers increased the TSS content. The acidity content was maximum in control and inorganically fertilized treatments while FYM reduced the juice acidity. The juice recovery was ranged from 40 to 52 percent and maximum juice (52 %)was recorded again in RDF of N, P, K + FYM + PSB + Azotobactor + VAM treatment.

Effect of different INM treatments on morphological parameter of bael

The parameters on plant height, tree spread and stem diameter were measured and data presented in Table 23. The data revealed that maximum plant height (1.00 m) was recorded in RDF of N, P, K +FYM +PSB + Azotobactor and RDF of N, P, K + FYM + PSB + Azotobactor + VAM treatments and minimum plant height was recorded in control treatment likewise same pattern was recorded in tree spread and stem diameter.

Table 23. Effect of different INM treatments on morphological parameter of bael orchard (Average age of plant: 4 years)

Treatment	Tree height (m)	Tree Spread		Stem diameter (cm)
		N-S (m)	E-W (m)	
Control	0.65	0.25	0.25	15
RDF of N, P and K	0.80	0.25	0.25	18
RDF of N, P, K + FYM	0.80	0.25	0.25	20
RDF of N, P, K +Azotobactor	0.80	0.25	0.25	20
RDF of N, P, K + PSB	0.85	0.25	0.25	20
RDF of N, P, K + VAM	0.85	0.25	0.25	20
RDF of N, P, K +FYM + Azotobactor	0.85	0.30	0.30	20
RDF of N, P, K + FYM + PSB	0.85	0.30	0.30	20
RDF of N, P, K + FYM + VAM	0.80	0.30	0.30	20
RDF of N, P, K +FYM +PSB + Azotobactor	1.00	0.30	0.30	25
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	1.00	0.30	0.30	25
SEm±	0.62	0.26	0.23	5.25
CD (5%)	NS	NS	NS	NS

Effect of different INM treatments on physico-chemical properties of the soil

The physico-chemical properties of the soil under different INM treatments were measured periodically and data presented in Table 24 depicts the changes in the different properties over the year. The data revealed that pH of the soil did not change much when only chemical fertilizers were applied but on the application of FYM, pH of the soil lower down. On the application of biofertilizers pH of the soil did not change much. Data regarding the organic carbon status revealed that application of FYM increased the level of OC while inorganic fertilizers and biofertilizers have not changed the OC status of the soil. Available P and K_2O also have been affected by the application of INM treatments and recommended dose of N, P and K increased the availability of P and K_2O in the soil and their maximum status was recorded on the application of application of inorganic fertilizers along with FYM. Likewise availability of zinc and iron content in the soil has also been increased over the application of FYM.

Effect of different INM treatments on soil moisture of the soil

The soil moisture status of the soil under different INM treatments was monitored and results revealed that application of FYM alone or in combination with inorganic and biofertilizers increased the soil moisture status at both the strata. Monitoring of soil status at two depths revealed the more moisture has been accumulated at lower depths. Application of biofertilizers alone did not improve the soil moisture status of the soil (Table 25).

Effect of different mulches on soil properties, growth, yield and quality of mango cv Kesar

Soil temperature

In general, soil mulched with organic mulches showed beneficial effect in suppressing the fluctuation of soil temperature at 20 cm depth

Table 24. Effect of different INM treatments on physic-chemical properties of the soil

Treatment	pH	Organic carbon (%)	Available P (kg/ha)	Available K_2O(kg/ha)	Available Zn (ppm)	Available Iron (ppm)
Control	8.10	0.07	07.85	175.00	0.50	3.50
RDF of N, P and K	8.20	0.07	12.50	195.00	0.50	3.00
RDF of N, P, K + FYM	7.90	0.10	14.00	190.00	0.60	4.25
RDF of N, P, K +Azotobactor	8.00	0.07	11.80	190.00	0.55	3.80
RDF of N, P, K + PSB	8.10	0.07	12.00	185.00	0.55	3.50
RDF of N, P, K + VAM	8.00	0.08	12.50	190.00	0.60	3.50
RDF of N, P, K +FYM + Azotobactor	7.80	0.11	12.50	195.00	0.65	4.80
RDF of N, P, K + FYM + PSB	7.80	0.10	12.50	195.00	0.60	4.80
RDF of N, P, K + FYM + VAM	7.80	0.11	12.50	200.00	0.65	4.80
RDF of N, P, K +FYM +PSB + Azotobactor	7.80	0.11	12.50	200.00	0.65	5.00
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	7.80	0.12	12.50	200.00	0.65	5.00
Initial level	8.20	0.08	08.00	180.50	0.50	3.50

Table 25. Effect of different INM treatments on soil moisture of the soil

Treatment	Soil moisture (%) after 24hrs of irrigation	
	0-0.30m	0.30-0.60m
Control	2.80	3.50
RDF of N, P and K	2.50	3.00
RDF of N, P, K + FYM	4.50	6.00
RDF of N, P, K +Azotobactor	2.80	3.50
RDF of N, P, K + PSB	2.50	3.50
RDF of N, P, K + VAM	2.80	3.50
RDF of N, P, K +FYM + Azotobactor	4.50	6.50
RDF of N, P, K + FYM + PSB	4.00	6.00
RDF of N, P, K + FYM + VAM	5.00	6.00
RDF of N, P, K +FYM +PSB + Azotobactor	4.50	6.50
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	4.00	6.00

throughout the experimentation. Significant differences in soil temperature were recorded at different months owing to various types of soil covering treatments (mulches). Among the organic mulches tried, soil temperature lowered significantly with paddy straw followed by maize straw mulch.

Soil moisture

Among the organic mulches, soil moisture content was recorded maximum with paddy straw mulch at both the depths of soil (0-15 cm and 15-30 cm). Amongst the organic mulches evaluated, soil moisture ranged 19.40-14.80, 20.20-16.30% in paddy straw and it was recorded 14.60-11.70, 15.80-13.10 % in control at both the depths from soil surface after mulching.

Vegetative growth

Growth in terms of stem girth, plant height and spread was recorded maximum with paddy straw mulch followed by black polythene mulch, while minimum was observed in control.

Fruit yield and quality attributes

Plants treated with paddy straw mulch recorded highest yield (70.20 kg/ plant), followed by black polythene mulch (63.00 kg/plant) and it was recorded minimum in control (44.00 kg/plant). Maximum TSS (20.00 0 Brix) was noted in paddy straw mulch followed by polythene mulch.

Effect of different mulches on soil properties, growth, yield and quality of sweet orange cv Sathgudi

Maximum fruit yield per plant (27 kg) was recorded in paddy straw mulch followed by black polythene mulch (24.10 kg). Minimum fruit yield (19.00 kg/ plant) was recorded under control. Maximum fruit weight (230.00g) and TSS (13.10oBrix) was also recorded in paddy straw mulch.

Effect of different mulches on soil properties, growth, yield and quality of aonla

Soil properties

Results of study on the soil properties as influenced by different kinds of mulches revealed that the soil physico-chemical properties were

improved by the application of mulches (organic and inorganic) than control (no mulch). The bulk density was recorded lowest with paddy straw mulch (1.19 Mg m^{-3}) and it was highest in no mulch condition (1.38 Mg m^{-3}) followed by black polythene (1.36 Mg m^{-3}) rice husk (1.32 Mg m^{-3}). Hydraulic conductivity was recorded highest in paddy straw mulch (0.51 cm/ h) followed by maize straw (0.49 cm/hr) whereas minimum was observed with control (0.35cm/h). Organic mulches showed considerable reduction in soil pH and EC values when compared with control. Organic carbon was recorded maximum with paddy straw mulch (6.2 g Kg^{-1}) and it was recorded lowest in black polythene mulch even slightly less than control.

Soil moisture

Soil moisture content was recorded highest in black polythene mulch (19.79-29.10%) closely followed by paddy straw (19.50 - 29.00%) and it was recorded lowest under control (14.00 - 20.80%) at 0-15 cm from soil surface. Among the organic mulches tried, soil moisture content was recorded highest with paddy straw followed by maize straw and subabul loppings.

Soil temperature

Various kinds of mulches not only conserve the soil moisture but also moderate the soil temperature. Among the different organic mulches tried, soil temperature ranged from 15 to 300 C in paddy straw mulch, while it was recorded 18.0-34.0° C in control at 20 cm depth from soil surface.

Soil microbial population

Bacterial population was recorded highest in paddy straw mulch (119990) followed by maize straw (104368) and it was least in black polythene (26795) followed by control (34978) and rice husk (48580). Actinomycetes population was recorded maximum in black polythene (78000) followed by paddy straw (73395) and it was recorded lowest in number in subabool lopping (10747) followed by control (10941) and grasses mulch (18403). Fungal population was recorded maximum in paddy straw (33750) followed by maize straw mulch (26940) and grasses (22260) while minimum was recorded in black polythene mulch (9921) followed by control (13535) in the month of October, 2012.

Earthworm population

The earthworm population in the basin soil treated with paddy straw and maize straw mulch recorded 75 and 60 per cent more earthworm population in 1 m-3 basin soil than control (no mulch) in the month of October, 2012.

Vegetative growth

Vegetative growth was influenced significantly by application of different mulches. Plant height (7.40 m), root stock girth (55.17cm) and scion girth (49.89 cm) were recorded maximum in paddy straw followed by black polythene mulch, while it was recorded minimum in control. Plant height, rootstock girth and scion girth were recorded 7.30 m, 54.98 cm and 49.75 cm with black polythene mulch. Differences among grasses, subabool loppings and maize straw could not reach the level of significance.

Yield

Average yield per plant (102.47 kg) was recorded maximum in paddy straw mulch it was recorded lowest in control (82.30 kg) under rainfed conditions of hot semi-arid ecosystem and recorded 24.50 per cent more yield with paddy straw than control during 11th year of orchard life.

Quality attributes

The fruit weight (46.10g), fruit length (4.14 cm) and fruit breadth (4.20 cm) were recorded highest from the trees which were mulched with paddy straw mulch and and it was minimum in control

(weight-44.80g, length-4.00 cm and breadth- 4.04cm cm). The quality in terms of TSS (9.500 Brix), total sugars (6.00 %) and vitamin C (510 mg/ g) were recorded highest with paddy straw mulch and these parameters were recorded lowest in control.

Drip irrigation

An experiment on drip irrigation system was conducted on 10 year-old plants of aonla with seven treatments comprising of three intensities (20, 40, and 60 % wetted area) and two frequencies of irrigation (alternate day and 4th day interval) and control. Different treatment combinations of irrigation and per cent wetted area had influenced significantly the growth, yield and quality of aonla.

Vegetative growth

Results of the study on drip irrigation in aonla revealed that the maximum annual increase in vegetative growth in terms of plant height , stem girth and plant spread was recorded the highest from the plants which were irrigated at alternate day with 60 per cent wetted area. Similarly, plants irrigated at alternate day with 60 per cent wetted area had also the highest percentage of nutrient concentration in aonla shoots and being lowest under control.

Yield

Yield per plant (105.90 kg) was recorded highest in the plants which were irrigated at alternate day with 60 per cent wetted area and it was recorded lowest under control (89.93 kg). Nutrient status in aonla shoots was also increased by the different frequencies of irrigation and per cent wetted area than control.

Fruit quality

Fruit weight (50.00 g), fruit length (4.25 cm), fruit width (4.30 cm) were recorded maximum from the plants irrigated at alternate day with 60 per cent wetted area. The quality in terms of TSS (8.000 Brix), total sugars (5.72 %) and vitamin C (518.00 mg/ 100g) were recorded highest in the fruits of alternate day irrigation with 60 per cent wetted area.

Crop Physiology and Biotechnology

Development of phyto-chemical markers for arid horticultural crops

Phylogenetic inter-relationship among date palm cultivars using RAPD profile

A total of 43 date palm cultivars were screened using RAPD profile. Perusal of data revealed that amplification with OPD 1 gave a total of 9 bands. Among these, band numbers 5, 6 and 7 were present in majority of taxa, leaving band nos. 1, 2, 3 & 9 wererestricted representation. Similarly the data with OPD 3 revealed a total of 10 bands among all 43 cultivars attempted. Perusal of data revealed that band nos. 4, 5, 7 and 8 were distributed in majority of taxa whereas band nos. 1, 2, 3 & 10 were of restricted occurrence.

The data with OPD 5 showed a total of 7 amplified bands among which band nos. 2, 3, 4 and 5 were found in majority of taxa. However, other bands were of restricted occurrence. The data on OPD 16 showed only 6 bands, of which 4, 5 & 6 were having universal distribution, being represented in majority of taxon. However, the other bands had restricted distribution. The results of clustering demonstrated that the date palm cultivars can be grouped into 2 major groups.

Phylogenetic inter-relationship among bael cultivars using RAPD profile

A total of 10 cultivars of bael were screened using RAPD primers. A total of 3 primers were attempted during current study and it was observed that OPD 1 gave a total of 9 bands, none of which had universal occurrence. The cultivars which did

not show amplification with this primer were Pant Shivani, Pant Urvashi and Bikaner Local. OPD 3 gave a total of 7 amplified bands among which, 1, 2, 3 and 4 were represented in majority of taxon.

The results obtained with OPD 2 showed a total of 13 bands, of which band no. 1, 2, 3 were present in few cultivars whereas other bands were present in more than 60% of cultivars.

Physiological and biochemical investigations in horticultural crops under abiotic stresses

Effect of water stress on carbohydrate profile in mateera and musk melon

An experiment was conducted to study the carbohydrate profile in mateera and musk melon under different regimes of water stress. In this experiment, the seeds were germinated and then transferred in plastic pots. After 10 days of growth, the seedlings were given stress treatment by irrigating the seedlings with the solution of PEG 6000 having the water potential of 0.2 MPa, 0.5 MPa and 1.0 MPa. The controls were irrigated regularly.

After 15 days of treatment, the seedlings were harvested and separated into root and shoot. Both were analyzed for total soluble sugars and starch content. Perusal of data revealed that in root tissue, the level of soluble sugar content in mateera increases with the magnitude of the water stress. This is illustrated by the fact that the soluble sugar content in root was 50 mg g^{-1} fr. wt. in control which gradually increased to 86 mg g^{-1} fr.wt. in plants treated with 1.0 MPa solution. Similar results were also obtained in the root tissue of musk melon, but the level of sugar accumulation was much lower than that recorded in the mateera (Fig.20).

The data on soluble sugar content in shoot revealed that in the level of soluble sugar content in shoot is differs slightly with the imposition of water stress. This is illustrated by the fact that in control the level of soluble sugar was to the tune of 70 mg g^{-1} fr. wt. which increased slightly to 96 mg g^{-1} fr. wt. at 1.0 MPa treatment. Similar results were also obtained with respect to musk melon also (Fig. 21). The results highlights that accumulation of soluble sugars in root is the typical adaptive mechanism in drought tolerant plants. These reserve sugars not only increases the osmotic potential of the cell sap but also act as source of energy for growth and development as soon as the water is available to the plants.

The data on Starch content (Fig. 22-23) reveals that the starch content decreased with the imposition of the water stress. This is illustrated by the fact that in mateera the starch content was to the tune of 55 mg g^{-1} fr. wt. which declined to 36 mg g^{-1} fr. wt. at 0.5 MPa and to 16.0 mg g^{-1} fr. wt. at 1.0 MPa treatment. Similar results were also obtained in musk melon which also demonstrated decrease in the starch content in root.

Perusal of data on starch content in shoot revealed that starch content also declined with imposition of water stress. This is illustrated by the fact that in mateera shoot the starch content was 84 mg g^{-1} fr. wt. in control which dropped to 62.0, 56.0 and 32.0 mg g^{-1} fr. wt. at 0.2 MPa, 0.5 MPa and 1.0 MPa treatment, respectively.

The data were further analysed and it was found that the sugar/ starch ratio is also a typical parameter in adaptation to drought tolerance. The data on sugar/ starch ratio in root revealed that in mateera (drought tolerant) the ratio increased with increase in intensity of water stress. This is illustrated by the fact that the ratio was 0.91 at control which increased to 1.62, 2.05 and 5.37 at 0.2 MPa, 0.5 MPa and 1.0 MPa treatment. However, in musk melon the magnitude of increase in sugar/ starch ratio was very low (Fig. 24-25).

To develop ameliorating agents for frost

Frost is becoming the major constraint for production of horticultural crops in arid region. Thus,

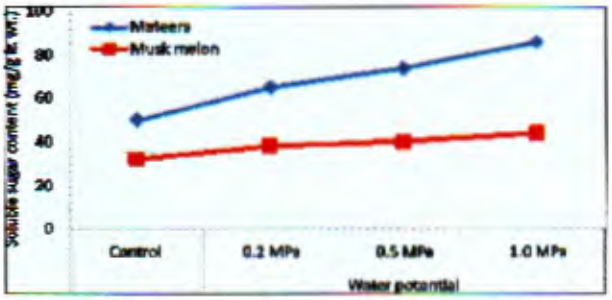


Fig. 20. Effect of water stress on soluble sugars in root

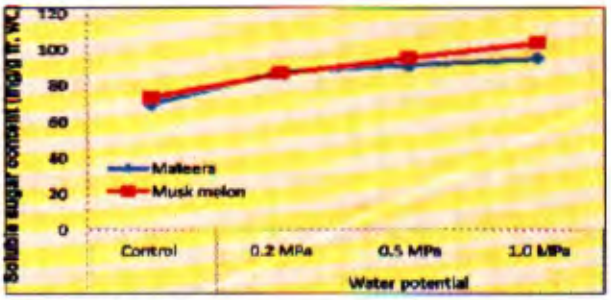


Fig. 21. Effect of water stress on soluble sugars in shoot

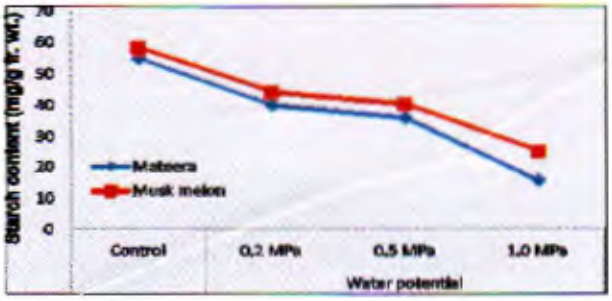


Fig. 22. Effect of water stress on starch content in root

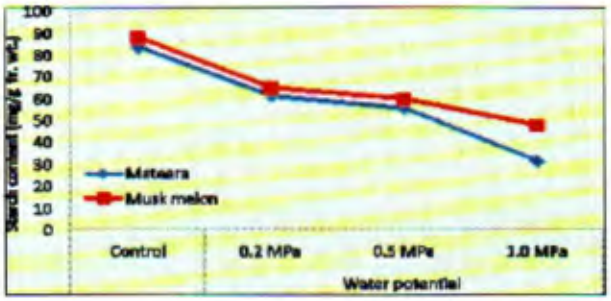


Fig. 23. Effect of water stress on starch content in shoot

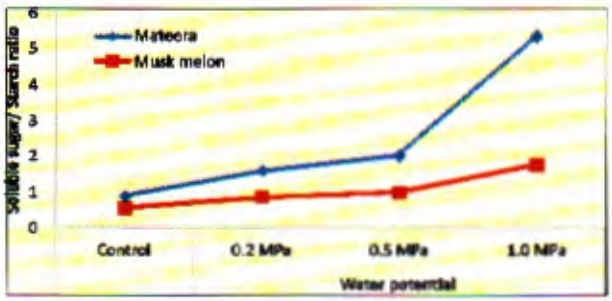


Fig. 24. Effect of water stress on soluble sugars/starch ratio in root

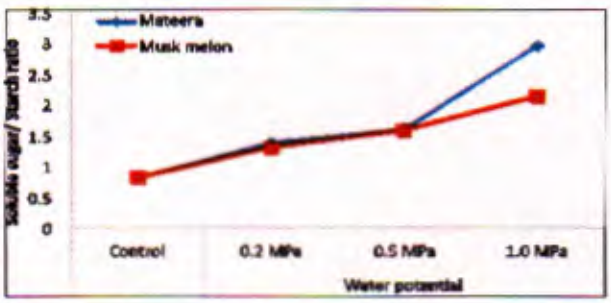


Fig. 25. Effect of water stress on soluble sugars/starch ratio in root

to ameliorate the effect of frost, various treatments such as 0.1% solutions of each Thiourea, Sulphuric acid, Sodium Salicilate, Calcium Nitrate and KNO3 were sprayed at 15 days interval from 1st December on ber, pomegranate, aonla and bael plants. After the occurrence of frost, the damage caused was assessed and it was found that in aonla none of the treatments were able to control damage by frost. However, in ber the damage was reduced by spraying 1% sulphuric acid, in pomegranate by spraying KNO3 and sodium salicylate, in bael by spraying KNO3 (Table 26).

In case of aonla, attempts were made to defoliate the leaves by spraying KI and ethaphon. The treatments were able to reduce the leaf load but were not able to control the damage from frost.

In lasora, the spray of KI was done to shed the leaves so that the plants can be saved from frost. The results demonstrated that no leaf shedding occurred, but the leaves turned yellow and they tide over the frost condition. The plants again regained after frost period (Fig. 26), whereas the control plants died due to frost (Fig 27).

Table 26. Effect of different ameliorating agents on the percentage of frost injury

Crop	CaNO3 (0.1%)	KNO3 (0.1%)	Thiourea (0.1%)	Sodium salicylate (0.1%)	H2SO4 (0.1%)	KI	Ethaphone
Ber	47.5	45.0	23.75	46.75	26.25	-	-
Bael	87.5	57.5	75	82.5	92.5	-	-
Pomegranate	66.25	62.5	78.75	60.0	76.28	-	-
Aonla	87.5	88.75	90.0	85.0	92.5	85.0	90.0

Fig. 26. Lasora plant treated with KI

Fig. 27. Untreated lasora plant

In vitro propagation

Establishment of aseptic culture of different cultivars of date palm

Different explants such as shoot tip, meristem pieces, leaf explants and immature fruit tissues of date palm cultivar Halawy were subjected for initiation of aseptic culture for callus induction and somatic embryogenesis. The explants initially washed thoroughly by tap water and thereafter subjected for different sterilization procedure using following treatments:

1. Sterilisation with 0.01% mercuric chloride solution for 1 hour
2. Sterilisation with 0.1% mercuric chloride solution for 10 minute
3. Sterilisation with 0.01% mercuric chloride solution for 1 hour+ ascorbic acid and citric acid(0.01%)
4. Sterilisation with 0.1% mercuric chloride solution for 10 minutes + ascorbic acid and citric acid(0.01%)

These treatments were found to show varied response to different explants. The maximum (80%) aseptic culture of inflorescence exlants were established with the procedure of sterilization with 0.1% mercuric chloride solution for 10 minutes + ascorbic acid and citric acid (0.01%). The better response (70%) was also observed with the procedure of sterilsation with 0.01% mercuric chloride solution for 1 hour+ ascorbic acid and citric acid (0.01%) when applied to leaf and fruit tissue explants. Shoot tip explants were responded poorly

with all sterilization procedures. The aseptic cultures of shoot tip explants were also gradually infected by endophyte bacterial contamination.

Studies on embryogenic callus formation in date palm

Different explants such as shoot tip, meristem pieces, leaf explants, root tip and immature fruit tissues of date palm cultivar Halawy were subjected for callus induction and somatic embryogenesis. The aseptic explants were inoculated on different media for callus induction and development of embryogenic condition of callus.

MS medium containing different additives and different plant growth regulators alone or in combination were used for callus induction.

The details of media compositions were as following:

For inflorescence explants

1. MS+NAA 0 mg/l
2. MS+NAA 0.1mg/l
3. MS+NAA 1.0 mg/l
4. MS+NAA 10 mg/l

For shoot tip and immature fruit tissue explants

1. MS+ 2, 4-D 0 mg/l
2. MS+ 2, 4-D 10 mg/l
3. MS+ 2, 4-D 50 mg/l
4. MS+ 2, 4-D 100 mg/l

For leaf and root section

1. MS+NAA 0.5 mg/l
2. MS+NAA 2.5mg/l
3. MS+NAA 5.0 mg/l
4. MS+2,4-D 0.5 mg/l
5. MS+2,4-D 2.5 mg/l
6. MS+2,4-D 5.0 mg/l
7. MS+ 2-iP 0.5 mg/l
8. MS+2-iP 2.5 mg/l
9. MS+2-iP 5.0 mg/l

The cultures of different explants were subjected for sub-culturing on the same media at 3-4 week intervals for callus initiation and embryogenesis. The cultures were incubated in dark. After three months of incubation, in explants particularly shoot tip exhibited growth and enlagement of the culture at media composition of MS+ 2, 4-D 100 mg/l whereas root sections shown adventitious root tip growth (Fig. 28). Callus obtained from these explants after 08 month of subculturing. Once the callus formation started, the callus was transferred for embryo formation on media devoid of hormone or at 0.5 NAA concentration. The developed embryos were transferred for germination on media containing 0.1 NAA.

Fig. 28. Adventitious root tip growth, callus formation and somatic embryo development in date palm

The inflorescence explants maintained healthy without browning up to 06 months by subculturing on media composition of MS+NAA 10 mg/l. After 06 month of culture initiation most of the explants

became brown and only few culture resulted callus growth. The resulted callus is being continuously subcultured for making its embrogenic state.

Only 3% leaf explants was found responsive to callus induction medium tried under the present experiment. Very less quantity of callus obtained in leaf explants at media composition of MS+2,4-D 5.0 mg/l, whereas other media compositions failed to result callus formation. However enlargements in leaf explants was noticed with media compositions of MS+NAA 2.5mg/l and MS+NAA 5.0 mg/l.

Optimisation of bioreactor parameter for organogenesis in date palm

The organogenesis of root and shoot formation is rather slow in date palm. In order to speed up the growth of shoot and root, the saplings developed through zygotic embryos were transferred in bioreactor culture vessel of 3.0 L media capacity containing salts of MS medium with 0.1 mg per litre NAA. Three regimes of temperatures such as 23°C, 28 °C and 33°C were tested for improving growth of shoot and root formation. The better shoot growth was recorded at 23°C whereas root growth was maximum at 28 °C.

Studies on induction of multiple micro sucker and induction of rooting in micro suckers

The experiment conducted in green house and 50% ago shade net house. The 02 years old date palm seedling plants were planted in shade house during the month of August 2011 for induction of multiple sucker. The plants were maintained with proper fertilization and irrigation either through mist or drip system. The plants were periodically sprayed with different concentration of BA (0, 25 and 50 mg/l) during the month of February, July and October. At the same time leaf pruning was also performed. The maximum sucker (8 suckers per plant) were recorded in plants treated with 50 mg/l BA within a year of the study. The mist irrigation system was found to encourage scale insect infestation in the plants. Thus, for further experimentation, the drip method of irrigation is being used for watering in the plants.

Standardization of environmental parameters for hardening plantlets of date palm

Plantlets derived from zygotic embryos of date palm cultivar halawy were evaluated for survival during hardening procedure under three step plant hardening unit. To improve the desiccation problem of in vitro raised plantlets during hardening process, 20 plants were transferred in pots containing potting mixture of sand, vermiculite and coco peat in the ratio of (1:1:1) and put inside environmentally controlled green house under 30 ±2°C temperature, 10000 Lux light intensity and 03 level relative humidity (60, 70 and 80%). Only 40% of plants survived at 70% RH where as the humidity level of 60% and 80% were found detrimental in terms of either desiccation of leaves or rotting of leaves respectively. Further, experiments are needed for ON/OFF timings of intermittent mist and other parameters

Molecular Biology

Identification of specific marker var. Thar Shobha of khejri (*Prosopis cineraria*)

The screening of RAPD markers specific to Khejri variety Thar Shoba was done by bulk segregant analysis method (BSA). Genomic DNA extracted from the leaves of fifteen naturally growing khejri trees were pooled to make bulk of one set and another was genomic DNA of Thar Shoba. These two samples were tested with eighty random primers (twenty of each series of OPA, OPN, OPBA and OPBE primers) in PCR. Out of 80 random primers, nine primers such as OPBE02, OPBE04, OPBE05, OPBA04, OPBA13, OPN09, OPA12,

OPA14 and OPA18 were found to be differentiating Thar Shoba from other naturally growing khejri trees. Further, these primers were used in PCR with large number of genomic DNA samples extracted from naturally growing trees to ascertain its specificity and efficiency. Totally 83 khejri tree samples were collected from different regions of Thar desert and their genomic DNA was extracted. The DNA of these samples was subjected to PCR with nine differentiating primers. Out of nine primers four (OPBA13, OPA12, OPA14 and OPBE05) were specific to Thar Shoba and differentiating from natural population with 100 per cent efficiency (Table 27). The banding profiles generated by these primers were similar between natural population and Thar Shobha except the 200 bp produced by OPBA13, 350 bp by OPBE05, 550 bp by OPA12 and 300 bp by OPA14 were found specific to Thar Shoba (Fig. 29). PCR reaction was performed thrice to know its reproducibility of random primers.

Table 27. Details of screened RAPD primers specific to Thar Shoba

S.No	RAPD Primer name	Size of the band specific to Thar Shoba (bp)	Level of specificity (%)
1	OPBE02	480, 700	94
2	OPBE04	350	96.4
3	OPBE05	350	100
4	OPBA04	1400, 1500	89.2
5	OPBA13	200	100
6	OPN09	1000	86.7
7	OPA12	550	100
8	OPA14	300	100
9	OPA18	750, 1400	94

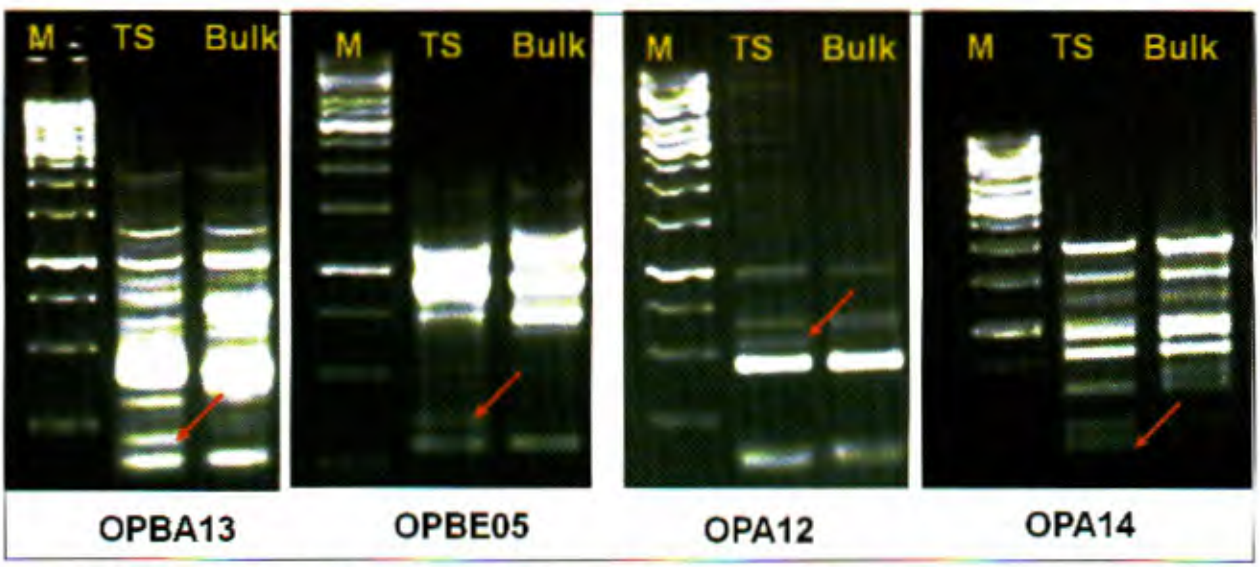


Fig. 29. Random primers differentiating khejri variety Thar Shoba from the natural population (arrow indicates bands specific to Thar Shoba)

Crop Protection

At Bikaner

Screening of watermelon and bottle gourd genotypes for tolerance against diseases under field conditions

The field trials were carried out during 2012 for screening of 22 watermelon genotypes such as RW-177-3, RW-187-2, Charleston Gray, Mahbooby, IC- 315313, IC- 325808, Thar Manak, AHW- 19, AHW- 65, Ashahi Yamato, Sugar Baby, Arka Manak, GP- 20, GP- 35, GP- 42, Bikaner Local-1, Bikaner Local-2, Chomu Local, Churu Local, Jaisalmer Local, Barmer Local-1 and Barmer Local-2 and 20 bottle gourd genotypes (Pusa Santushti, Pusa Sandesh, PSPL, Chomu Local, Azad Harit, Panchmahal Local, Pusa Naveen, Pusa Samridhi, Udaipur Local, Arka Bahar, Thar Samridhi, PN-22, DBG-5, DBG-6, Jodhpur Local, IC-567538, Sriganganagar Local, Tonk Local, Punjab Long and Nagaur Local) for tolerance against diseases under field conditions without applying of plant protection measures. Among 22 watermelon genotypes, disease incidence of mosaic symptoms ranged from 5.0 to 26.67%. Minimum disease incidence (5.0%) was recorded in variety 'Ashahi Yamato' against mosaic disease. Disease severity of Alternaria blight was also observed from 5.75 to 21.50% in watermelon genotypes.

Among 20 bottle gourd genotypes, all the genotypes were infected with Alternaria leaf blight, Cercospora leaf spot (Fig. 30) and powdery mildew (Fig. 31) to some extent. Disease severity of Alternaria leaf blight and Cercospora leaf spot was also recorded from 4.50 to 20.75% and 5.25 to 26.25%, respectively. Disease severity of powdery mildew ranged from 7.50 to 53.25%. Six varieties such as Pusa Naveen, Pusa Samridhi, Pusa Santushti, Pusa Sandesh, PSPL & Arka Bahar and two varieties (Pusa Naveen and Pusa Samridhi) showed less disease severity (up to 10%) against Alternaria leaf blight and powdery mildew, respectively. Minimum disease severity was found in four varieties viz., Pusa Naveen, Pusa Santushti, Pusa Samridhi and Pusa Sandesh against Cercospora leaf spot of bottle gourd.

Powdery mildew of ber

The powdery mildew of ber is a recalcitrant disease problem for this region and has to be dealt with a multipronged strategy.

New disease resistant/disease tolerant genotypes

An orchard of 60 ber plants of seedling origin was raised in the year 2006 and the plants were screened against powdery mildew. Mean infection of powdery mildew (measured in terms of Percent Disease Index,PDI) was ranging between 5.88 to

Fig. 30. Cercospora leaf spot symptoms

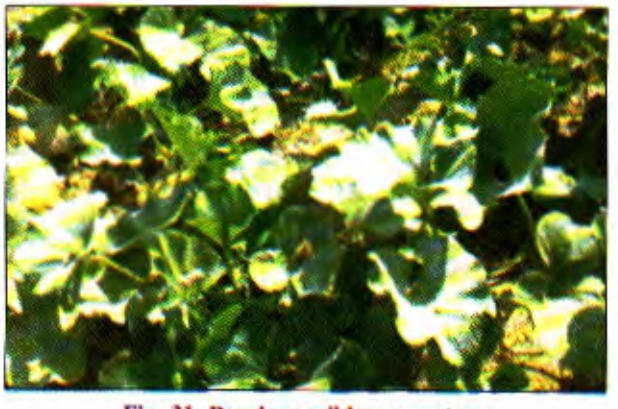


Fig. 31. Powdery mildew symptoms

43.2. After evaluation, 6 plants were identified which were further evaluated and only 3 plants have been selected which are numbered as 10.2, 13/2 and 2/2, and which have better fruit quality with low powdery mildew infection. The fruit size of these plants ranged between 20 to 30.5 g, and TSS ranging between 18-22.6° Brix. Genetype 2/2 had acidity 0.621%. The genotypes have thicker fruit skin but they were tasting good. The mean disease intensity ranged between 8-9 in 2/2 to 18.1 in 13/2. They were also subjected to artificial inoculation and the results were confirmed. The selected genotypes were multiplied in field and were also evaluated for their performance.

Pesticidal control of ber powdery mildew

A schedule of spray evolved earlier for this region was further tested and it was found very efficacious and was recommended for powdery mildew control. Accordingly to it, the first spray should be with a systemic fungicide vig. Tridemefon 25 wp (Bayleton, 0.1%) or peneconazole (Topas, 0.05%)or hexconazole 10EC (Contaf, 0.1%)during the first week of October which should be followed by a second spray after an interval of 12-15 days with wettable sulphur 80 wp (Sulfex, 0.25%) and a third spray after a careful monitoring with the same fungicide i.e. Sulfex, 0.25%. This schedule protects the crop from aggressive attack of powdery mildew in October to first half of November when flowering, anthesis pollination and fruit set is taking place; and when sulphur (a cheaper fungicide) sprays should be avoided at the flowering time.

In order to further strengthen this schedule mixing of pot. dihydrogen phosphate (0.5%) with fungicides, addition of detergent powder (10-15g/10 l water), mixing with liquid formulation of insecticides, etc. were also found effective. Because of timely application of this schedule, the powdery mildew was found completely manageable in plant protection plots. Mean PDI ranged between 2.81 in treatment to 31.2 in untreated control of the same plots and above 50-60 percent in other plots.

Foliar spray of inorganic salts and organic compounds of non-pesticidal nature to manage ber powdery mildew

Two sprays on variety Gola during October month with KH_2PO_4 (0.5%) (PDI=12.81), $NaHCO_3$ (0.5%) (PDI=19.25), $MgSO_4$ (0.1%) (1991), CaCl2 (0.5%), (21.51), KMS (Pot. metabisulphite) (0.1%) (22.66), phenol, 0.1% (27.18), and $KMnO_4$ (0.1%) (26.25) were able to reduce the disease servcrity, the untreated control plants had PDI=36.2.

Disease Management in *Pseudocercospora punicae* leafspots by foliar sprays of inorganic salts

The disease was not very severe during the main fruiting season, the hasta bahar. During rainy season spray with copper oxychloride 50 wp (Blitox, 0.3%) (PDI=5.42) mancozeb 72 wp (Indofil M-45, 0.2%)(PDI=6.0) KH_2PO_4 (0.1M) (PDI=8.2), KMS (0.1%) (8.5), and $KMnO_4$ 0.1% (9.5) were found effective in reducing the disease intensity which ranged between 12.32 to 17.1 in control. Mixing of KH_2PO_4 (0.5g/l)with Blitox (3g/l) reduced the disease severity from 12.32 in control to 2.8 in treatment.

Disease Management in aonla

Pink fruit spots were best managed by one spray of copper oxy-chloride 50 wp @ 3g/l during middle of August. Spray with KH_2PO_4, 1000ppm and Borex, 6000 ppm were also effective in diseae reduction.

Fruit rot of aonla due to Penicillium islandicum was found to be managed by one pre harvest spray with KH_2PO_4 (1000ppm), Carbendazim (0.05%), or Pot. Metabisulphate (0.1%). The best control however, was achieved by dipping the fruits in chlorothalonil (0.05%), or 10% brine or carbendazim (0.05%) for 5-10 min. Additional care like avoiding bruising during picking, transport and storage and

culling of rotten fruits during initial 3-4 days also helped managing the disease with almost negligible infection upto 10-11 days.

Use of foliar fertilizer sprays to manage Cercospora leafspots and powdery mildew of bottle gourd

Cercospora laginariae leafspots of bottlegourd were found to be best managed by foliar sprays during September of Carbendazim (0.05%) mixed with KH_2PO_4 (5%) with PDI= 6.0 as compared to 27.4 in control. Sprays of phenol (0.05%) (PDI=8.3), Carbendazim (0.0.5%)(7.2) KMS, 0.1& (13.5), $KMnO_4$, 0.1% (21.8) and Acetyl salicylic acid, 500ppm (17.6) also helped reduce the disase intensity. Powdery mildew (Sphaerotheca fuligenea) was also best managed by spraying with carbandazim 0.0.5% + KH_2PO_4 (0.5%) (PDI= 12.4), carbendazim alone (6.3), $KMnO_4$ 0.1% (9.5) and $CaCl_2$ (0.1%) (14.2) when compared with untreated control (12.5).

Downy mildew of another cucurbit, spongegourd, caused by Pseudoperonospora cubensis was best managed by spray with copper oxychloride Blitox (PDI=11.2) or mancozeb, 0.2% (PDI=9.5). However, only KH_2PO_4 (PDI=20.2), phenol (0.0.5%) (22.3) and KMS (23.7) reduced the disease intensity as compared to control (35.2).

Biological control of diseases

Biocontrol of post emergence damping off (PEDO) in tomato nursery

The seed of tomato when treated with the local isolate of Trichoderma viridae recorded less disease incidence of PEDO (17 per bed, small plot of size 0.25m^2) as compared to its respective control (57). The fungicides treated seeds showed very less mortality (02) whereas the solarized plot recorded slightly more (22), the formalin treated plot recorded (05) mortality incidence. There was not much variation in efficacy amongst various cultures and it was concluded that the isolation should be carried out from the soil where vigorous plants are growing without any sign of soil borne diseases.

The seedling stand was also more in case of T.viridae treated seeds (252), as compared to untreated control (105) However, in soil-solarized beds, no. of plants was 215, in formaldehyde treated beds, it was 247 whereas in Ridomil MZ treated plots, it was 272.

Biocontrol effeicacy of Ampelomyces quisqualis isolates against okra powdery mildew

This year infection on okra was negliable, even after spray of A.Q. culture. The infection percentage was not very high (22.5 percent), hence it was not considered for drawing any conclusion.

Multiplication of VAM fungus on maize roots

VAM fungus (Glomus mosseae and other Glomus spp) were multiplied on the maize roots by the previously standardized method which was based on the reports from IIHR, Bangalore on Ragi. The infection percentage was estimated by the method suggested by Nency Johnson (1999).

Leaf litter decomposing fungi

Out of a mixture of 4 fungi 3 were successfully isolated, cultured, multiplied and added to compost pits; which decomposed the leaves in 3-4 months.

Studies on multiplication of resistance against fungicides

Out of about 12 isolates of *T. viridae*, none exhibited any resistance against the three fungicides commonly used for treating the seeds to protect them from PEDO viz. Ridomil MZ, Blitox and mancozeb. Assessing them by the poisoned food

techniques and spore germination, all isolates were found sensitive to the three poisons.

Studies on multiplication of antagonistic fungi *T. viridae* on cheaper medium

T. viridae was best multiplied on FYM. Following method was attempted for multiplication:

- The fungus was grown on PDA in Petriplates for 7 days. Then it was thoroughly mixed with sterilized FYM (1 kg lots kept in Hi-media autoclaveable polythene bags and sterilized for at 15lb/sq.inch and then cooled at room temperature before inoculation).
- These bags were in turn used for inoculation of larger lots (10kg FYM, sterilized similarly) moisture level was maintained 70-80% in both the cases. These cultures have enough cfu for using them as inoculants.

During the routine plants pathological studies, a need was felt to evolve quick method for microscopic examination of hyalive fresh fungi. Phloxine method was used and it was refined by adding thymol crystal, glycerol, $NaHCO_3$ or NaOH pallets, or rose-bangal, wherever needed. This extra addition improved the efficiency of phloxine stain and removed difficulties like growth of water moulds in stain in bottle, poor staining of naturally acidified tissue like tamarind mango and aonla fruit, quick drying of mounting medium, and low staining of cytoplasm.

Insect Pest Management

Khejri

Incidence and morphomatric analysis of Homoeocerus variabilis

During the present study, the average incidence of coreid bug, Homoeocerus variabilis on khejri plant ranged between 16.7 and 66.7 per cent. The incidence and the numbers were higher in winter months (November to February) than during other seasons and the maximum incidence of 66.7 per cent was recorded in December and the minimum in July. Thus the highest mean number of this bug species per tree was recorded in December (222.9/plant) followed by January (198.5/plant) and the lowest was in July (27.3/ plant). The data linear measurements of the coreid bug, *H. variabilis* have been presented in Tables 28 and Fig.32. The females laid eggs in soil at a depth of 4 to 7 mm. Eggs are light green in colour, elongated and oval shape. The length and width of adult male body was 12.220 mm and 4.275, with antennal length 10.405 mm. The width of head, length and width of thorax and scutellum measured 1.386 mm, 1.999 mm, 3.087mm and 1.786 mm, respectively. The length of fore, middle and hind was measured 8.343 mm, 9.143 mm and 12.484 mm, respectively. The female was distinctly bigger than the male, with the length and width of body, length of antenna, width of head, length and width of thorax, length of scutellum and length of fore, middle and hind leg measuring as 15.493 mm, 5.775 mm, 11.411 mm, 1.541 mm, 2.786 mm, 4.506 mm, 2.045 mm, 9.449 mm, 10.136 mm and 14.689 mm, respectively (Table 29).

Muskmelon

The eleven varieties/ genotypes were selected for final evaluation trials against fruit fly, *Bactrocera cucurbitae* (Coquillett) resistance. AHMM/BR-1, RM-50 and AHMM/BR-8 were the most resistant; MHY-5, D. Madhu and Pusa Sharabati were moderately resistant; AHMM/BR-13, Pusa Madhuras and Arka Jeet were susceptible whereas Arka Rajhans and GMM-3 were highly susceptible varieties/ genotypes in both seasons (Table 30). The fruit fly infestation and larval density were higher in rainy season than summer season. The larval density per fruit increased with an increase in percentage fruit infestation and there was a significant positive correlation ($r = 0.971$; $p < 0.01$) between per cent fruit infestation and larval density per fruit (Table 31). Pooled data of larval density

Table 28. Mean linear morphometric data of different life stages of bug (*Homoeocerus variabilis*)

S. No.	Measurement (mm)	Nymphs*					Adults*	
		I instar	II instar	III instar	IV instar	V instar	Male	Female
1.	Length of body	4.093± 0.011	7.444± 0.010	8.700± 0.014	10.523± 0.017	11.390± 0.081	12.220 ± 0.081	15.493± 0.036
2.	Width of body	1.971± 0.015	3.251± 0.010	3.993± 0.006	4.379± 0.007	4.848± 0.012	4.275± 0.027	5.775± 0.051
3.	Length of antenna	4.016± 0.016	6.603± 0.013	7.803± 0.017	8.406± 0.014	8.984± 0.010	10.405 ± 0.013	11.411± 0.022
4.	Width of head	0.727± 0.004	1.152± 0.003	1.276± 0.004	1.357± 0.003	1.405± 0.002	1.386± 0.004	1.541± 0.007
5.	Length of thorax	0.516± 0.004	0.862± 0.003	0.966± 0.003	1.119± 0.002	1.271± 0.003	1.999± 0.016	2.786± 0.020
6.	Width of thorax	0.827± 0.004	1.596± 0.005	1.786± 0.004	2.523± 0.010	2.761± 0.004	3.087± 0.014	4.506± 0.012
7.	Length of scutellum	1.158± 0.007	1.498± 0.013	2.491± 0.011	3.175± 0.007	3.488± 0.009	1.786± 0.008	2.045± 0.008
8.	Length of fore leg	2.508± 0.014	5.570± 0.021	6.564± 0.017	7.825± 0.013	8.128± 0.015	8.343± 0.016	9.449± 0.025
9.	Length of middle leg	2.753± 0.038	5.304± 0.013	6.584± 0.019	7.920± 0.016	8.355± 0.013	9.143± 0.020	10.136± 0.024
10.	Length of hind leg	3.288± 0.021	7.070± 0.015	8.325± 0.014	9.573± 0.013	10.242± 0.046	12.484 ± 0.026	14.689± 0.024

*Mean of twenty specimens ± S. Em.

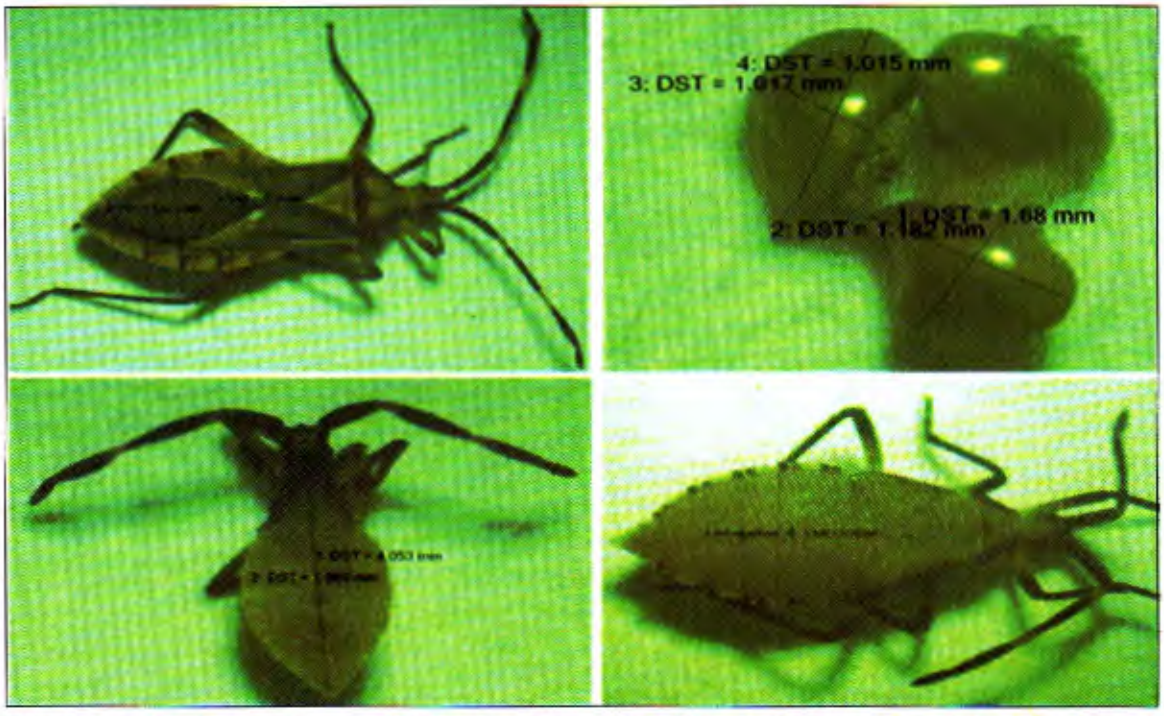


Fig. 32. Different developmental stages of Homoeocerus variabilis: Upper left, adult; upper right eggs; lower left, 1st instar nymph; lower right, 5th instar nymph.

Table 29. Mean linear adult morphometric data of bug (*Homoeocerus variabilis*)

S. No	Body parts measured (mm)		Male	Female
			Mean* ± S. Em	Mean* ± S. Em
1.	Length of parts of antenna	Scape	0.436 ± 0.002	0.496 ± 0.002
		Pedicel	2.467 ± 0.007	2.662 ± 0.008
		Flagellum	7.543 ± 0.012	8.265 ± 0.033
2.	Length of hemielytra		9.049 ± 0.033	11.185 ± 0.056
3.	Width of hemielytra		2.579 ± 0.006	8.371 ± 0.009
4.	Length of hind wing		7.278 ± 0.025	9.019 ± 0.016
5.	Width of hind wing		2.404 ± 0.006	3.409 ± 0.007
6.	Length of body up to genitalia		12.220 ± 0.081	15.493 ± 0.036
7.	Length of body up to wing tip		11.678 ± 0.043	14.362 ± 0.039
8.	Width of scutellum		2.366 ± 0.014	2.886 ± 0.005
9.	Width of vertex		0.255 ± 0.002	0.360 ± 0.004
10.	Vertical diameter of eye		0.464 ± 0.003	0.571 ± 0.004
11.	Transverse diameter of eye		0.441 ± 0.002	0.494 ± 0.003
12.	Length of sternum region		2.251 ± 0.008	2.779 ± 0.018
13.	Width of sternum region		2.993 ± 0.013	3.347 ± 0.008
14.	Length of rostrum		3.077 ± 0.016	3.695 ± 0.024
15.	Length of parts of fore leg	Coxa	0.697 ± 0.004	0.742 ± 0.003
		Femur	2.984 ± 0.014	3.239 ± 0.013
		Tibia	3.075 ± 0.012	3.720 ± 0.014
		Tarsus	1.588 ± 0.013	1.748 ± 0.006
16.	Length of parts of middle leg	Coxa	0.700 ± 0.004	0.843 ± 0.004
		Femur	3.150 ± 0.010	3.631 ± 0.015
		Tibia	3.539 ± 0.013	3.846 ± 0.013
		Tarsus	1.755 ± 0.008	1.817 ± 0.006
17.	Length of parts of hind leg	Coxa	0.803 ± 0.003	0.881 ± 0.006
		Femur	4.726 ± 0.016	5.251 ± 0.017
		Tibia	5.084 ± 0.017	6.323 ± 0.016
		Tarsus	1.872 ± 0.003	2.235 ± 0.007

*Mean of twenty specimens

per fruit in both the seasons (11.14-24.30 larvae per fruit) was significantly lower in resistant varieties/ genotypes and higher in susceptible varieties/ genotypes. The fruit infestation in rainy season ranged from 13.33 to 86.11% whereas in summer season, its ranged from 12.63 to 79.52%. Pooled data of fruit infestation in both seasons (12.98-82.81%) was significantly lowest in resistant varieties/ genotypes and highest in susceptible varieties/ genotypes. In both seasons pooled data, the per cent fruit infestation was highest in Arka Rajhans (82.81 %) and lowest in AHMM/BR-1 (12.68 %) followed by RM-50 (15.49 %) (Table 30).

Table 30. Larval density and per cent fruit infestation of fruit fly on different varieties/ genotypes of musk melon during final screening trials

Varieties/ genotypes	Larval density/ fruit			Fruit infestation (%)			Resistance category
	Rainy season	Summer season	Pooled	Rainy season	Summer season	Pooled	
AHMM/BR-8	12.44^{a}	12.42^{ab}	12.43^{a}	17.22 (24.47)*^{ab}	14.21 (22.13)^{a}	15.72 (23.34)^{a}	R
RM-50	12.33^{a}	11.78^{a}	12.06^{a}	16.67 (24.07)^{a}	14.31 (22.21)^{a}	15.49 (23.16)^{a}	R
AHMM/BR-1	11.22^{a}	11.06^{a}	11.14^{a}	13.33 (21.38)^{a}	12.63 (20.78)^{a}	12.98 (21.11)^{a}	R
MHY-5	15.78^{b}	14.32^{bc}	15.05^{b}	33.89 (35.58)^{b}	26.39 (30.87)^{b}	30.14 (33.28)^{b}	MR
Durgapura Madhu	17.22^{bc}	16.45^{cd}	16.84^{bc}	41.11 (39.86)^{cd}	33.72 (35.48)^{c}	37.41 (37.70)^{c}	MR
Pusa Sarabati	18.56^{cd}	18.22^{de}	18.39^{cd}	47.22 (43.39)^{de}	45.82 (42.58)^{d}	46.52 (42.99)^{d}	MR
Arka Jeet	19.34^{cd}	19.06^{cf}	19.19^{c}	62.78 (52.47)^{f}	58.00 (49.59)^{e}	60.39 (51.00)^{e}	S
AHMM/BR-13	19.78^{de}	20.40^{efg}	20.09^{de}	61.00 (51.36)^{f}	58.08 (49.64)^{e}	59.54 (50.48)^{e}	S
Pusa Madhuras	21.89^{e}	20.71^{fg}	21.30^{ef}	51.11 (45.62)^{e}	49.04 (44.43)^{d}	50.08 (45.02)^{d}	S
Arka Rajhans	24.89^{g}	23.71^{h}	24.30^{g}	86.11 (68.14)^{g}	79.52 (63.11)^{f}	82.81 (65.53)^{f}	HS
GMM-3	23.44^{fg}	22.78^{gh}	23.11^{fg}	81.11 (64.35)^{g}	76.35 (60.91)^{f}	78.73 (62.52)^{f}	HS

*Values in parenthesis are angular-transformed

Biochemical fruit traits of the re-evaluated muskmelon varieties/ genotypes

Total sugar, reducing sugar and non-reducing sugar of different varieties/ genotypes fruits were ranged from 309 to 553.27, 62.07 to 124.27 and 246.93 to 429 (mg/g on dry weight basis), respectively with values significantly lower in resistant varieties/ genotypes and higher in susceptible varieties/ genotypes. The pH was significantly highest in Arka Rajhans (6.56) and lowest in RM-50 (5.67). Tannins, phenols, total alkaloid and flavinoid contents ranged from 0.02 to 0.12 mg/g, 15.27 to 39.13 mg/g, 0.24 to 1.25 % and 0.40 to 1.05 mg/g, respectively with values significantly higher in resistant varieties/ genotypes and lower in susceptible varieties/ genotypes (Table 31). Total sugar, reducing sugar, non-reducing sugar and pH of fruit had a significant positive correlation ($P = 0.01$) whereas, tannins, phenols, alkaloids and flavinoid contents had significant negative correlations with the percentage fruit infestation and

Table 31 Biochemical fruit traits of different varieties/ genotypes of musk melon

Varieties/ genotypes	Total Sugar** (mg/g)	Reducing Sugar** (mg/g)	Non Reducing Sugar** (mg/g)	Tannins content** (mg/g)	Phenols Content** (mg/g)	Total alkaloids** (%)	Flavinoid content** (mg/g)	pH***
AHMM/BR-8	336.97 (18.38)^{efg}	66.60 (8.22)^{ab}	270.37 (16.47)^{fg}	0.12^{a}	34.73^{b}	1.11^{b}	1.05^{c}	5.87^{abc}
RM-50	353.34 (18.32)^{efg}	72.4 (8.57)^{bc}	280.87 (16.79)^{fgh}	0.12^{a}	38.50^{a}	1.18^{b}	0.97^{b}	5.67^{a}
AHMM/BR-1	309.00 (17.60)^{a}	62.07 (7.93)^{a}	246.93 (15.73)^{a}	0.13^{a}	39.13^{a}	1.25^{a}	1.01^{ab}	5.77^{ab}
MHY-5	357.57 (18.94)^{efg}	76.27 (8.79)^{cd}	281.30 (16.80)^{fgh}	0.09^{b}	31.17^{c}	0.89^{c}	0.76^{d}	5.74^{a}
Durgapura Madhu	361.83 (19.05)^{g}	81.37 (9.08)^{de}	280.47 (16.78)^{fgh}	0.07^{bc}	28.43^{d}	0.87^{c}	0.83^{c}	6.01^{b}
Pusa Sarabati	366.90 (19.18)^{g}	86.23 (9.34)^{e}	280.67 (16.78)^{fgh}	0.08^{b}	27.07^{de}	0.74^{d}	0.67^{e}	6.06^{c}
Arka Jeet	403.17 (20.10)^{g}	105.07 (10.30)^{f}	298.10 (17.29)^{g}	0.06^{cd}	19.77^{f}	0.39^{ef}	0.57^{f}	6.04^{c}
AHMM/BR-13	393.63 (19.87)^{g}	101.93 (10.15)^{f}	291.70 (17.11)^{g}	0.05^{d}	21.77^{f}	0.44^{e}	0.76^{d}	6.36^{d}
Pusa Madhuras	370.63 (19.28)^{g}	89.93 (9.54)^{e}	280.70 (16.78)^{fgh}	0.08^{b}	26.37^{d}	0.69^{d}	0.73^{de}	6.03^{c}
Arka Rajhans	553.27 (23.54)^{h}	124.27 (11.18)^{g}	429.00 (20.73)^{h}	0.02^{e}	15.27^{g}	0.24^{f}	0.40^{h}	6.56^{d}
GMM-3	519.27 (22.80)^{h}	116.60 (10.84)^{g}	402.67 (20.09)^{h}	0.03^{e}	16.27^{g}	0.30^{f}	0.48^{g}	6.54^{d}

*Values in parenthesis are square root-transformed, **Analysis on dry weight (DW) basis, ***Analysis on fresh weight (FW) basis Value following different letter are significantly different using Turkey's HSD test

Table 32. Correlation coefficient (r) between percent fruit infestation and larval density per fruit with different biochemical fruit traits of muskmelon varieties/ genotypes

	% Fruit Infestation	Larval Density	TS	RS	NRS	TC	PC	TAC	FC
Larval Density	0.971**								
TS	0.893**	0.835**							
RS	0.986**	0.940**	0.924**						
NRS	0.808**	0.759**	0.970**	0.838**					
TC	-0.969**	-0.928**	-0.904**	-0.970**	-0.824**				
PC	-0.987**	-0.953**	-0.861**	-0.973**	-0.775**	0.969**			
TAC	-0.985**	-0.948**	-0.847**	-0.978**	-0.751**	0.960**	0.993**		
FC	-0.951**	-0.916**	-0.877**	-0.939**	-0.794**	0.917**	0.933**	0.930**	
pH	0.855**	0.825**	0.865**	0.851**	0.831**	-0.848**	-0.839**	-0.822**	-0.700*

**Significant at P = 0.01 (two-tailed)

* Significant at P = 0.05 (two-tailed)

TS- total sugar (mg/g), RS- reducing sugar (mg/g), NRS- non-reducing sugar (mg/g), TC- tannins content (mg/g), PC- phenols content (mg/g), TAC- total alkaloid content (%) & FC- flavinoid content (mg/g).

the larval density per fruit (Table 32). Backward stepwise regression analysis indicated that total alkaloid and pH contents explained 97.96% of the total variation in fruit fly infestation. The maximum variation in fruit infestation was explained by total alkaloid contents (97%) followed by pH contents (0.96%), flavonoid (0.88%), total sugar (0.51%), phenols (0.32%), reducing sugar (0.18%), non-reducing sugar (0.10%) and tannins (0.01%). The total alkaloid and total sugar contents explained 92.83% of the total variation in larval density per fruit. The maximum variation in larval density per fruit was explained by total alkaloid (89.77%) followed by total sugar (3.06%), flavonoid (0.86%), pH (0.76%), phenols (0.74%) and non-reducing sugar (0.69) whereas, rest of the biochemical fruit traits explained <0.1% variation in larval density.

Post harvest management and value addition in arid horticultural crops

At Bikaner

Preparation of bael pulp powder and RTS

Bael pulp powder was made from ripe fruits of bael. For this, the pulp was extracted and seeds removed. The pulp was dried under low temperature in shade. The powder thus produced was collected and stored in glass jars. At different duration of storage (Table 33), RTS was prepared using this powder and organoleptic testing was perfomed using 10 judges. The scoring revealed that the RTS prepared from bael powder scored high at 2 months storage with an overall acceptability of 6.6. Similar results were also obtained at 3 and 5 months storage when the RTS was rated high with acceptability of 6.33 and 7.15, respectively. The RTS prepared after 6 months storage revealed that the acceptability of bael powder RTS dropped very low and became unacceptable to the consumers. Thus, it can be concluded that that the bael powder can be stored at room temperature up to 5 months and RTS can be prepared from this.

Table 33. Organoleptic scoring of different products developed from bael juice

Parameter	2 months	3 months	5 months	6 months
Appearance	7.6	8.3	7.85	4
Taste	6.2	7.44	7.25	3
Flavour	6.6	7.22	6.5	2
Colour	7.8	7.72	8.1	5
Sweetness	7.0	7.16	7.65	3
Acceptability	6.6	6.33	7.15	4

Development of value added product from kinnow fruits

In order to utilize the unmarketable size kinnow fruits, an experiment was conducted to develop Ready to Serve drink (RTS) from these fruits. In order to further value add this product, attempts were made to blend this juice with carrot juice or ginger or combination of both. The organoleptic sores obtained from the testing are presented in table 34. Perusal of data revealed that the RTS from plain kinnow juice rated high on all points and had an overall acceptability of 6.5. The blending of this with 30% carrot juice also showed similar preference being rated 8.0 for colour, 7.0 for taste, 7.5 for appearance, 7.16 for sweetness and 6.5 for flavor.

Blending of kinnow juice with ginger was rated low by the panel of judges having an over all acceptability score of 5.5. This was rated 6.9 for colour, 5.5 for taste, 6.0 for appreanace, 5.5 for sweetness and 5.0 for flavor. Similarly, blending of kinnow juice with mint showed high acceptance, as is illustrated by the over all acceptability score of 7.5. This RTS was rated 7.0 for colour, 7.5 for taste, 7.58 for appearance, 7.5 for sweetness and flavor.

In an another combination, viz. Kinnow juice + carrot juice + ginger, the acceptability was low i.e. 5.0. The RTS rated 6.5 for colour, 5.5 for taste, 6.16 for appearance, 5.8 for sweetness and 5.3 for flavor.

Table 34. Organoleptic scores of different products developed from kinnow juice

Parameter	Kinnow juice	Kinnow juice + ginger	Kinnow juice+ carrot juice (30%)	Kinnow juice + mint	Kinnow juice+ carrot juice (30%) + ginger
Colour	7.5	6.9	8.0	7.0	6.5
Taste	7.3	5.5	7.0	7.5	5.5
Appearance	7.0	6.0	7.5	7.58	6.16
Sweetness	6.16	5.5	7.16	7.5	5.8
Flavour	6.5	5.0	6.5	7.5	5.3
Acceptability	6.5	5.5	6.6	7.5	5.0

Thus, it is concluded that kinnow juice as such is acceptable to the consumers and further by adding carrot juice (30%) or mint flavor can add value to this product.

Storage studies in ber

Varietal variation in shelf life

An experiment was laid out to study the shelf life of ber cultivars, viz. Gola, Umran, Seb, Thar Bhubharaj and Goma Kirti. For this, the ber fruits were collected and stored in perforated polythene bags at 7° C in refrigerator. The data on Physiological weight loss was assessed on alternate day and the percentage weight loss is presented in Table 35. Perusal of data revealed that all the cultivrs under study remained in good state upto 20 days and the physiological weight loss ranged from 1.53 to 2.88% in different cultivars. The minimum weight loss was in cv. Seb, followed by Umran (2.27%), Goma Kirti (2.49%) and Gola (2.88%).

At the end of the experiment, the fruits were analysed for TSS and acidity. Perusal of data revealed that the TSS increased with the storage period. For instance, the TSS of Gola was 14.6 at the start of experiment which increased to 17.5 after 20 days of storage. Similar results were obtained with other cultivars also.

Table 35. Percentage loss in weight in different ber cultivars stored in polytheme bags

	Sev	Gola Kiriti	Goma	Umran	Thar Bhubharaj
Day 2	0.69	0.26	0.134	0.2	0.124
Day 4	0.85	0.34	0.288	0.32	0.241
Day 6	0.51	0.54	0.534	0.56	0.39
Day 8	0.62	0.78	0.667	0.79	0.591
Day 10	0.72	1.12	0.94	0.98	0.82
Day 12	0.85	1.42	1.3	1.25	1.02
Day 14	1.02	1.85	1.64	1.47	1.33
Day 20	1.53	2.88	2.49	2.27	2.46

The acidity of the cultivars differs from 0.5 to 2.0% in different cultivars after 20 days of storage.

Storage after different pre-treatments

An experiment was set up using fruits of cv. Umran to study the effect of different treatments and packing material on the storage of ber fruits. Fort this the fruits of cv. Umran were collected from S. K. Nagar and divided into 5 major groups. One set was kept as control (without any treatment) and other set was treated with one of the treatment viz. Calcium chloride (1%), Boric acid (0.1%), Ascorbic acid (0.1%0 and edible oil (1%). After treatment the

fruits were air dried and kept in either net bag or poly bags and stored at 7O C in refrigerator.

On alternate day the fruits were taken out and physiological weight loss was calculated. The data thus generated is presented in Table 36. Perusal of data revealed that the fruits stored in net bag had higher physiological weight loss as compared to poly bag stored fruits. It was concluded that under low temperature storage, the treatment of 1% edible oil gave lower physiological weight loss.

At Godhra

Value addition in semiarid fruits

Aonla shreds

Analysis of data of aonla shreds treated with different salt concentrations ranging from 2 percent to 30 percent and storage at ambient conditions up to two years indicated that solar drying of aonla shreds after treating them with salt; resulted in increased percent dry weight as the salt concentration increased. It increased from 13.6 per cent in 2% salt treated shreds to 32 % in 30 per cent salt treatment. Ascorbic acid content was found to be significantly influenced by the application of salt. It showed a decreasing trend with increased concentration of salt (3072 to 510 mg /100g). After one year of storage under ambient condition ascorbic acid content decreased drastically from 288.17 mg /100g in 2 percent salt treated shreds to 94.13 g/ 100g in 30 percent salt treated shreds indicating that as the concentration of salt increased ascorbic acid content of aonla shreds decreased. Aonla shreds treated with 2% salt helped in higher retention of ascorbic acid and acidity. However in the second year of storage it showed browning whereas shreds treated with10, 20, and 30 percent salt retained better colour and appearance higher retention of Vitamin C (44 mg/100g) in treatment having ten percent salt. Percent acidity and TSS showed similar results (0.86percent and 26.3 o Brix).

Oil less pickle

Oil less aonla pickle with 10 to 50 % salt was prepared and stored under ambient conditions. As the salt concentration increased the amount water extracted also increased. The final product decreased as the amount of salt increased. The

Table 36. Effect of pre-treatment of fruits on physiological weight loss

Days after storage	Calcium chloride (1%)		Boric acid (0.1%)		Ascorbic acid (0.1%)		Edible oil oil (1%)		Control	
	Net bag	Poly bag	Net bag	Poly bag	Net bag	Poly bag	Net bag	Poly bag	Net bag	Poly bag
2	2.73	0.2	2.57	0.12	2.57	0.32	2.64	0.24	1.85	0.64
4	3.62	0.92	4.13	0.69	3.87	0.51	4.44	0.29	3.2	1.20
6	4.86	1.48	6.05	1.28	6.14	0.78	7.22	0.42	5.16	1.84
8	6.59	2.05	8.14	1.89	8.48	1.05	9.57	0.58	7.32	2.66
10	8.76	2.34	10.34	2.15	10.73	1.26	12.17	0.78	9.06	3.58
12	10.55	3.40	12.31	2.60	12.73	1.52	14.59	0.92	11.16	4.42
14	12.15	4.52	16.8	3.10	14.39	1.88	16.69	1.12	13.12	5.35

pickle prepared in 10% and 20% salt spoiled after 25 and 30 days of storage. However pickle with 30, 40 and 50 % salt did not spoil under ambient conditions without oil. Thus preparing oil less pickle with aonla pieces when treated with 30 % salt was found to be the best treatment as it is the lowest concentration of salt. Organoleptic tests also indicated that preparation of oil less pickle with 30 % salt was the tastiest of the treatments. Analysis of the pickle indicated that percent acidity decreased as the concentration of salt increased. However in respect of total soluble solids it was reverse. Ascorbic acid content of the fruit decreased with increased concentration of salt both initially as well as 6 months after storage. Acidity, TSS and ascorbic acid content decreased considerably during the storage period.

Aonla squash

Analysis of aonla fruit squash with different concentrations of juice from 25 percent to 75 percent and its ambient storage without application of chemical preservative was studied and the observations recorded revealed that there was reduction in ascorbic acid content to the tune of 85 percent after one year of storage under ambient condition, which further declined to the tune of 90 percent after two years of storage. However, reduction in total soluble solids was at slower pace, which was just 6.62 percent in squash where 25 % juice was used to prepare squash after one year of storage and 20.30 percent after two years of ambient storage. Maximum reduction in TSS was observed in squash where 75 % juice was used. The reduction was 56.98 % in the first year and 66.41 % in the second year of storage. Organoleptic analysis revealed that still the squash has not spoiled and can be used for RTS preparation. Mineral composition of aonla squash indicated that in respect of Ca after one year of storage showed increasing trend ranged from 0.05 % in 25 % juice to 0.15 % in 75 % juice. However in respect of Mg content it was reverse. Potassium content increased from 0.06 to 0.12 %.

Agricultural Extension

At Bikaner

Dynamics of horticultural growth and development in hot arid regions of western Rajasthan: An status study

Socio-economic attributes of farmers of the surveyed areas of hot arid regions

It was observed that there was high heterogeneity in existing social structure and social system. Socialization was stereotype (based on preconception or prejudice). Social contravention (process whereby contending group or individuals strive to prevent each other to achieve some objective/ success) was high. There was high inertia in culture and resistance to change. Technology adoption solidarity (cohesiveness and unity) was very poor. The horizontal social groups observed predominant over vertical groups and reference groups. They beliefs highly in local Gods and Godesss. Arbitrary relations were predominant in the societies. Population was heterophilic in nature. Majority of the farmers are laggards and a few are innovators. There was high disguised unemployment. Scientific orientation was very low and political orientation was very high. Intrinsic caste system was deeply rooted. Non agricultural business arena was high with broad gage. More than 40% farmers were dummy/pseudo farmers. High socio-economic disparities are prevalent. Real farmers have, no or low educational level. Hardly, windfall profit (advantage earned by first adopter) makers were observed only 45%.

Dynamics of decision making in technology adoption-rejection

Decisions making system in technology adoption - rejection was mainly hierarchical and male dominated. However, three types of innovation decision making system were observed: (i) Optional

innovation decision making 44% (ii) Collective innovation decision making - 19% (iii) Authority innovation decision making- 37%

Psychological characteristics of farmers of the study areas

There existed only I or II level motivation amongst the respondents as per need hierarchy (Maslow model). Self of fantasy and daydreaming was high. The behaviours were unstable and unreliable. High disparity was observed between intrinsic and extrinsic responses of the farmers. Sensitivity and creativity with respect to innovative technologies and ideas were poor. KAP gap (KAP refers to knowledge, attitude and practice) were low towards adoption of arid horticultural crops. Attitude: The majority of the farmers were "ethnocentric" and arena of attitude of most of them was surrounded by "The Self". They were ambivalence (inconsistent attitude) towards new ideas or technologies. They had doubtful faith in scientists and innovative technologies. The aspirations of the respondents were high for benefit and income but poor for hard work.There was much difference between covert and invert behaviours of the farmers/ clients.

Training need of the farmers

Major training needs as observed during the study were: basic knowledge orientation training need, training need for motivation, training need for improved plant propagation techniques and nursery management of arid fruit crops, training need for orchard development of arid fruit crops through in-situ budding techniques, training need for water saving and soil fertility increasing technologies. Training needs for quality seed production of arid vegetable crops, training needs for modern agro-techniques of arid fruits and vegetable production, training need for pant protection methods, training need for improved technologies of value addition of arid fruits and vegetables, training need for marketing management of arid horticultural produces, etc.

Horticulture based farming/ cropping system in study areas: The information / data related to horticulture based farming system/ cropping in hot arid region of western Rajasthan were collected during 2012-13. It was found that the mixed farming and cropping system were the predominant in the study areas. The farmers rear various animals like cow, buffalo, sheep, goats, camel, bullocks, donkey, etc. It was observed that the major breeds of cow reared by the horticultural crop growers were Deshi/ local, Rathi, Tharparker, Jersey, and Holstein Frision and cross breeds. The cows reared by them were 03-16 in number for the purpose of milk production, FYM and draft purpose. Amongst the buffalo breeds, Deshi/local, Murrah, Surti, Jaffarabadi etc. were the major breeds which were reared by the horticultural crop growers ranging from 00-6 in numbers for milk, FYM production. The Chokla, Magra, Poogal, Sonadi, Marwari and Nali were the major breed of sheep, which were for wool, meat, FYM and milk production. The major breeds of goat reared by farmers are Marwari, Jakharana, Lohi, cross breeds, etc. Another very important farm animal was camel which was being reared by the arid horticultural crop growers. The camel is reared by 64.25 per cent arid vegetable growers 02-04 in number. The major purpose of rearing the camel was draft work in different agricultural operations. It is mainly used for ploughing the fields. Another import purpose of rearing camel was transportation work and camel wool production for extra income. Some people use the milk of female camel for drinking purpose also. The camel milk is considered as very nutritious and anti-biotic food substance. The cross breeds, Bikaneri, Jaisalmeri, etc were the major camel breeds which were reared by horticultural crop growers.

Amongst the cropping system, mixed cropping system, intercropping and sole cropping system were followed by the farmers.

(i) Mixed cropping system: The study revealed that the majority of the farmers of surveyed areas /districts adopt mixed cropping system in rainfed conditions during kharif season along with livestock production i.e. rearing of cows, camels, sheeps, goats and a few buffalos. Thus, the mixed farming system is the most important conventional farming system which is practiced by majority of the farmers of the districts. The major component crop of mixed cropping system as followed by the farmers of the districts were perlmillet, seasemum, mateera, snapmelon, kachari,clusterbean, roundmelon, mothbean, cowpea, groundnut (Bikaner), bottlegourd, small millets (Nagaur), etc. which are grown in different combinations during kharif season in rainfed conditions. In addition to above cropping system 4-40 local variety of Khejri (propis ceneraria) plants/ha were also observed on farmer's field which were grown mainly to produce sangari (pods) for vegetable and loong (leaves) as green fodder for animal feeding. The mixed cropping system was the most prominent conventional cropping system which was practiced by majority (> 70 %) of the farmers of the study areas during the kharif season. The major combination of component crops of this mixed cropping system were observed are as follows.

Pearlmillet+ Seasemum + Mateer / Snapmelon /Kachri/ Tinda / ridge gourd Pearlmillet + Seasemum+ Mateera + Snapmelon + Kachri + Cowpea Pearlmillet + Clusterbean+ Mateera/ Snapmelon/Kachari/Tinda/ridge gourd Clusterbean+ Mateera /Snapmelon/Kachari/ Tinda/ Cowpea (iv) Pearlmillet+Mothbean+ Mateera/ Snapmelon/ Kachari/Tinda/ridge gourd (v) Pearlmillet + Seasemum+Moth bean/ Kachari/Snap melon/ Mateera Perlmillet+ Seasemum + Clusterbean + Cowpea + Mothbean + mateera + snapmelon + kachri + roundmelon

In addition to above cropping system, 04-44 perennial khejri plants/ha were also observed on farmer's field which are grown mainly to produce sangari (pods) for vegetable/ pickle purpose, lum (leaves) as green/dry fodder for animals and wood for fuel.

(ii) Sole cropping: During kharif season and irrigated conditions only one third population of the farmers grew mateera, snapmelon, kachri as sole crops. The farmers also grew brinjal, tomato, bottle gourd, ridge gourd, roundmelon, Indian aloe, etc. on small scale and some of the farmers grew ber, aonla, pomegrante, lasora, etc. on their fields as sole crops at small scale (0.2 1.0 ha). More than one-third population of the farmers grew brinjal, cauliflower, cabbage, spinach, chilli, fenugreek (leaves), coriander (green), carrot, radish, tomato, etc. on small scale (0.1 0.7 ha.) as sole crops during rabi season. The farmers which having irrigation facilities grew, mateera, snapmelon, kachri, ridgegourd, roundmelon, bottlegourds, Tar kakadi, brinjal, tomato, cluster-bean(veg.), chilli, etc. during summer (zaid) season also as sole crops on small scale (0.1to1.0 ha).

(iii) Intercropping: Some of the farmers grew clusterbean, groundnut, mateera/ snapmelon/ kachri, Indian aloe/ groundnut/ brinjal / chilli, bottlegourd, ridge gourd, bittergourd, etc. in their ber, aonla/ pomegranate orchards as intercrops during kharif season. During Rabi season (irrigated conditions), cumin/ pea/ green fodder /mustard/ cauliflower/ cabbage/ spinach/ fenugreek /wheat /gram/ chilli/ brinjal etc. were grown as intercrops in ber, aonla/ pomegranate/ lime/ kinnow orchards. A few ber, aonla, pomegranate growers grow vegetable crops as intercrop in their orchards during summer (zaid) season also. During Rabi season (irrigated conditions), wheat, gram, mustard, taramira, cumin / fenugreek/green fodder etc., are grown at large scale (2.0-8.0) while brinjal, cauliflower, cabbage, spinach, chilli, fenugreek (leaves), coriander(green), carrot, radish, tomato, etc. are grown on small scale. The farmers which are

having irrigation facilities for growing, mateera, snapmelon, kachari, ridgegourd, roundmelon, bottlegourds,Tar Kakadi, brinjal, tomato, cluster-bean(veg.), chilli, etc. during summer (zaid) season also at small scales (0.3-1.4 ha). It was also observed that a few farmers grew lasora, lime/lemon, Kinno, Mosambi, etc. on their fields particularly in Bikaner district.

Indigenous Technological knowledge (ITKs)/ traditional technological knowledge (TTKs) : The various Indigenous Technological knowledge (ITKs)/ traditional technological knowledge (TTKs) were also colletced during the study. The major Indigenous Technological knowledge (ITKs))/ traditional knowledge as used/practiced by the farmers of the hot arid regions of western Rajasthan in the field of arid horticulture are narrated below in short.

Indigenous Technological knowledge (ITKs)/ traditional technological knowledge (TTKs) related to value addition: The local people of the hot arid regions had a lot of own wisdom and experiences through which they prepare various value added products of arid fruits and vegetables for earning money and for their own consumption. The major value added products as prepared by farmers/ local peoples by using their own indigenous technological knowledge (ITKs)/ traditional technological knowledge were pickles of sangari of khejri, kachri, ber, ker, lasora, tumba, clusterbean, local mashroom, carrot, chilli, round melon, Indian aloe, karonda, aonla, brinjal, etc. The dehydrated products like dehydrated pods (sangari) of khejri, clusterbean, khip, mothbean, green gram; dehydrated kachri, snapmelon (fofalia), round melon, local mashroom, bottle gourd, carrot, ker, lasora, ber; dehydrated leaves of gram, fenugreek, bathua, mustard, carrot, spinach, flower buds of fog (fogle); shake/ juice of mattera, kachri, snapmelon, bottle gourd, bitter gourd, ber, aonla; jem/ jelly of karonda, ber, aonla, snapmelon, kachri, bottle gourd; dry powder of kachri, ker, lasora; rousted seeds, magaj, laddu, cold drinks, oil, sweets of mateera seeds; rayata and other recipes of fog, bathua, bottle gourd, fenugreek, round melon, spinach, kinpoli, etc. were prepared by farmers/ locale peoples regularly as per season and availability of the above fruits and vegetables. With the participation and help of farmers/ people, some traditional technologies/ products like pickles, jam, jelly, sarbat, juice, chatuney, powder, dehydrated value added products of arid fruits and vegetables were refined / standardized.

ITKs / TTKs for the control of termite: The ITKs / TTKs like wrapping of grease bands around tree trunk (fruit crop), application of kerosene in the field through irrigation water, application of milk water /curd (in individual plants/soil), put on fire in the field/pits before plantation/sowing, mixing half burn neem leave+lime stone powder mixture in the soil, mixing of neem kernel powder in the soil, mixing of mustard/seasamum oil cake in the soil, etc. were used by the farmers to protect their horticultural crops from the attack of termite.

ITKs /TTKs for the control of diseases and insects: Pasting of lime stone solution on pruned part of the fruit crops, burning of mustard/ seasamum oil/Loh Ban in fruit/vegetable crops fields to avoid the attack of viral and fungal diseases, insect-pests attack; spraying of cowdung/goat/sheep excreta and kerosene oil solution to protect the crops from the attack of wild animals; spray of ash + kerosene oil mixture on vegetable crops, spray of ash and FYM mixture over vegetable seedlings to control purple blotches, thrips and other insects; smoking +dusting of ash on fruits and vegetable crops to avoid the effect of frost injury; spraying of neem kernel powder solution on the crops to control pests/diseases; application of neem karnel cakes/ powder in the soil to control soil born diseases, insect-pests, etc. were used by farmers to protect their horticultural crops from the attack of diseases and insects.

ITKs / TTKs for thevegatble's seed storage safely: ITKs / TTKs like storage of vegetables

seeds with dry neem leaves, coating mustard oil on seeds, with dry ash/sand in air tight earthen pots, within natural dry pods/fruits and storage of vegetable seeds with dry chillies in air tight pots, etc. were used by farmers to store the vegetable seeds safely.

Other important ITKs / TTKs as reported by the farmers were: Dusting of dry ash+FYM over vegetable seedling for better growth and development., pasting of fresh cowdung on pruned part of the fruit crops, put on fire in pits of fruit crop before planting, use of tea water in cauliflower/ cabbage, rose marigold fields to increase the size, growth, quality and better look of products; application of mustard/seasemum oil cakes in brinjal and chilli fields to improve size and contrast colour of fruits, mixing of khejri leaves (loom) in the soil, application of wooden ash + oil cakes + sheep and got manure/FYM in the soil, firing of the waste products of the farm/crop residues in situ; ripening the snapmelon, ber, papaya etc. by putting them in grain storage/wheat straw/dry grasses/papers; solar drying of kachri and tinda slice, clusterbean pods, sangari of khejri, fenugreek, coriander leaves, ber, aonla, chilli etc; preservation of mateera, snapmelon, kachri and other fruit for some time in wet sandy soil at cool place, etc.

Potential natural & other resources for arid horticultural development: During the survey work of this study, various natural resources were also identified and listed which may be potential inputs/ resources for horticultural development in hot arid climatic conditions. Amongst them major are as under.

A plenty of land resources: In the arid zones of India, a vast area of land is available, which is unutilized presently for horticultural purpose. The hot Indian arid zone is spread over nearly 31.7 million hectare land area of which 41.5 per cent it arable and 19 per cent it cultural wasteland. The unutilized land of the arid zones may be prepared/ developed, through necessary ameliorating processes and can be used for the production of arid horticultural crops.

Potential bio-diversity/promising germplasm in arid regions: In hot arid regions of Rajasthan, a large number promising germplasm/ a plenty of biodiversity is existed which can be exploited for the development of arid horticultural development. The native fruit species such as ker (*Capparis decidua* Edgew), pilu (*Salvadora oleoides*), lasora/gonda (*Cordia myxa*), gondi (*Cordia sharal*), wild jharber (*Ziziphus nummularia*), bordi (*Ziziphus mauritiana* var. *rotundifolia*) and jujube or ber (*Ziziphus mauritiana* Lam.) mateera (*Citrullus lanatus*), kher, kummat, mulberry (*Morus* spp.), karonda (*Carissa caronda*), etc. were identified as important and potential germplasm which may be utilized for horticultural development in hot arid regions. Amongst the vegetables germpalsm like Khip, tumba, local mashroom, kankora, fog, clusterbean, mothbean, cow pea, green gram, amaranth (chandlai), fenugreek, drumstick, chenopod (bahtua), cactus pear, land caltrops, mustard, gram, black nightshade(makoa), giloy, kachari, mateera, snapmelon, round melon, khejri, indian aloe, spinach, carrot gajara, spiny brinjal, bottle gourd, radish, sangari of radish, onion, beans, tomato, chilli, okra, etc. were identified as important and potential vegetable germplasm which can be utilized for the development of new vegetable crops for commercial production in hot arid environment.

Surplus human labour resources: During the survey work of the this research study, it was observed that owing to long slack seasons and low cropping intensity, landlessness, a considerable surplus family labour is available in the arid zones. This surplus and potential labour of the farming communities can be put to use for developing, growing, managing the horticultural crops in arid regions. In this way, the surplus labour of the arid zone can be effectively utilized as an important input for the development of arid horticulture.

Conducive climate conditions : It was felt that the existed peculiar agro-climatic conditions of the arid region imparts unique quality in fruits such as in ber, pomegranate, sweet orange, and in vegetable such as chilli, cumin, fenugreek, and cucurbitaceous

crops, etc. The hot arid region of the western Rajasthan is the only area where commercial date palm production may be possible.

Water resources: During the survey work of this research study, the major sources of water for the irrigation (at least life saving irrigation) were Indira Gandhi Canal water, Well, tube well, ponds, khadin, nadi, tanka, etc. which are the crucial factors for the horticultural development in hot arid regions.

Energy/power sources: During the study, it was felt that there was vast availability of natural sources of energy in hot arid zone of western Rajasthan like solar energy, wind energy, biogas, natural oil & gas, animal power, etc. which may be boon in advancement of horticulture in this zone.

Animals resources : There was observed very large population animal in hot arid zone which may be of utilized for production of very good quality of FYM, developing very good horticulture based farming system, as a source of draft power and in other works.

Sources of biopesticides: During the survey work of the this research study, there were observed various plants like Neem, Dhatura, Ank, tumba, Arnia, etc. which were used by the farmers as biopesticides in different ways to protect their crops.

Traditional vegetables grown: Kankora, kundru, pods of khip, amaranth, fenugreek, drumstick, chenopod, spiny brinjal, sangari of khejri, indian aloe, spinach, carrot, brinjal, bottle gourd, radish, sangari of radish, onion, fog flower buds, clusterbean pods, mothbean pods and products, cow pea pods and products, green gram pods and products, ber, land caltrops, mustard leaves, gram leaves, black nightshade(makoa), giloy, etc. were observed the major traditional vegetables which were grown by farmers indifferent seasons in hot arid climatic conditions and used as fresh in current season or through out the year after converting them in the form of value addition. Except these, kachri, mateera, snapmelon, round melon, etc. were the other major traditional vegetables which were used by the farmers / local peoples of the hot arid region as fresh in current season or in the form of value addition through the year.

Changing in farming system/ cropping system: During the study, it was observed that the farmers want to change their cropping / farming system. The farmer's were turning from traditional cropping system / farming system to towards the cash crops like cumin, caster, garlic, vegetables and fruit crops, etc. along with livestock production. Now, the farmers are becoming business minded. They want to grow only those crops which could give immediate high return and profit. They want to catch high marketing price and earn more and more money through modernization of their farming and cropping system.

Extension models / methodology designed for TOT: On the basis of analysis of situation of hot arid region, some extension models / methodology were designed/ developed under this project which may be useful in transfer of technologies on the farmer's fields in future. These models / methodology are (i) Five Ws and One H based Model/ methodology (What - technology, Why- potentiality of technology, Where- field of desirable farmer/ client, When- time of executing of the technology on desirable farmer's/ client's field, Who- facilitator and to Whom- desirable farmer / client based Model) (ii) IVSL Model (Institute-Village- School-Linkage Model) (iii) In Situ PIKASO Model (In situ Peasant's-Inputs- Knowledge Awareness Skill-Originating Model) (iv) DESART- OFF Model/ Methodology (Development of Education- Skill-Attention - and Regeneration of Technologies on Farmer's Field Model/Methodology), etc.

Constraints in technology adoption of arid horticultural crops / technologies

During the survey work of this study, there were observed various constraints/ bottlenecks which hinder the growth and development of

horticulture in hot arid zone of western Rajasthan. Such major constraints/ bottlenecks were identified, listed and divided in different groups. Amongst them major are narrated in short as under.

(a) Ecological constraints : Amongst the ecological constraints, major were : Water scarcity, poor and erratic rainfall, severe frost injury during winter, very deep and salty ground water, occurrence of very frequent drought and famine, high temperature during summer season, poor and problematic soils, high wind and storms, etc.

(b) Technological constraints: Amongst the technological constraints, major were: Lack of location specific suitable technologies, lack of proper technical guidance, lack of desirable knowledge and skills, etc.

(c) Infrastructural constraints : Amongst the infrastructural constraints, major were: No local market to sell produces, lack of reliable source of inputs at local level, no/ poor credit (loan, subsidy) support system, poor and scare water resources, lack of reliable source of technological information, poor and irregular supply of electricity, etc.

(d) Institutional constraints: Amongst the institutional constraints, major were: Negligence of extension work, poor response of experts, unfamiliarity and long distance of research institutions, lake of dedicated extension personnel, no coordination and cooperation among systems, aberration of team work philosophy, lack of technological interventional programmes, poor linkages amongst research, extension and clients,

(e) Economic constraints in order of intensity / seriousness were: Distress sale of products and poor bargaining, maximum products are perishable in nature, low price and input-output ratio, no security against crop failure and low income, no subsidy and credit support for inputs, unfamiliarity with developmental schemes and programmes, heavy economic loss due to / diseases and pests, inputs are not available at reliable cost in the locality, etc.

(f) Socio-psychological constraints in order of intensity/seriousness were: Deep faith in traditional cropping system & cultural practices, lack of awareness, interest & knowledge amongst the clients, fear of crop failure/ low income/ market sale/ consumption, orthodoxic thinking of the farmers/clients, scattered population or villages, scientific sphere of mind was legging behind. Moreover, the suggestions of farmers / experts / field workers to overcome the constraints in adoption of arid horticultural crops were also collected and documented

Technological intervention for arid horticultural development and its impact assessment

- **Visit and interaction/ meetings with farmers at the Institute :** More than 600 farmers (both men& women) belongs to hot arid region of Rajasthan and other states of the country were visited to the Institute's farm/ experimental blocks and had interaction / meetings with tem to acquaint/ expose them with latest arid horticultural technologies as developed by the Institute.
- **Visit and interaction with students/young farmers at the Institute:** Besides the farmers, more than 150 B.Sc (Ag)/ young farmers and school students came from different agricultural colleges/ university and schools of the Rajasthan state and other states of the country were visited to experimental blocks and research laboratories of the Institute to acquaint them with latest technological know-how of the arid horticulture.
- **Visit and interaction/ meetings with agricultural supervisors/professionals,at**

the Institute: Moreover, about 200 agricultural supervisors, professionals, lecturers, teachers, scientists/ trainees, and other dignitaries came from different line departments of state government, SAUs, colleges/ schools, ICAR research centres, , NGOs etc. were visited to experimental blocks & research laboratories of the institute and had interaction with them to acquaint with latest improved arid horticultural technologies and research and extension activities of the Institute.

- **Visit to farmer's fields and interaction/ meetings with them:** More than 20 of farmer's fields were visited and they were provided with technical guidance / assistance in overcome their problems related to arid horticultural crop production.The farmer's meeting/ interactions were carried out to guided and provided solution to their problems.

- **Research-extension-farmers-interface meetings:** During the reported period, there were held 23 Research-Extension-Farmers-interface meeting with 23 groups of farmers during their exposure visit at the Institute, farmer's field visits, during survey work and at the site of front line demonstrations, exhibitions and during the other programmes.

- During the reported period, the work on organization of Farmer's Interest Groups / Commodity Interest Groups/ Self-Help Groups were also initiated at the different sites/ locations/ villages of Bikaner districts (Rajasthan) where front line demonstrations of improved varieties of arid fruits/vegetables crops and their agro-techniques were conducted. Moreover,more than 10 Groups of farmers which had interest in propagation/ multiplication and growing of Thar Shobha variety of khejri, AHK-119 variety of kachri were also organized in different villages of Bikaner, Churu, Nagaur and districts (Rajasthan) during field visits/ survey work. Later on, these groups were fallow upped and they were visited to the Institute and had essential technological interaction/ discussion with them to meet their interest. They were also motivated to adopt other improved arid technologies on their fields.

- **Front line demonstrations/ adaptive trials:** During the year, three frontline demonstrations of each improved varieties vegetable crop viz - Thar Mank (Mateera), AHS-82 (snap melon), AHK- 119 (Kachri), Thar Bhadavi (Cluster bean) and two front line demonstration of Thar Shobha (Khejri) were conducted on farmers fields (in Chak No. 489 RDL, 03 NGM, Panchayat Khara; 439 RDL Jamsar, Rasmi farma Khara No. 64, 65, 73 near kanasar village villages) of Bikaner districts of Rajasthan. In addition, 16 method demonstrations about improved agro-techniques of arid fruits and vegetable production were given to visiting farmers/ extension functionaries or during farmer's field visits/ interaction.

- **Farmer's trainings:** During the reported period, 07 farmer's training programme(on/ off campus were conducted /organised (at the Institute and at Chak No. 489 RDL, 03 NGM. Panchayat Khara; 439 RDL Jamsar, Rasmi farma Khara No. 64, 65, 73 near kanasar village villages, of Bikaner district)

- **Participation in farmer's fair and arranging technological exhibitions:** During the reported period, we participated and organized 05 exhibitions of arid horticultural technological in Kisan Mela/ farmers-scientists interaction meet organized by Directorate of Extension Education, Rajasthan University of Veterinary and Animal Science, Bikaner at Gram Panchayat- Dhaani Pandusar, Tehsil-Lunkarnsar and Distt.- Bikaner dated 24.08.12., Participation and organization of

exhibition in KVK, conference at PAU, Ludhiyana from 21.11.12 to 23.11.12, Participation and organization of exhibition in XI Agril. Science Congress held at OUAT, Bhubhaneswar, from 07. 02. 13. to 09.02.13, Participated and arranged an exhibition of CIAH technologies in Pusa Krishi Mela organized at IARI, Pusa New Delhi from 06.03.13 to 08.03.13 and Participated and arranged exhibition in farmer's fair organized by DEE, SKRAU, Bikaner at Lunkarnsar, Bikaner on 17.03.13.

- **Initiatives for popularization of arid horticultural technologies:** For the popularization of innovative arid horticultural technologies developed by the institute, various activities like creating technological awareness, interest and knowledge amongst the farmers/ clients through daily news papers/ press media/ means of mass media on different occasions during the reported time. Other important activities like farmer's visits and research-extension-farmers-interface meetings, conduction of technological front line demonstrations/ adaptive trials on farmer's fields, method demonstrations, farmer's trainings, celebration of farm innovators day, visit to farmer's fields and organization of farmers interest groups to acquaint them with latest improved technologies arid fruits and vegetables crop production, organization of technological exhibitions, providing technical literature to farmers/ clients, online technical guidance and mobile advisory service/ ICT / e-extension based programmes, etc. were carried out during the reported time for the popularization of innovative arid horticultural technologies amongst the farmers / clients.

- **Celebration of Farm Innovators Day:** Coordinated the celebration of Farm Innovators Day held on 09.10.12 in the Institute in which more than 20 innovative farmers were participated. They were acquainted with several scientific facts and improved technologies of arid horticulture developed by the Institute. The Farm Innovators also expressed/presented their experiences and innovative technological ideas and facts related to arid horticultural crop production. Their feedbacks and suggestions were also invited and recorded to encourage the horticultural development in hot arid regions.

- **Inter Intuitional linkages/ programmes organised/assisted:** Strengthen functional linkage with sister organization / Institutions of the ICAR, KVKs, ATIC and Directorate of Extension of SKRAU, Bikaner, CAZARI regional station Bikaner, state Govt. Deptt. of agriculture/ horticulture, CAD/IGNP departments, press media persons, NGOs, etc. to facilitate the transfer of CIAH technologies on local farmer's field and to encourage the arid horticultural development. The above institutions were assisted and cooperated as and when they required our assistance and help in successful completion of their programmes like extension programmes, trainings, interface meetings, assistance in technological campaign/ programmes, technological support and advice, other issues related to human resource development.

- **Mobile advisory service/ ICT based/ e-extension based activities:** During the reported time, the various farmers were answered & guided using mobile service, online telephonic conversation to solve their existing based problems related to horticultural crop production. Some advance farmers are replied for their technical guidance through e- mail, Institute's film show on computer system/ TV for client's knowledge, production of online (Institute's website) technological news through six monthly newsletter, providing CD/ DVD of the Institute's film and other programmes to needy clients, etc.

- **Extension teaching- learning aids and e-learning materials developed:** Technological photographs, graphs, charts, written materials for training programmers, slides/ CD/ DVD for presentation of technical matter/ films, newsletters, etc. were prepared and communicated to needy clients.

- **Initiatives for commercialization of technologies:** The important activities like conduction of technological front line demonstrations/ adaptive trials on farmer's fields, providing seeds and planting material to farmers, organizing farmer's trainings programmes Farm Innovators Day, research-extension-farmers-interface meetings, organization of farmers interest groups organization to acquaint them with latest improved technologies arid fruits and vegetables crop production and adopting the same for their economic benefits. During the year, three frontline demonstrations of each improved varieties vegetable crop viz - Thar Mank (Mateera), AHS-82 (snap melon), AHK- 119 (Kachri), Thar Bhadvi (Cluster bean) and Two front line demonstration of Thar Shobha (Khejri) were conducted on farmers fields (in Chak No. 489 RDL, 03 NGM, Panchayat Khara; 439 RDL Jamsar, Rasmi farma Khara No. 64, 65, 73 near kanasar village villages) of Bikaner districts of Rajasthan. In addition, 16 method demonstrations about improved agro-techniques of arid fruits and vegetable production were given to visiting farmers/ extension functionaries or during farmer's field visits/ survey work to push the innovative arid horticultural technologies towards their commercialization on farmer's fields as well as in marketing paradigms. The seeds/ planting materials of above improved varieties and training on their production technologies were provided to farmers to encourage the production of the same at large commercial scale. As a result of technological exposure, some of the farmers have started the production of above improved varieties for commercial and business point of view.

- **Process and products developed:** The pickle and ice-cream of date palm, kachri juice, ber and kachri pachak, ber toffee, ect. were prepared using peculiar process/procedures and methods.The ber and kachri pachak, ber toffee were very testy, palatable and had good keeping quality. These products may be boon for farming communities for entrepreneurial point of view. Some of the farmer's traditional knowledge based procedure/ process and methods of preparing value added products of arid fruits and vegetables were also identified and tried to refined /standardize them in scientific manners.

At Godhra

Performance of varieties of brinjal

Nine brinjal varieties namely, Kashi Taru, Kashi Prakash, Kashi Komal, Kashi Sandesh, Pusa Uttam, Pusa Shyamala, Doli-5, GOB-1 and local variety, were evaluated for their yield performance in Panchmahals district. The varieties were cultivated during July 2012 to January 2013 in Central Horticultural Experiment Station. The fruit yield was highest in Kashi Sandesh (2.3 kg/plant) followed by Pusa Shyamala (1.6 kg/plant) and Kashi Komal (1.6 kg/plant).

Marketing of brinjal fruits by the tribal farmers of panchmahals district in Gujarat

Three hundred brinjal farmers of Panchmahals district were surveyed. After harvesting the brinjal fruits the farmers are not doing any value addition. They are marketing the fruits next day. Four types of supply chains were prevalent in the study area, viz., Producer commission agent wholesaler retailer

Table 37. Supply chains of marketing brinjal from producer to consumer

Type	Supply chain	Farmers	
		No.	Per cent
I	Producer – commission agent – wholesaler – retailer – consumer	55	18.33
II	Producer – wholesaler – retailer – consumer	78	26.00
III	Producer – retailer – consumer	154	51.33
IV	Producer – consumer	13	04.33
	Total	300	100.00

consumer ; Producer wholesaler retailer consumer; Producer retailer consumer; and Producer consumer. Majority of the farmers use the supply chain of Producer retailer consumer, followed by Producer wholesaler retailer consumer.

The price obtained by the farmer by using various supply chains were presented in Table 38. The Producer wholesaler retailer consumer supply chain offered the highest price followed by Producer retailer consumer. The Producer wholesaler retailer consumer supply chain catered big markets with the customers like big hotels, metropolitan cities, and quality conscious people who could afford premium price. Eventhough the intermediaries were nonexistent in the producer-consumer supply chain the price was less. It was because of the low purchasing power of the rural consumers. The farmers did not have the time and resources to directly sell the produce to consumers in cities. The innovative marketing concepts like uzhavar sandhai tried to use this supply chain. The scaling up of this concept for the various produces was difficult. The major limiting factor in getting better prices for the produce was that the prices were not fixed by the producer. The intermediaries like commission agents, wholesalers and retailers fix the price. While fixing the price these intermediaries were not factoring in the cost of production, profit for the farmer, wastages at the production, constraint and risks associated with the production. The marketing unit of produce was 20kg. It was called as man in Gujarati. The price ranged from Rs.20 to Rs.300/man. Sometimes the intermediaries were not willing to procure the farmers produce due to glut in the market. The farmers threw away the produce. It was essential to educate the farmers to add value to the brinjal fruits. The markets

Table 38. Price of brinjal fruits/kg obtained by farmers through various supply chains

Type	Supply chain	Price (Rs.)
I	Producer – commission agent – wholesaler – retailer – consumer	3.75
II	Producer – wholesaler – retailer – consumer	6.32
III	Producer – retailer – consumer	5.23
IV	Producer – consumer	4.15

The consumer's preferencce of brinjal fruit based on the shape, size and colour of the fruit was captured in Table 39. The cosmopolite city markets like Surat and Vadodara prefered medium sized, round type, and purple fruits. Generally these fruits weighed around 100gm to 250 gms, soft, less number of seeds, more pulp, and sweet in taste. These fruits were suitable for preparations like Bhartha, a spicy brinjal curry made from the pulp of the brinjal fruits. The city dwellers and hotels preferred these fruits because it consumed less time to cut the fruits and

Table 39. Consumer Preference of brinjal fruits at various markets as perceived by the farmers

S.No.	Market	Type of fruit
1	Surat	Medium size, round type, purple colour
2	Vadodara	Medium size, round type, purple colour
3	Halol	Medium sized, long type, deep purple colour
4	Kalol	Medium size, round type, purple colour; and Medium sized, long type, deep purple colour
5	Gogamba	Medium sized, long type, deep purple colour

cook. Moreover, it was one of the main vegetable figuring in the menu of the dinners during marriages, and functions. Brinjal blended well in both spicy curry and salty dhal and sambar. Small town markets like Gogamba and Halol preferred slender, long type, and deep purple fruits. These markets catered the rural people. These fruits weighed 20gm to 100gms. The fruits were attractive, appealing to eyes, had thick rinds which facilitated long shelf life at ambient condition. The price was low. The consumers having small family size needed just 250gm -500gm.

The price trend of brinjal fruits from the month of January to December was presented in the Table 40. It was evident from the results that the price remained high during February to August and remained low during September to January. The Kharif crop fetched low price whereas the rabi and summer crop fetched high price. Moreover, certain communities like Patels did not consume brinjal upto diwali. The reason for their abstinence might be due to Shoot and Fruit Borer infestation which was high during this period. Major supply of brinjal fruits to the markets was during kharif. It also might be the reason for low price. During rabi and summer the supply of fruits was low because the farmers who had adequate irrigation facilities could grow the crop. Hence there existed a need for development of high temperature tolerant varieties.

Table 40. Month wise Price trend of brinjal fruits (N=300)

Months	Low price		High price	
	Farmers (No.)	Farmers (%)	Farmers (No.)	Farmers (%)
January	206	68.67	94	31.33
February	142	47.33	158	52.67
March	129	43.00	171	57.00
April	115	38.33	185	61.67
May	80	26.67	220	73.33
June	86	28.67	214	71.33
July	59	19.67	241	80.33
August	136	45.33	164	54.67
September	184	61.33	116	38.67
October	169	56.33	131	43.67
November	192	64.00	108	36.00
December	235	78.33	65	21.67

3

EDUCATION, TRAINING AND TECHNOLOGICAL INTERVENTION

At Bikaner

Farm Visit

About 600 farmers visited the Institute and 23 research- extension-farmers-interface meetings were held at the institute. They were acquainted with latest improved arid horticultural technologies to popularizing the same amongst the farmers for adoption purpose. Besides these, more than 150 B.Sc (Agri.) and school students visited from different agricultural colleges/ university and schools of the Rajasthan state and neighboring to acquaint them with latest technological know-how of the arid horticulture. Moreover, about 200 professionals, lecturers, teachers, scientists/ trainees, and other dignitaries came from different SAUs, colleges/ schools, ICAR research centres, state line department, NGOs etc. visited the experimental blocks & research laboratories of the institute and had interaction with them to acquaint with latest improved arid horticultural technologies and research and extension activities of the Institute.

Front line demonstrations/ adaptive trials

Three frontline demonstrations of each improved varieties vegetable crop viz - Thar Manak (Mateera), AHS-82 (snap melon), AHK- 119 (Kachri), Thar Bhadavi (Cluster bean) and two front line demonstration of Thar Shobha (Khejri) were conducted on farmers fields (in Chak No. 489 RDL, 03 NGM, Panchayat Khara; 439 RDL Jamsar, Rasmi farma Khara No. 64, 65, 73 near Kanasar village) of Bikaner districts of Rajasthan. In addition, 16 method demonstrations about improved agro-techniques of arid fruits and vegetable production were given to visiting farmers/ extension functionaries or during farmer's field visits/ interaction (Fig. 33)

Farmer's trainings

During the reported period, 07 farmer's training programme(on/ off campus were conducted / organised (at the Institute and at Chak No. 489 RDL, 03 NGM, Panchayat Khara; 439 RDL Jamsar, Rasmi farma Khara No. 64, 65, 73 near kanasar village villages, of Bikaner district).

Participation in farmer's fair and arranging technological exhibitions

- Participated and organized 05 exhibitions of arid horticultural technolog in Kisan Mela/ farmers-scientists interaction meet organized by Directorate of Extension Education, Rajasthan University of Veterinary and Animal Science, Bikaner at Gram Panchayat- Dhaani Pandusar, Tehsil- Lunkarnsar and Distt.- Bikaner dated 24.08.12.
- Participation and organization of exhibition in KVK, conference at PAU, Ludhiana from 21.11.12 to 23.11.12.
- Participated and organized of exhibition in XI Agril. Science Congress held at OUAT, Bhubhaneswar, from 07. 02. 13. to 09.02.13.
- Participated and arranged an exhibition of CIAH technologies in Pusa Krishi Mela

organized at IARI, Pusa New Delhi from 06.03.13 to 08.03.13.

- Participated and arranged exhibition in farmer's fair organized by DEE, SKRAU, Bikaner at Lunkarnsar, Bikaner on 17.03.13.

Celebration of Farm Innovators Day

Farm Innovators Day was held on 09.10.12 in the Institute in which more than 20 innovative farmers participated. They were acquainted with several scientific facts and improved technologies of arid horticulture developed by the Institute. The Farm Innovators also expressed/presented their experiences and innovative technological ideas and facts related to arid horticultural crop production. Their feedbacks and suggestions were also invited and recorded to encourage the horticultural development in hot arid regions.

Mobile advisory service/ ICT based/e-extension based activities

Various farmers were answered & guided using mobile service, online telephonic conversation to solve their existing problems related to horticultural crop production. Some advance farmers are replied for their technical guidance through e- mail, Institute's film show on computer system/ TV for client's knowledge, production of online (Institute's

A

B

C

D

Fig. 33 (A-D). Farmers, students and farm functioneries visited Institute

website) technological news through six monthly newsletter, providing CD/DVD of the Institute's film and other programmes to needy clients, etc.

Extension teaching- learning aids and e-learning materials developed

Technological photographs, graphs, charts, written materials for training programmers, slides/ CD/ DVD for presentation of technical matter/ films, newsletters, etc. were prepared and communicated to needy clients.

At Godhra

Farm visit

During the year 2012-13, 1034 farmers, 420 farm women, 157 students and 85 extension workers and 11 VIPs visited the CHES farm. A total of 1707 visitors visited the farm.

Exhibition

Participated and put up a stall of CHES in the exhibition organized by ASM Foundation, New Delhi and OUAT, Bhubaneswar during the event of 'Global Conference on Horticulture for Food, Nutrition and Livelihood' held at Bhubaneswar, during 28-31 May 2012.

Participated and put up a stall of CHES in the exhibition organized by CII and Government of Gujarat during the event of 'National convention: The next frontier of agri-business and technology' held at Gandhinagar, during 3-4 September 2012.

Organized an exhibition in collaboration with DMAPR, Anand during the event of Kisan Mela held at CHES, Vejalpur, on 16.02.2013.

Participated and put up a stall of CHES in the exhibition organized by FTC, Godhra, Government of Gujarat and KVK, Panchmahals during the event of 'Kisan Mela' held at KVK,Vejalpur, on 19.02.2013.

Participated and put up a stall of CHES in the exhibition organized by ATMA, Godhra, Government of Gujarat and KVK, Panchmahals during the event of 'Kisan Mela' held at KVK,Vejalpur, on 20.02.2013.

Kisan Mela

Organized a kisan mela, in collaboration with DMAPR, Anand, at CHES,Vejalpur on 16.02.2013. Dr. N. K. Krishna Kumar, DDG (Horticulture), ICAR, New Delhi, Dr. S. K. Sharma, Director, CIAH, Bikaner, Dr. S. Maiti, Director, DMAPR, Anand, Dr. A. R. Pathak, Vice Chancellor, Navsari

Fig. 34. Farmers training organized at Bikaner

Agricultural University, Navsari and Dr. Sanjay Singh, Head, CHES, Vejalpur delivered speeches during the occasion. Around one thousand farmers attended the kisan mela. An exhibition was also arranged during this occasion (Fig. 35). Various ICAR institutes, SAUs, State departments, and KVKs, participated in the exhibition and displayed their technologies in stalls. The farmers were taken around the station farm and exposed to various research activities and plantation of fruit crops. It was followed by Farmer-Scientist interaction.

Training programme

- Organized a two days training programme on 'Semi-arid horticulture for rural development' to 38 farmers and farmwomen from Piplod and Vandar villages of Dahod district, Gujarat in collaboration with ATMA, Dahod during 26-27 June, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Organized a two days training programme on 'Semi-arid horticulture for rural development' to 34 farmers from Dahod taluk of Dahod district, Gujarat in collaboration with ATMA, Dahod during 23-24 July, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Organized a training programme on 'Semi-arid horticulture for rural development' to 34 farmers from Limkheda taluk of Dahod district, Gujarat in collaboration with ATMA, Dahod during 24 September, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Organized a training programme on 'Semi-arid horticulture for rural development' to 34 farmers from Dhanpur taluk of Dahod district, Gujarat in collaboration with ATMA, Dahod during 25 September, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Organized a training programme on 'Semi-arid horticulture for rural development' to 34 farmers from Devgadh Baria taluk of Dahod district, Gujarat in collaboration with ATMA, Dahod during 26 September, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Organized a training programme on 'Semi-arid horticulture for rural development' to 30 farmers from Devgadh Baria and Limkheda taluks of Dahod district, Gujarat in collaboration with ATMA, Dahod during 19 February, 2013 at Central Horticultural Experiment Station, Vejalpur.

Fig. 35. Dr. S.K. Sharma, Director, CIAH, Bikaner delivering speech in Kisan Mela held at CHES, Vejalpur on 16.02.2013

Fig. 36. Dr. N.B. Singh, Expert, NRAA, New Delhi getting feedback from the participants of the training programme organized for the horticulture officers of Gujarat during 6-8 March 2013

- Coordinated a one-month training course on 'Semi-arid horticulture for rural development' to 2 BRS students from Shri. I.K.Chavda Gram Vidyapith, Kahnvadi, Anand district during December 01-31, 2012 at Central Horticultural Experiment Station, Vejalpur.
- Coordinated a training programme on 'Advances in rainfed and arid horticulture (Fruits and vegetables)' for 25 horticulture officers and horticulture supervisors of Gujarat state department of horticulture during 6-8 March 2013 at Central Horticultural Experiment Station, Vejalpur jointly organized by National Rainfed Area Authority, Planning Commission, Government of India, New Delhi and Central Horticultural Experiment Station, Vejalpur (Fig. 36).
- Training to farmers (100) was organised on 25th March, 2012 to create awareness among the farmers and other stakeholders about provision of PPV& FRA, New Delhi.

Mass Media Meet

On 22.06.2012 a 'Mass Media Meet' was organized by CHES, Vejalpur in collaboration with DMAPR, Anand. The press and electronic media of Panchmahals district were invited and the station's technologies were showcased to them through lecture and visit of the Station farm. The event was widely covered in both press and electronic media (Fig. 37).

RAWE

Organized the one day exposure visit to CHES by 44 B.Sc. (Horticulture) students of ASPEE College of Horticulture, NAU, Navsari on 09.04.2012; 79 B.Sc. (Hons.) (Agri) students of B.A.College of Agriculture, AAU, Anand on 16.07.2012; and 34 B.Sc. (Horticulture) students of ASPEE College of Horticulture, NAU, Navsari on 18.03.2013 under RAWE programme (Fig. 38).

Fig. 37. Dr. Sanjay Singh, Head is being interviewed by the Gujarati television channel VTV during the 'Mass Media Meet' organized at CHES, Vejalpur in collaboration with DMAPR, Anand on 22.06.2012

Fig. 38. Dr. Sanjay Singh, Head teaching the research programmes of the station to the B.Sc. (Horti.) students of NAU, Navsari visiting the station under RAWE programme on 09.04.2012

4

WOMEN EMPOWERMENT

About 150 farm women visited the Institute and had research- extension-farmers-interface meetings with them. More than hundred of the farm women of hot arid region were also contacted during the field visit / survey work. They were educated about modern arid horticultural technologies, particularly in the field of production of value added products of arid fruits and vegetables. For this purpose various group discussions, interface meetings, individual contacts were held (Fig. 39). They were taught about the techniques which may be helpful in reducing the drudgery in crop production and post harvest management. They were motivated to participate in main stream of arid horticultural developmental programmes.

Fig. 39. Visit of farm women to experimental blocks of the Institute

5

AWARDS AND RECOGNITIONS

Award

A. K. Singh

Singh, A. K., Singh, Sanjay, Joshi, H. K. and Sisodia, P. S. (2012).Genetic diversity for morphological and physico-chemical characters of Morinda spp. from Madhya Pradesh. Noni Search, 2012, Noni- A tool for wellness, pp. 206-212 (Best poster presentation).

Dr. S. M. Haldhar

Awarded 'Rastriya Gaurava Award 2012' for the best research work in agriculture (Entomology) by IIFS, New Delhi dated 04, May, 2012.

Awarded 'The Best Citizens of India Award 2012' for the best research publication in agriculture (Entomology) by International Publishing House, New Delhi.

Dr. Hare Krishna

Awarded best Oral Paper for presentation entitled 'Bioactive compounds rich squash from mulberry (*Morus* sp.) for nutritional security' during International Conference on Sustainable Agriculture for Food and Livelihood Security (ICSA-2012) from 27-29 November, 2012.

Recognitions

Dr. Sanjay Singh

Singh, Sanjay and Singh, A. K. and Sharma S. K. (2012). Future crops in India for nutrition and health care. Key note lecture in Global conference on horticulture for food, nutrition and livelihood options organized by Lt. ASM foundation at OUAT, Bhubneswar, Odisha during 28-31 May, 2012.

Nominated as examiner of M. Sc. Thesis of Thakor Priyesh Dhirajlal (Registration No. 4-833-2010) on the topic "Studies on Scion sticks storage method on success of softwood grafting in mango cv. Kesar. NAU, Navsari.

Nominated as examiner the M.Sc. Thesis of Sh. Rajpur Nikhil Ramchandra (Registration No. 4-872-2010) on the topic "Estimation of heat units requirements for maturation of mango cultivars. NAU, Navsari.

Acted as DDG Nominee in the promotion of Scientist (Hort.) from scientists to scientist Sr. Scale at DMAPR, Boriavi on 22.09.2012.

Acted as coordinator in a one-month training course on 'Semi-arid horticulture for rural development' to 2 BRS students from Sh. I. K. Chavda Gram Vidyapith, Kahnvadi, Anand district during December 01-31, 2012 at CHES, Vejalpur.

Acted as co-chairman in the session VII-Organic farming" in National seminar on tropical and sub tripical frutis held at NAU, Navsari, Gujarat during 9-11 January, 2013.

Acted as member in the SAC meeting at KVK, Panchmahal on 7-6-2012.

Dr. S. S. Hiwale

Nominated by D.G., ICAR, New Delhi to the Institute Management Committee of Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat, for the period of three years.

Vice Chancellor MPKV, Rahuri, nominated as external referee for evaluation and thesis viva of PhD student, Miss Rajput, L.V., for the thesis entitled "Assessment of variability studies in F2 and F3 generations in bitter gourd".

Director of Research, NAU, Navsari, nominated for conducting M.Sc. thesis viva of P.P. Chauhan and Miss Abhilasha of Aspee Collage of Horticulture and Forestry.

Nominated to 25th Scientific Advisory Committee meeting of KVK, Dahod, held on 19/03/13.

Dr. S. Raja

Bharat Shiksha Ratan Award (2012) - A national level Award for Vegetable Science was given by The Global Society for Health and Education Growth, New Delhi.

Dr. B. D. Sharma

Director General, Indian Council of Agricultural Research, New Delhi nominated me as Member Secretary, Quinquennial Review Team of Central Institute for Arid Horticulture and All India Coordinated Research Project on Arid Zone Fruits

Director General, Indian Council of Agricultural Research, New Delhi nominated Member, Institute Management Committee of Directorate of Rapeseed Mustard Research, Bharatpur for three years.

Director, CIAH, Bikaner nominated me to act as Examination Coordinator of the ARS/NET Examination held at Bikaner on 24-02-2013

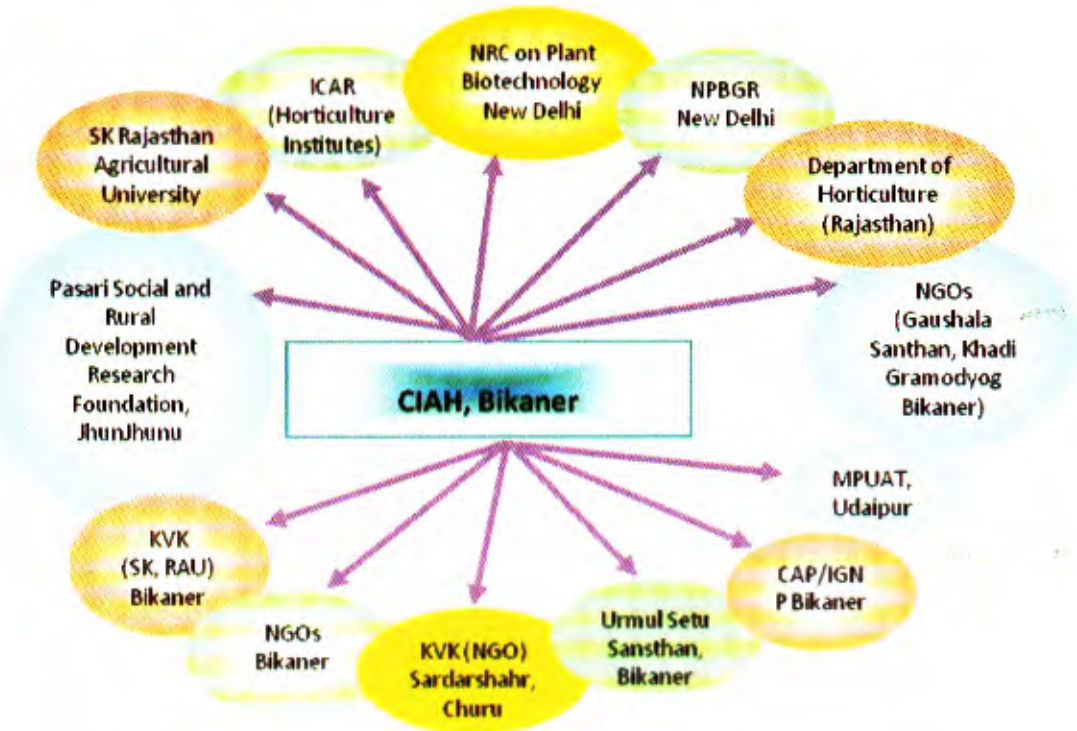
Deputy Director General (Animal Science), Indian Council of Agricultural Research, New Delhi nominated me as Arbitrator.

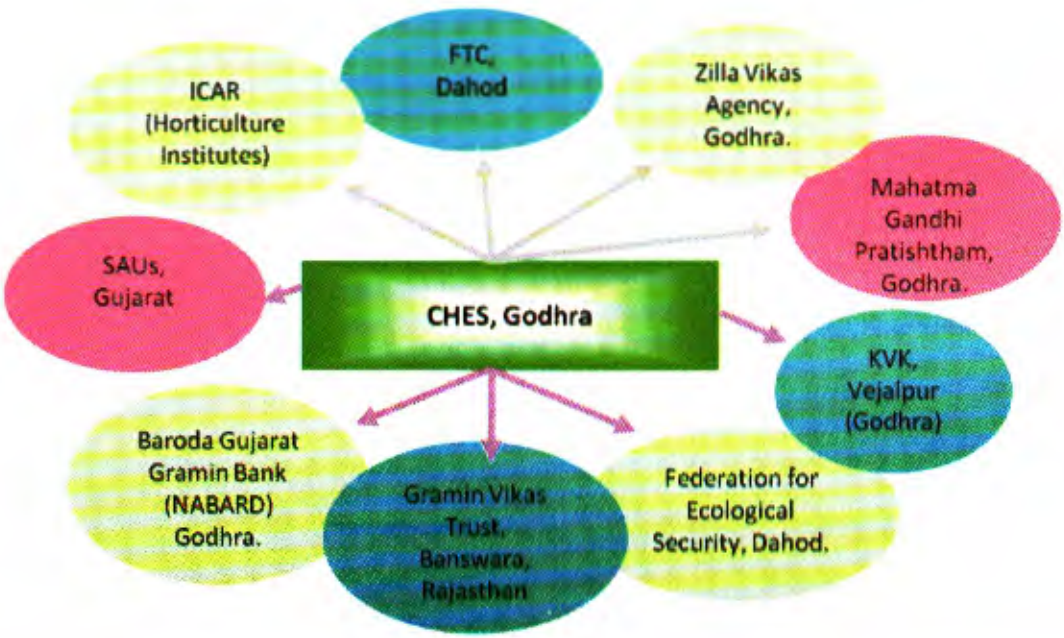
ICAR, New Delhi has nominated me to act Member, Institute Management Committee of Central Institute for Arid Horticulture, Bikaner for the three years.

Acted as Rapporteurs in Nutrient management in Arid Fruit Crops Session, ATR and Plenary Sessions in Group meeting of AICRP on AZF, held at CHF, Jhalawar during 27-29th December 2012.

6

LINKAGES AND COLLABORATIONS





7

EXTERNALLY FUNDED PROJECTS

CIAH, Bikaner

1. Bioprospecting of genes and allele mining for abiotic stress tolerance

Name of CCPI and Co-PI

Dr. P. N. Sivalingam, CCPI

Dr. Dhurendra Singh, Co-PI

Identification of core collection of *Ziziphus mauritiana*

Genetic diversity of fifty two core accessions was identified through Inter Simple Sequence Repeat marker (ISSR). The similarity co-efficient among these accessions was 0.24 -0.73. The accessions S6R21 and S6R12 were highly diverse in the clusters. This indicates that the high diversity exists among these accessions (Fig. 40).

Salient features on moisture stress tolerant *Ziziphus nummularia* (Burm.f.) Wight & Arn. from Jaisalmer (CIAHZN-J)

Ziziphus nummularia is well distributed and growing as wild in Jaisalmer district, the north-

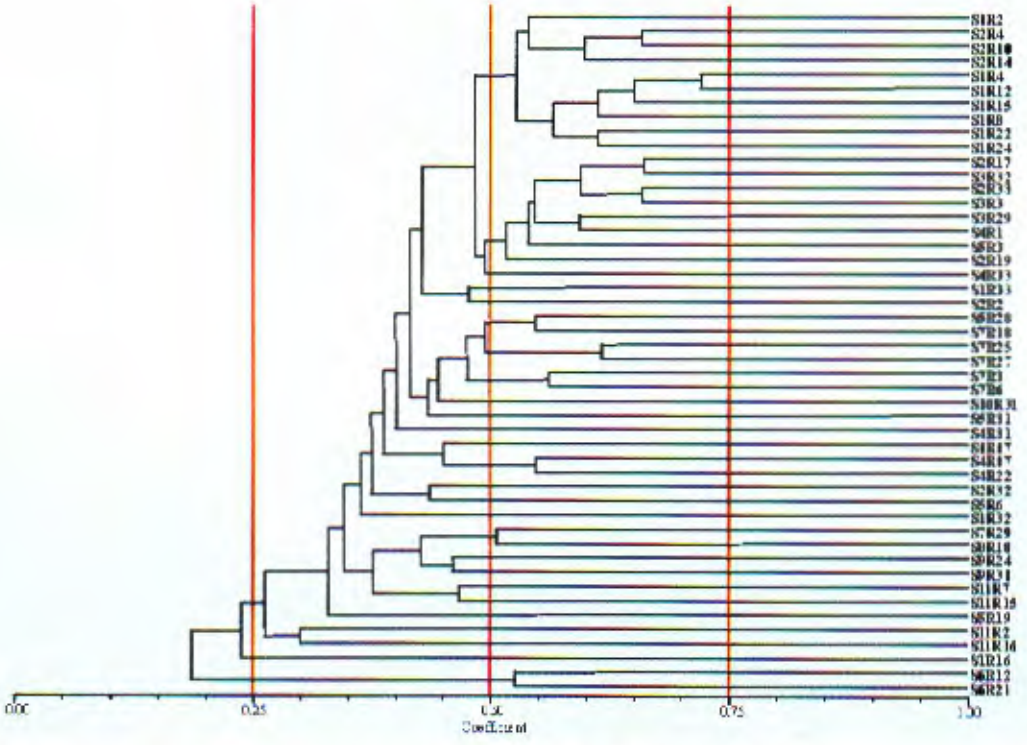


Fig. 40. Genetic diversity of core collection of ber by ISSR marker

western parts of Rajasthan where the average annual rainfall is less than 150mm. The stones of CIAHZN-J were collected and tested for moisture stress tolerance. Seeds of CIAHZN-J had 67 per cent germination at 0.5 MPa and it has ability to germinate at 0.73 MPa. Increased root length from 10 to12 cm and the ratio of root dry weight to fresh weight was 0.5 found in CIAHZN-J genotype at 0.5MPa. Withdrawing water up to 15 days to three months old seedlings of CIAHZN-J genotype showed the average cumulating morphological stress rating of 3.0, maintaining relative water content of more than 60 %, downward rolling of leaves and maintaining membrane stability at normal level during stress are the unique features of this genotype. Stomatal conductance of CIAHZN-J was 256.5 mmol/m2/sec, proline level was increased by 35 fold and catalase increased by two fold during stress compared to control. This genotype has very higher tolerance to moisture stress compared to *Z. mauritiana* and *Z. rotundifolia*.

Fig. 41. Nature of *Ziziphus nummularia* tree (CIAHZN-J)

2. Validation of DUS testing guideliens for cucurbits i.e. watermelon and muskmelon

Nodal Officer : Dr. S. K. Sharma

PI : Dr. B. R. Choudhary

A total of nine released varieties of watermelon and 13 of muskmelon were evaluated during summer, 2012 in randomized block design (RBD) with three replications for various descriptor states according to the DUS minimal descriptors formulated. The important descriptors of qualitative state in watermelon and muskmelon are as follows.

Close view of leaves, fruits and stem with thorns

Table 41. Descriptive state for qualitative traits in watermelon

Trait	State	Example varieties
Leaf blade: degree of primary lobing	Weak	Durgapura Lal
	Medium	Sugar Baby
	Strong	Arka Manik, RW 187-2
Leaf blade: degree of secondary lobing	Weak	Durgapura Lal
	Medium	Sugar Baby
	Strong	Thar Manak
Ovary: pubescence	Sparse	Durgapura Lal
	Dense	Arka Manik, RW 187-2
Sex expression (at full flowering)	Monoecious	Arka Manik, Durgapura Lal
	Andromonoecious	AHW-65
Fruit: shape in longitudinal section	Flat globe	Sugar Baby
	Cylindrical (oblong)	Charleston Grey
	Elongated globe	Asahi Yamato
Fruit: stripes	Faint/faded	Asahi Yamato, Charleston Grey, Sugar Baby
	Diffused	Arka Manik
	Clearly defined	Thar Manak
Fruit: colour of flesh	Yellow	RW 187-2
	Pink	AHW-65
	Red	Sugar Baby
Seed: length	Short	Arka Manik
	Medium	Sugar Baby
	Long	Charleston Grey
Seed: width	Narrow	Asahi Yamato
	Medium	AHW-19
	Broad	Charleston Grey
Seed: colour of coat	White	RW 187-2
	Cream	Asahi Yamato
	Brown	AHW-19
	Black	Arka Manik

Table 41(a). Descriptive state for qualitative traits in muskmelon

Trait	State	Example varieties
Leaf blade: depth of lobs (depth of	Weak	MHY-3
terminal lob)	Medium	GMM-3
	Strong	RM-50
Leaf blade: length of terminal lob	Medium	Kashi Madhu
	Long	RM-50
Ovary: pubescence	Sparse	Kashi Madhu
	Dense	Arka Jeet
Fruit: shape in longitudinal section	Ovate	MHY-5
	Oblate (flat globe)	GMM-3, Kashi Madhu
	Obovate	Durgapura Madhu
Fruit: colour of skin	Yellow	Kashi Madhu, Pusa Sharbati
	Orange	Arka Jeet
Fruit: strength of attachment of peduncle	Present	Kashi Madhu, Hara Madhu
at maturity	Absent	Arka Jeet
Fruit: shape at peduncle end	Rounded	Hara Madhu, Pusa Madhuras
	Truncate	Kashi Madhu, Durgapura Madhu
Fruit: shape at blossom end	Rounded	Durgapura Madhu, GMM-3
	Truncate	Kashi Madhu, Durgapura Madhu
Fruit: diameter of pistil scar	Small	Durgapura Madhu
	Medium	Pusa Madhuras
	Large	Kashi Madhu
Fruit: grooves	Absent	Arka Jeet, MHY-3
	Present	RM-43, Kashi Madhu
Fruit: sutures	Absent	Arka Jeet, MHY-3
	Present	Hara Madhu, Kashi Madhu
Fruit: colour of flesh	White	Arka Jeet
	Greenish white	GMM-3
	Green	Durgapura Madhu
	Orange	Kashi Madhu, Punjab Sunehri
Seed: colour	White	Kashi Madhu, Arka Jeet
	Creamy yellow	Durgapura Madhu, GMM-3, Hara Madhu

3. Validation of DUS descriptor for ber (*Ziziphus* sp.)

PI : Dr. Hare Krishna

Co-PI : Dr. R. Bhargava

During the period under report, 30 varieties were critically evaluated for morphological description. The analysis of data reveals that wide genetic variability exists with respect to different morphological parameters. Morphological diversity in ber has been noticed for growth habit (erect, semi-erect & spreading); thorn characteristics (thorniness and shape); foliage characteristics such as leaf apex, base, shape, size, curving, pubescence etc. Likewise, morphological diversity has also been noted for fruit characters such as fruit shape, nature of fruit surface, fruit apex, pulp cavity, pulp: stone ratio; fruit quality attributes like TSS, acidity and ascorbic acid contents; and stone characteristics such as size and weight (Fig. 42&43).

4. DUS Centre for date palm horticultural crop.

PI : Dr. R. S. Singh

Co-PI : Dr. R. Bhargava

Under DUS centre on Date palm, morphological and fruit characters in 26 date palm varieties were recorded during first year and report presented in second meeting of sub-task force held on 8th November, 2012 at CIAH, Bikaner. A wide genetic diversity with respect to plant morphological characters was observed among the date palm cultivars. Perusal of data revealed that plant height ranged from 135- 490cm, rachis length ranged from 99- 296 cm, leaf length ranged from 99 290 cm whereas leaf width ranged from 33-96 cm. The number of thorns ranged from 8-19 per leaf whose length and breadth ranged from 3.5-10.4 cm and 2.3-5.6 cm, respectively. Similarly, number of strands per spathe ranged from 24-69, number of berries per strand ranged from 4-21 and number of bunches per plant ranged from 3-12 giving an average yield ranging from 0.7-44.0 kg per tree. Collection of data on spathe emergence, flowering and fruiting is in progress.

Fig. 42. Variability in shape of the fruit among different ber genotypes

CHES, Godhra

5. Validation of DUS descriptors for bael (*Aegle marmelos* Correa)

PI : Dr.A.K.Singh,PI

Co-PI : Dr.Sanjay Singh, Co-PI

Varieties of bael viz, CISHB-1, CISHB-2, NB-5, NB-7, NB-9, NB-16, NB-17, Pant Aparna, Pant Sujata, Pant Urvashi, Pant Shivani and Goma Yashi were studied for distinct, uniform and stable characters under rain fed conditions of hot semi-arid ecosystem during the year 2012-13. The detailed features are as under:

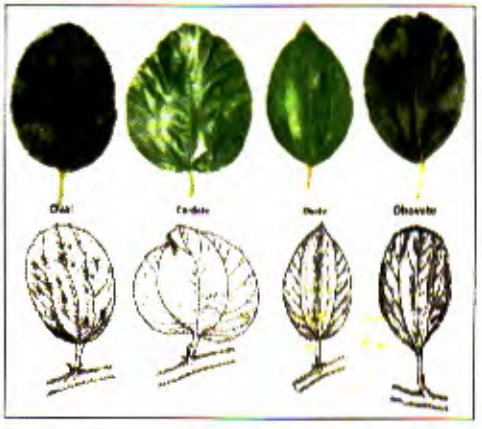


Fig. 43. Variation in leaf shapes in ber

1. Vegetative characters

Varieties	Growth habit	Foliage	Trunk colour	Bark splitting	Leaf colour
CISHB-1	Erect	Semi -compact	Grey	Irregular	Light green
CISHB-2	Spreading	Dense	Blackish Grey	Irregular	Dark green
NB-5	Spreading	Semi- Compact	Greyish	Regular	Green
NB-7	Spreading	Semi- Compact	Greyish	Rectangular-Irregular	Green
NB-9	Spreading	Semi Compact	Greyish	Cylindrical	Green
NB-16	Spreading	Semi -Compact	Yellowish Grey	Cylindrical	Dark green
NB-17	Spreading	Semi -Compact	Grey	Rectangular	Green
Pant Aparna	Spreading	Semi -Compact	Greyish Black	Cylindrical Rectangular	Dark green
Pant Sujata	Spreading	Dense	Blackish	Rectangular	Dark green
Pant Shivani	Spreading	Dense	Blackish Grey	Irregular	Light green
Pant Urvashi	Spreading	Semi Compact	Blackish Grey	Rectangular	Light green
Goma Yashi	Spreading	Semi Compact	Grey	Rectangular	Green

2. Leaf characters

Varieties	Leaf size	Leaf surface	Leaf waviness	Leaf shape	Leaf apex
CISHB-1	Small	Smooth	Non wavy	Ovate	Lanceolate
CISHB-2	Medium	Smooth	Slightly wavy	Ovate	Acute
NB-5	Small	Smooth	Slightly wavy	Ovate elliptical	Acute
NB-7	Very large	Smooth	Wavy	Ovate	Acute
NB-9	Small	Smooth	Slightly wavy	Ovate elliptical	Acute
NB-16	Medium	Smooth	Slightly wavy	Ovate	Acute
NB-17	Large	Smooth	Slightly wavy	Ovate	Acute
Pant Aparna	Large	Smooth	Slightly wavy	Ovate elleptical	Acute
PantSujata	Medium	Smooth	Slightly wavy	Ovate lanceolate	Acute
PantShivani	Large	Smooth	Slightly wavy	Ovate	Acute
Pant Urvashi	Medium	Smooth	Slightly wavy	Ovate	Acute
Goma Yashi	Medium	Smooth	Slightly wavy	Ovate elleptical	Acute

3. Fruit Characters (non measurable)

Varieties	Growth habit	Foliage	Trunk colour	Bark splitting	Leaf colour
Varieties	Immature fruit colour	Pulp colour	pulp taste	Fruit shape	Shell thickness
Goma Yashi	Green	Pale yellow	Very sweet	Globose	Very thin
CISHB-1	Light green	Lemon yellow	Sweet yellow	Ovate	Thin
CISHB-2	Green	Greenish yellow	Medium	Globose elleptical	Thick
NB-5	Green	Yellow	Sweet	Glogose elleptical	Very thin
NB-7	Light green	Light yellow	Medium	Globose	Medium
NB-9	Dark green	Yellow	Sweet	Elleptical	Thick
NB-16	Green	Light yellow	Medium	Elleptical	Very thick
NB-17	Pale yellow	Light yellow	Sweet	Round three lobed	Medium
Pant Aparna	Dark green	Yellow	sweet	Elleptical	Thin
Pant Urvashi	Green	lemon yellow	Medium	Uneven globose	Thick
Pant Shivani	Light green	Yellow	Sweet	Uneven globose	Medium
Pant Sujata	Green Yellow	Yellow	Medium	Globose elleptical	Medium

4. Fruit characters (Non measurable)

Varieties	Mucilage	Fibre content	Fruit surface	Styler end cavity end	Stem end cavity
Goma Yashi	Very less	Very less	Very smooth	Slightly sunken	Slightly depressed
CISHB-1	Less	Medium	Slightly rough	smooth	smooth
CISHB-2	High	Medium	Uneven slightly rough	Slightly sunken smooth	smooth
NB-5	Less	Less	Smooth	Smooth	Slightly sunken
NB-7	Very high	Medium	Smooth	Highly depressed	Flattened
NB-9	Medium	High	Slightly rough	Sunken	Vascicated flattened
NB-16	Medium	High	Rough	Sunken	Vascicated flattened
NB-17	Less	High	Smooth	Smooth	Slightly depressed
Pant Aparna	High	Less	Slightly rough	Slightly sunken	Slightly depressed
Pant Urvashi	High	medium	Slightly rough	Slightly sunken	Slightly depressed
Pant Shivani	High	High	Smooth	Slightly depressed	Slightly depressed
Pant Sujata	Medium	Medium	Smooth	Slightly depressed	Slightly depressed

6. Characterization of aonla varieties for developing DUS test guidelines

Co Nodal Centre

Name of Co-PI: Dr. A. K. Singh

Aonla varieties viz, NA-7, Krishna, Kanchan,Chakaiya. Banarsi, Francis were studied for their vegetative, flower, fruiting behaviors under rainfed conditions of semi-arid ecosystem. The detailed characters of varieties are as under:

Vegetative characters

Characters	Banarasi	Krishna	Francis	NA-7	Chakaiya	Kanchan
Tree height	Semi- tall	Semi tall	Tall	Tall	Tall	Tall
Tree form	Spreading	Spreading	Erect & drooping	Semi-spreading	Up right	Semi-spreading
Branch	Angled	Angled	Angled	Angled	Terete	Terete
Foliage	Sparse	Sparse	Dense	Dense	Sparse	Sparse
Leaf length(cm)	1.55	1.40	1.30	1.35	1.70	1.60
Leaf width(cm)	0.37	0.31	0.32	0.30	0.30	0.32
Leaf Shape	Oblong	Oblong	Oval Oblong	Elliptical	Oblong	Oval oblong
Leaf apex	Obtuse	Obtuse	Obtuse	Obtuse	Acute	Acute

Fruit characters

Characters	Banarasi	Krishna	Francis	NA-7	Chakaiya	Kanchan
Fruit set (%)	19.46	23.15	32.84	42.42	22.93	39.84
Fruit size	Large	Large	Large	Medium	Medium	Small
Fruit length (cm)	3.60	3.60	3.91	3.80	3.40	3.30
Fruit width (cm)	4.44	4.20	4.29	4.00	4.10	3.53
Fruit weight (g)	49.83	44.66	42.73	43.05	30.66	29.94
Fruit shape	Triangular	Triangular	Flattened round	Flattened round	Flattened round	Flattened round
Fruit stalk	Short and thick	Short and thick	Short and thin	Short and thick	Short and thin	Short and thin
Fruit stem and cavity	Sallow	Deep	Sallow	Deep	Sallow	Sallow
Fruit ridges on stem end	Prominent	Less Prominent	Less Prominent	Less Prominent	Less Prominent	Less Prominent
Styler end	Levelled	Prominent	Levelled	Less prominent	Levelled	Levelled
No. of segments in fruits	6	6-8	6	6	6	6-8

Seed characters

Characters	Banarasi	Krishna	Francis	NA-7	Chakaiya	Kanchan
Stone shape	Triangular	Triangular	Oval	Oval round	Round	Round
Stone size	Large	Large	Medium	Large	Small	Small
Seed	Large	Large	Medium	Large	Small	Small
Flesh colour	Whitish green	Pinkish to yellowish green	Whitish green	Whitish green	Whitish green	Whitish green

Quality characters

Characters	Banarasi	Krishna	Francis	NA-7	Chakaiya	Kanchan
Juice (%)	49.00	50.75	50.92	44.90	51.25	42.92
Astringency	Medium	High	Medium	Medium	High	Medium
Pulp (g)	39.80	34.00	32.70	33.10	31.80	22.17
TSS (Brix)	13.00	11.00	9.16	7.83	10.33	11.00
Acidity (%)	2.19	2.32	1.92	2.11	2.15	2.47
Vitamin-C(mg 100/ g pulp)	484.00	549.00	566.50	500.20	527.00	504.27

7. Identification, collection, characterization, evaluation and conservation of Noni (*Morinda* spp.) of western India (Gujarat and M.P.)

Name of PI & Co-PI

Dr. A. K. Singh, PI

Dr. Sanjay Singh, Co-PI

Sh. H. K. Joshi, Co-PI

Identification and collection of *Morinda* (seeds, fruits and shoots) genotypes

Survey was made in the various parts of diversity rich area of Gujarat (Anand, Mehsana, Panchmahal, Dahod and Vadodara) during the 2012-13. A total of ten elite genotypes were identified and collected in the form of shoots, leaves, flowers, seeds, etc. for analysis of morphological and quality characters. Leaf, blossom biology and fruit physico-chemical attributes were studied. Leaf length of newly collected genotypes varied from 16.74 cm to 27.00 cm and leaf breadth from 7.59 to 18.23 cm while vain pairs/leaf and petiole length varied from 8.15 to 11.00 and 1.20 cm to 2.00 cm, respectively, among the different evaluated genotypes.

In-situ evaluation and characterization of different genotypes of noni

A total of thirty two elite genotypes of *M. tomentosa* were evaluated during the year 2012-13 (October, 2012-March, 2013) for their growth under rainfed conditions of western India. Among the genotypes evaluated for growth characters, plant height, stem girth and number of primary branches were recorded the maximum in CHESN-16 (3.98m), CHESN-5 (34.10cm) and CHESN-12 (10.00), respectively.

Yield per plant during third year was recorded the maximum in CHESN-1 (7.12kg) followed by CHESN-31 (6.90 kg) and CHESN-16 (6.85kg),

while minimum yield was observed in CHESN-22(2.10kg) followed by CHESN-16(2.43kg) and CHESN-12 (3.95kg) among the evaluated genotypes. Physical attributes of fruits of various genotypes of *M. tomentosa* in terms of fruit weight, fruit length, fruit breadth, pyrines /fruit, number of seeds/ fruit and seed weight ranged between 18.65-47.00 g, 2.41 - 4.90 cm, 2.31 - 3.81 cm, 10.95 - 23.00, 21.12 - 55.00 and 0.05-0.11 g, respectively. The TSS (°brix), pH, acidity (%) and vitamin C content (mg /100 ml juice) of fruit varied between 7.00 - 12.00 4.00-6.00, 1.15-1.51 and 29.16 - 40.15, respectively. Carbohydrate (% by wt), moisture (%), total ash (%) in fresh fruit juice were recorded 9.11, 90.0 and 0.69, respectively whereas the biochemical composition of fresh fruit juice viz, fat (g), protein (g), sugar (g), energy (K cal), calcium (as Ca mg), potassium (mg), sodium (mg), zinc (as Zn mg) and tannin (g) were recorded 0.0, 0.2, 0.0, 37.24, 97.71, 42.48, 90.49, 0.24 and 0.37, respectively in all the evaluated genotypes under rainfed conditions.

1. C. Number (IC-0594655 to 0594686) of 32 established genotypes M. tomentosa have been received from NBPGR, New Delhi.

2. Seeds (500g) have been provided to NBPGR, New Delhi

Multiplication and conservation of collected genotypes of noni (*Morinda* spp.)

Seeds of all the established genotypes were sown in nursery. Saplings are growing well. It can be commercially propagated through air layering in the month of July in *M. tomentosa*. All the genotypes are growing well under rainfed conditions of hot semi-arid ecosystem. Seeds sown during monsoon recorded 47.19% germination in M. tomentosa.

Identification of pests and diseases and their management

It is a hardy tree and is often found free of major diseases and pests; however, few fungal pathogens and pests were identified which occasionally bring about losses to the plantation of *Morinda* spp. Among fungal diseases, anthracnose caused by *Colletotricum gloeosporioides*, leafspots caused by *Alternaria alternata* and fruit rot caused by *Rhizopus stolonifer* are important. The anthracnose is characterized by appearance of distinct small, round, dark brown to tan necrotic spots on lamina of the leaf which gradually increase in size and become irregular, but still their centre shows 1-2 concentric rings. Gradually, the centre of necrotic spots is detached and blown away by wind current, and a shot hole left behind. The adjacent spots tend to coalesce and sometimes give blighted look, the centre of spot show sign of fungal growth and its fruiting bodies. The rainy season and few weeks after rains is favourable period for its development. The average disease intensity was measured 1.32-5.1 per cent. It is managed by sprays of chlorothalnil (0.2%), copper oxychloride 50 w. p. (0.3%), mancozeb 70 w. p. (0.2%) and carbendazim 50 w. p. (0.1%). The Alternaria leafspots are characterized by small, 2-4 mm in diameter white to light brown spots on leaf lamina. It is only a minor disease and seen during rainy season. The fruit rot is a post harvest disease caused by *Rhizopus stolonifer* and is characterized by dark discolouration of the green fruits which grow in size and cover almost half or more area of the fruits. The fruit turns soft and emits a characteristic bad odour and the entire fruit turns dark coloured within 2-3 days and becomes so much soft that even with the gentle pressing, its pulp is disintegrated. To manage this disease, avoidance of injury to fruit and dipping the fruit in copper oxychloride 50 w. p. 0.3% solutions for 3-5 minutes were found effective. The common insect pests of Aledi (*M. tomentosa*) are defoliators which eat away the soft green portion of leaf lamina leaving behind only the skeleton of leaf. Sometimes, entire tip portion of twigs are damaged by eating away by the pests. Sprays of dimethoate (1.5 ml / litre) are generally applied to manage the pests.

Performance of *Morinda citrifolia* L. under rainfed condition

A trial to study the performance of *M. citrifolia* were conducted purely under rainfed condition during the year 2012-13. Saplings of *M. citrifolia* were planted in 2010 and evaluated for growth, flowering, fruiting behaviour at Central Horticultural Experiment Station, Vejalpur purely under rainfed conditions of semi-arid ecosystem. The plant height, stem girth and plant spread varied from 1.620-1.84 m, 14.50 cm to 19.00 cm and 1.59 m -1.70 m, respectively. Fruit quality attributes of *Morinda citrifolia* in terms of fruit girth, fruit length, total number of fruits, fruit weight, number of seeds/ fruit, seed weight and fruit yield per plant ranged from 6.10 cm to 8.0 cm, 5.15 cm to 6.50 cm, 50 to 72, 45-68g, 60-109, 0.030-0.039g and 3.90 kg to 5.30 kg, respectively during 2nd year of orchard life purely under rainfed conditions of hot semi-arid ecosystem. The TSS, acidity, vitamin C and pH of juice varied from 4.5-6.0^0 brix, 0.21-0.29, 101-107 mg/100 ml juice and 6.00-8.05, respectively. The colour of fruit turned greenish white to white in colour while ripening. Cessation in growth of plant, curling and twisting of leaves was observed during summer (May- June), but plants regained their normal growth during monsoon. It may be stated that based on its performance, it can be recommended for growing under rainfed conditions of hot semi-arid ecosystem of western India.

8. Development of morphological descriptors and DUS test guidelines for jamun. (Co Nodal Centre)

Name of PI

Dr. Sanjay Singh

Detailed characters like vegetative, flowering and fruiting attributes were recorded to develop the DUS descriptor. It was observed that CHESJ-1 and CHESJ-2 were found to be spreading type, while CHESJ-2 and CHESJ-4 were found to be semi-spreading type. The peak period of full bloom and end of bloom was recorded in the month of March. Foliage was dense and leaf was elliptical lanceolate. Fruit shape of CHESJ-2, CHESJ-2 and CHESJ-4 was oblong, while it was ovoid in CHESJ-3. TSS (Degree Brix) was recorded 16.10,17.00, 15.30 and 15.50 in CHESJ-1, CHESJ-2 CHESJ-3 and CHESJ-4 respectively.

9. Enhancement of Livelihood of Tribal Farm Households of Panchmahals District in Gujarat State Through Agricultural Diversification

Name of PI & Co-PI

Dr. V. Lenin, PI

Dr. S. S. Hiwale & Sh. B. S.Khadda, Co-PI

Designing agricultural diversification strategies for livelihood security

Survey of key informants of Kyaria village, participatory rural appraisal, meetings with farmers and survey of development organizations were carried out. PRA tool social map was drawn by the people of the Kyaria village. From the map settlement pattern of the people was observed. They were living in three parts of the village namely, Bhagat falia, Kua falia and Bet falia. The Kadana dam water separated these falias. They were living in hillocks. The topography was highly sloppy. The lands were not plain. They cultivated maize and redgram in the kharif season. The farmers caught fish in the Kadana dam water inundating their fields in the village. During rabi and summer seasons they migrated to Rajkot and other areas and worked as agricultural labourers. A series of group meetings were conducted with the village people. Initially the livelihood diversification strategies were discussed with them. The villagers put forth the scientific goat rearing, backyard poultry, cultivation of aonla and ber, and kitchen gardening. The livelihood diversification strategies decided through constant

consultation with the farmers were the cultivation of aonla and ber, kitchen gardening, backyard poultry, and goat rearing.

Plantation of Aonla

Three farmers were randomly selected for Aonla plantation. They were, Shri.Damor Saibabhai Lalabhai, Shri.Damor Bharatbhai Motibhai and Shri.Katara Vagabhai Punjabhai. The aonla budded plants of NA-7 variety was procured from Central Horticultural Experiment Station nursery and transported to the village by Van. From village the planting materials were transported to the farmers' fields in boat. Forty plants were provided to each farmer. Our station staff prepared the layout of the Aonla orchards. The markings were made with wooden pegs at 5m x 5m distance. All the three farmers dug pits and planted the aonla plants in the marked places. The plants are coming up well.

Kitchen gardening

Through group meetings the list of vegetables and fruit crops for kitchen gardening was prepared by the villagers. The list included the vegetable crops, namely, Cluster bean, Okra, Tomato, Chilli, Bottle gourd, Brinjal, Drumstick, Palak, Ghiloda; and fruit crops namely, Lime, Mango, Ber, Aonla, Sapota, Jamun, Papaya and Bael. The vegetable seeds were procured and packets of different vegetable seeds namely, Okra, Cluster bean, Drumstick, Chilli, Tomato, Bottle gourd, and Palak, were made and distributed to the farmers in the next group meeting. They cultivated these vegetables in the backyard of their homes. These crops were mainly meant for household consumption.

Backyard poultry

Pratap Dhan breed of chicks were procured from MPUAT, Udaipur and distributed 11 chicks to each of the 3 selected farmers in Kyaria village. Six week old chicks were provided to the farmers. Weight of the chicks was observed periodically.

Goatery

Sirohi breed of goats were procured from the Lasani panchayat, Rajsamand district, Rajasthan state and distributed 4 female goats and 1 buck to each of the 3 selected farmers in Kyaria village.

Training programmes

Two training programmes on Ber production technology and scientific goat rearing were organized at Kyaria village.

10. Revolving fund scheme of ICAR funded seed project

For quality and high seed yield potentials in arid vegetable crops, seed crop production trials on snap melon (AHS-82), kachri (AHK-119), bottle gourd (Thar Samridhi), mateera (Thar Manak), Indian bean (Thar Maghi and Thar Kartiki), cluster bean (Thar Bhadavi) and moringa (AHMO-1-4s) were undertaken adopting HBCPSMA and studied as breeder and TFL seed production crop during 2012-13. About 150 kg TFL seed of institute varieties of arid zone vegetables was produce during the period under report for distribution to the farmers, NGO's, KVK's and state and private agencies (Table 42).

Table 42. Seed production of arid vegetable crop varieties at CIAH, Bikaner during 2012-13.

Crop - Varieties	Quantity (kg)
Kachri (AHK-119)	54.0
Snap melon (AHS-82)	50.0
Bottle gourd (Thar Samridhi)	2.0
Mateera (Thar Manak)	1.0
Cluster bean (Thar Bhadavi)	39.0
Indian bean (Thar Maghi and Thar Kartiki)	4.5
Moringa (AHMO-1-4s)	0.50
Total	151.0

Seed production trial in snap melon

For improving quality and seed yield potential in snap melon, a series of treatment combinations were studied adopting production site management approaches both under channel and drip technology of crop production with limited irrigation water. On an average basis, an improvement in fruit yield (q/ha) potential in snap melon variety AHS-82 was recorded under drip technology (laterals at 2.0 m and emitters at 0.50 m apart) of crop production by 17% higher from channel technology with limited irrigation water as well 38% higher from a rainfed crop under channel technology over the seasons from 2006 to 2012.

Similarly, the improvement in seed yield (q/ha) potential in snap melon variety AHS-82 was recorded under drip technology of crop production by 42% higher from channel technology with limited irrigation water as well 63% higher from a rainfed crop under channel technology over the seasons and years (Table 43).

Table 43. Performance of snap melon variety AHS-82 under varying production technology over the years (2006 to 2012).

Characters	Channel technology	Drip technology
Days to male flower (DAS)	38.99	40.49
Node number to male flower	3.78	4.31
Days to female flower (DAS)	43.51	44.31
Node number to female flower	4.85	5.32
Days to first harvest (DAS)	69.84	72.21
Fruit weight (kg)	0.751	0.856
Fruit length (cm)	17.97	19.31
Fruit girth (cm)	28.15	29.66
Flash thickness (cm)	2.23	2.43
Seed cavity (cm)	4.71	5.07
Number of fruits/plant	5.65	6.71
Fruit yield/plant (kg)	4.86	6.24
Fruit yield (q/ha)	235.66	274.65
Seed length (cm)	0.99	1.09
Seed width (cm)	0.41	0.47
Weight of 100 seeds (g)	1.91	2.29
Number of seeds/fruit	560.93	591.51
Weight of seeds/fruit (g)	12.91	14.75
Seed yield/plant (g)	51.89	73.61
Seed yield (q/ha)	2.594	3.679
Vine length (m)	2.52	2.69
Number of branches/plant	5.53	6.01

8

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RADIO/ TV TALK

S. S. Hiwale

Cultivation of Ber under rain fed conditions on 30/05/12 at All India Radio, Godhra.

Cultivation of Sapota under rain fed conditions on 02/01/13 at All India Radio, Godhra.

Raja, Shankar

Improved cultivation techninques in tomato on 30/05/12 at All India Radio, Godhra.

Singh, Sanjay

Cultivation of Jamun & Rayan on 24.05.2012 at All India Radio, Godhra.

9

RESEARCH PROGRAMMES AND PROJECTS

Code	Title	Investigators
	ON-GOING PROJECTS :	
CIAH: 1	**Introduction, collection, characterization, conservation and evaluation of germplasm of arid and semi-arid fruit and vegetable crops.**	**Dr. S. K. Sharma (Project Leader)**
	(a) *Ber*	Dr. Hare Krishna
	(b) Pomegranate	Dr. R. S. Singh Dr. S. S. Hiwale Dr. S. K. Maheshwari
	(c) Date palm	Dr. R. S. Singh Dr. R. Bhargava Dr. B. D. Sharma
	(d) *Aonla*	Dr. Sant Ram Dr. Hanif Khan
	(e) Indigenous and exotic underutilized fruit crops (Lasora, ker, pilu, karonda, phalsa, cactus pear, fig and mulberry).	Dr. Hare Krishna Dr. R. S. Singh Dr. Dhurendra Singh
	(f) *Bael*	Dr. R. S. Singh Dr. A. K. Singh Dr. Sanjay Singh
	(g) Wood apple, mango, sapota and custard apple.	Dr. S. S. Hiwale
	(h) Cucurbitaceous vegetable crops: Bottle gourd, round gourd, snap melon and kachri.	Dr. D. K. Samadia Dr. Hanif Khan
	(i) Cucurbitaceous vegetable crops: Muskmelon, watermelon sponge gourd and long melon.	Dr. B. R. Choudhary Dr. Rakesh Bhargava Dr. S. K. Maheshwari Dr. S. M. Haldhar
	(j) Jamun, tamarind, mahua, chiraunji, karonda, phalsa and khirni.	Dr. Sanjay Singh Dr. A. K. Singh Dr. R. Bhargava Dr. V. V. Appa Rao

Code		Title	Investigators
CIAH: 2		**Improvement of arid and semi arid fruit and vegetable crops including biotechnological interventions.**	**Dr. S. K. Sharma (Project Leader)**
	(a)	Improvement in *ber*	Dr. Hanif Khan Dr. Sant Ram
	(b)	Improvement in vegetable crops	Dr. D. K. Samadia Dr. Hanif Khan
	(c)	Genetic improvement of ridge gourd (*Luffa acutangula*) under arid environment.	Dr. B. R. Choudhary Dr. Hanif Khan Dr. S. K. Maheshwari Dr. S. M. Haldhar
	(d)	Breeding for yield, quality, biotic and drought resistance in cucurbitaceous crops.	Dr. S. Raja Shri H. K. Joshi
	(e)	Identification of Institute germplasm through biotechnological interventions :	
	(i)	Development of phyto-chemical markers in arid horticultural crops for varietal identification and assessment of phylogenetic relationship.	Dr. R. Bhargava Dr. R. S. Singh Dr. B. D. Sharma Dr. Dhurendra. Singh
	(ii)	Molecular characterization of arid fruits and vegetables by DNA markers.	Dr. P. N. Sivalingam Dr. Dhurendra. Singh Dr. D. K. Samadia
CIAH: 3		**Standardization of arid and semi-arid fruits and vegetables production technology.**	**Dr. S. K. Sharma (Project Leader)**
	(a)	Evaluation of fruit based diversified cropping models for arid region.	Dr. Hare Krishna Dr. R. Bhargava Dr. S. R. Meena
	(b)	Standardization and commercialization of micro-propagation techniques of horticultural crops under arid agro eco-system : Date palm	Dr. Dhurendra Singh Dr. P. N. Sivalingam
	(c)	Physiological and biochemical investigations in arid horticultural crops under abiotic stresses.	Dr. R. Bhargava Dr. R. S. Singh Dr. B. D. Sharma
	(d)	Post harvest management and value addition in arid horticultural crops.	Dr. Sant Ram Dr. R. Bhargava Dr. R. S. Singh Dr. S. R. Meena

Code		Title	Investigators
	(e)	Technological interventions for arid horticulture development and its impact assessment.	Dr. S. R. Meena Dr. R. S. Singh Dr. D. K. Samadia Dr. Dhurendra Singh
	(f)	Standardization of integrated nutrient management in arid horticultural crops.	Dr. B. D. Sharma Dr. R. Bhargava Dr. R. S. Singh Dr. S. K. Maheshwari
	(g)	Standardization of production technology of aonla.	Dr. A. K. Singh Dr. Sanjay Singh Dr. S. S. Hiwale Shri H. K. Joshi
	(h)	Standardization of production technology of mango and sweet orange.	Dr. Sanjay Singh Dr.A. K. Singh Dr. V. V. Appa Rao Shri H. K. Joshi Dr. S. S. Hiwale
	(i)	Organic farming studies in vegetables under semi-arid conditions.	Dr. V. V. Appa Rao Shri H. K. Joshi Dr. S. Raja
	(j)	Augmentation of vegetable cultivation by tribal farmers of Panchmahals district of Gujarat: An extention action research.	Dr. V. Lenin Dr. S. Raja
	(k)	Value addition in semi-arid fruit crops.	Dr. S. S. Hiwale Dr. V.V. Appa Rao
	(l)	Development of *khejri* based cropping models under rainfed conditions.	Dr. D. K. Samadia Dr. Hanif Khan Dr. S. R. Meena
CIAH: 4		**Plant health management studies in arid and semi-arid fruit and vegetable crops.**	**Dr. S. K. Sharma (Project Leader)**
	(a)	Integrated disease management in cucurbits (watermelon and bottle gourd) and fruit (pomegranate) under arid zone of Rajasthan.	Dr. S. K. Maheshwari Dr. Dhurendra Singh Dr. B. R. Choudhary
	(b)	Survey of insect-pests, their natural enemies and pest management strategies for cucurbits in arid region of Rajasthan.	Dr. S. M. Haldhar Dr. B. R. Choudhary Dr. R. Bhargava
	(c)	Biological control of diseases of semi-arid fruits and vegetables.	Shri H. K. Joshi

Code	Title	Investigators
	(d) Management of major fungal diseases of semi-arid fruits and vegetables using foliar sprays with inorganic salts and organic compounds.	Shri Shri H. K. Joshi Dr. V.V. Appa Rao Dr. Sanjay Singh
	CONCLUDED PROJECTS	
CIAH 2 (c)	Genetic improvement of chilli (*Capsicum annuum*) for resistance to biotic and abiotic stresses under arid environment.	Dr. Hanif Khan Dr. D. K. Samadia Dr. P. N. Sivalingam
CIAH 3 (d)	Investigation on causes and their management of fruit cracking in pomegranate.	Dr. B. D. Sharma Dr. R. Bhargava Dr. R. S. Singh Dr. Dhurendra Singh
CIAH 3 (f)	Dynamics of horticultural growth and development in hot arid regions of western Rajasthan : A status study	Dr. S. R. Meena
CIAH 3 (k)	Crop regulation in moringa and intercropping studies under semi-arid conditions.	Dr. S. Raja Dr. V. V. Appa Rao
CIAH 3 (c)	Integrated disease management in semi-arid horticultural crops.	Shri H. K. Joshi Dr. Sanjay Singh
	Externally funded projects	
EF 1	Bioperspecting of genes and allele mining for abiotic stress tolerance.	Dr. P. N. Sivalingam Dr. Dhurendra Singh
EF 2	Identification, collection, characterization, evaluation and conservation of Noni (*Morinda* spp. L.) of western India (Gujarat and M. P.).	Dr. A. K. Singh
EF 3	Validation of DUS testing guidelines for cucurbits i.e. watermelon and muskmelon.	Dr. B. R. Choudhary
EF 4	Validation of DUS descriptor for *ber* (*Ziziphus* sp.).	Dr. Hare Krishna Dr. R. Bhargava
EF 5	Validation of DUS descriptor for date palm (*Phoenix dactylifera*).	Dr. R. S. Singh Dr. R. Bhargava
EF 6	Enhancement of livelihood of tribal farm households of Panchmahals district in Gujarat State through agricultural diversification.	Dr. V. Lenin
EF 7	Validation of DUS descriptor for *bael*.	Dr. A. K. Singh
EF 8	Characterization of *aonla* varieties for developing DUS testing guidelines.	Dr. A. K. Singh (Co-Nodal Centre : CHES, Godhra)
EF 9	Development of morphological descriptor and DUS testing guidelines for jamun.	Dr. Sanjay Singh (Co-Nodal Centre : CHES, Godhra)

10

RAC, IMC, IRC, QRT

RAC

Chairman
Dr. S. P. Ghosh,
Former DDG (Hort.)
ICAR, New Delhi

Members
Dr. K. K. Jindal
Ex-ADG, ICAR, New Delhi

Dr. R. D. Rawal
Former Head, Plant Pathology,
IIHR, Bangalore

Dr. I. Irulappan
Former Dean (Hort.)
TNAU, Tamil Nadu

Dr. J. P. Gupta
Former Head, CAZRI, Jodhpur

Dr. V. Ponuswamy
Dean, College of Horticulture & Research
Institute Periyakulam, TNAU, Tamil Nadu

Dr. S. K. Sharma
Director, CIAH, Bikaner

ADG (Hort.-I), KAB-II, ICAR, New Delhi

Sh. Narendra Kumar Kiradu
Bikaner

Sh. K. Prabhakar Sadashi Chandane, President,
All Indian Pomegranate
Growers Association, Pune

Member Secretary
Dr. R. Bhargava, Principal Scientist
CIAH, Bikaner

The meeting of RAC was held on 21.05.2012

Institute Research Committee (IRC)

Chairman
Dr. S. K. Sharma
Director
CIAH, Bikaner

Members
All scientists of the Institute

Member Secretary
Dr. S. K. Maheshwari
Sr. Scientist (Plant Pathology)

IRC meeting was held on 4 to 5 June 2012.

Institute Management Committee (IMC)

Chairman
Dr. S. K. Sharma
Director
CIAH, Bikaner

Members
ADG (Hort.-II)
ICAR, New Delhi

Director (Hort.)
Govt. of Rajasthan
Jaipur

Director of Hort.
Gujarat State
Gujarat

Director of Research
S. K. RAU
Bikaner

Sh. Karan Singh
FAO, DMR
Bharatpur (Rajasthan)

Dr. Sanjay Singh
Head
CHES, Godhra

Dr. Rakesh Bhargava
Pricipal Scienist
CIAH, Bikaner

Dr. D. Singh
Sr. Scientist
CIAH, Bikaner

Member Secretary
Admn. Officer, CIAH, Bikaner.

The meeting of IMC was held on 19-06-2012

11

MEETING, CONFERENCE, TRAINING, LECTURES ETC.

Meeting

Dr. S. K. Sharma, Director

Attended second meeting of Task Force on Vegetable Crops at IIHR, Bengaluru during 19-20 April, 2012.

Participated in meeting with DDG (Hort.) on 23rd July, 2012

Participated in meeting with Hon'ble D.G. (Hort.) on 21-22 August, 2012

Participated in meeting at Pant Krishi Bhawan, Jaipur on 31.08.2012 as Member, Working Group on Agriculture, Govt. of Rajasthan.

Meeting with Hon'ble DDG (Hort.) ICAR on 06.09.2012.

Meeting with Hon'ble DG, ICAR on 07.09.2012.

Participated in the meeting of Regional Committee No. 06 at CAZRI, Jodhpur.

Participated in the meeting of Establishment of Centre of Excellence for Citrus at PAU, Ludhiana on 14.01.2013

Participated in the RFD Meeting on 16.01.2013 at ICAR, New Delhi

Participated in the RAC Meeting at IIVR, Varanasi on 29-30 Jan., 2013

Participated in the Working Group on Agriculture Meeting at Pant Krishi Bhawan, Jaipur on 01.02.2013 to be chaired by Dr. R.S. Paroda, Ex-Director General, ICAR, New Delhi

Attended Third Meeting of Task Force for Vegetable Crops on 14.02.2013 at NASC, New Delhi.

Chaired the DPC Meeting at NRC on Litchi, Muzzafarpur, Bihar on 11.03.2013

Attended meeting of Head of Division and Directors on 12-13 March, 2013 at NASC, New Delhi

During the reported time, the Hindi committee meetings were held on 08.06.2012 at CHES, Godhra and 11.09.2012, 31.12.2012 and 15.03.2013 at CIAH, Bikaner under the Chairmanship of Dr. S.K. Sharma, Director of the Institute. Quarterly Hindi workshops were also held on 27.06.2012, 28.09.2012 and 28.03.2013.

Institute Joint Staff Committee Meeting

Institute Joint Staff Committee Meeting was held on 08.06.2012 atCHES, Godhra and 11.09.2012, 31.12.2012 and 15.03.2013 at CIAH, Bikaner, in which various issues/agendas related to staff welfare were discussed at length.

Celebration of week/day

- The Institute's Foundation day was celebrated on 01.04.2012 in the campus of the Institute. The celebration programme was chaired by Dr. O.P. Pareek, the Founder Director of the Institute
- Anti- terrorism day was celebrated in the institute on 21.05.2012.
- Observance of Agriculture Education Day on 20.07.2012

- Massive Tree Plantation day/programme was held in the Institute on 22.07.2012.
- Observance of Farmers Innovators Day on 09.10.2012
- Observance of Vigilance Awareness Week during 31.10.2012 to 05.11.2012 and pledge taking ceremony on 31.10.2012 at 11 AM.
- Observance of Communal Harmony Campaign week and the Flag Day in the Institute from 19-25 November, 2012.
- Observance of ICAR Industry Meet on 18.12.2012

Dr. R. S. Singh

Attended Institutes' Research Council (IRC) meeting of CIAH from 4-5th May,2012

Attended Project Monitoring Committee (PMC) meeting of the Institute as Member Secretary on 02.6.2012.

Attended meeting of RFD, Nodal officer, Horticulture Division on 23.11.2012 at KAB-II, Pusa, New Delhi.

Attended ICAR Industry Day meet programme at CIAH, Bikaner on 18.12.2012.

Attended Institute Management Committee meeting of CIAH, Bikaner as invitee member on 19.6.2012

Attended RAC meeting of CIAH, Bikaner held on 21.5.2012.

Attended Review workshop of I/c PME Cell of ICAR Institutes on 8.12.2012 at NDRI, Karnal.

Attended RFD meeting of Horticulture Division, ICAR for preparation of draft RFD 2013-14 at NASC complex New Delhi on 16.1.2013

Attended Institute Management Committee meeting of Zonal Project Directorate (Zone VI) as member at CAZRI Campus, Jodhpur on 18th February, 2013.

Attended 7th DUS centre Review meeting at IIVR, Varanasi from 28Feb,to 01 March,2013.

Attended Jojoba meet programme organized by Thar Nursery, Bikaner on 16.3.13.

Dr. D. K. Samadia

Dr. D.K. Samadia attended ZREAC Kharif - 2012 Meeting held at ARS, SKRAU, Bikaner from 10 - 11 April 2012.

Attended and presented the research and development work of arid zone vegetable crops as voluntary centre under AICRP (VC) for the QRT 2007 to 2012 held at MPKV, Rahuri from 7 - 8 January 2013.

Dr. S. K. Maheshwari

Attended PMC meeting of CIAH, Bikaner as invitee member on 02-06-2012.

Acted as Member Secretary of IRC meeting of CIAH, Bikaner held on 4-5 June, 2012

Worked as external examiner of B. Sc. (Ag.) on July 1& 2, 2012 at Dayanand College, Ajmer (Raj.).

Worked as external examiner of B. Sc. (Ag.) on December 26, 27 & 28, 2012 at SKRAU, Bikaner (Raj.).

Worked as invigilator for conducting examination of NET of ICAR at SKRAU, Bikaner on 24-02-2013.

Conference/Semi-Symp/ Workshop / etc

Dr. S. K. Sharma

Co-chaired Technical Session VII on "Post harvest management and value addition" in the National Conference on Adaption to climate change for sustained production of banana on 9th April, 2012 at Jalgaon, Maharashtra.

Attended the Workshop on Horticulture Crops at IHITC, Jaipur during 14.05.2012 to 15.05.2012.

Participated in the one day workshop on RTI at ISTM, New Delhi on 21.09.2012

Participated in the 7th Indian Horticulture Congress 2012 at PAU, Ludiana.

Delivered lecture during symposium at CAZRI, Jodhpur on 1st Dec., 2012.

Acted as Chief Guest in the State Level Custard Apple Conference at MAU, Parbhani on 07.12.12.

Participated in National Consultation on "Management of Genetic Resources of Horticultural Crops" at NBPGR, Auditorium, New Delhi.

Attended the Agricultural Science Congress and visited the Cactus Repository of Dr. Das at OUAT, Bhubneshwar (Orissa) from 05.02.2013 to 09.02.2013.

Participated in the Director Conference at A P Shinde Symposium Hall, NASC Complex, Pusa New Delhi held on 19-20, March, 2013.

Dr. R. S. Singh

Attended International Conference on "Sustainable Agriculture for Food and Livelihood Security" held at PAU, Ludhiana during November 27-29, 2012.

Attended a National Seminar on "Agribusiness Potential in Rajasthan" held at IABM, SKRAU, Bikaner from 19-20 March, 2013.

Singh, R.S.; R. Bhargava; Garima Pal and S. K. Sharma. 2012. Effect of frost on fruit plants and its management in hot arid region. Poster paper presentation In: International Conference on Sustainable Agriculture for Food and Livelihood Security held at PAU, Ludhiana during November 27-29, 2012,

Singh, R. S.; R. Bhargava and S. K. Sharma 2013. Prospects of Agribusiness in Arid Horticulture: Status and Opportunities. paper presented in National Seminar on Agribusiness Potential in Rajasthan at IABM, SKRAU, Bikaner during 19-20March, 2013.

Dr. D. K. Samadia

Attended International Conference on Extension Education in the Perspectives of Advances in Natural Resource Management in Agriculture (NaRMA-IV) held at SKRAU, Bikaner (Rajasthan) from 19 - 21 December 2012.

Dr. Dhurendra Singh

Attended "International Conference on "Extension Education In The Perspectives Of Advances In Natural Resources Management In Agriculture (NaRMA-IV)" on Dec.19-21 2012 at SKRAU, Bikaner

Dr. S. K. Maheshwari

Participated and presented poster paper in International Conference on "Sustainable Agriculture for Food and Livelihood Security" held on November 27-29, 2012 at College of Agriculture, Punjab Agricultural University, Ludhiana (Punjab).

Participated and delivered an oral presentation of research paper in International Conference on "Extension Education in the Perspectives of Advances in Natural Resource Management in Agriculture (NaRMA-IV)" held on December 19-21, 2012 at SKRAU, Bikaner (Rajasthan).

Dr. Hare Krishna

Attended and presented an oral paper 'Bioactive compounds rich squash from mulberry (Morus sp.) for nutritional security' at International Conference on Sustainable Agriculture for Food and Livelihood Security (ICSA-2012) from 27-29 November, 2012 at PAU, Ludhiana.

Attended and presented a poster on "Phytochemical constituents and antioxidant properties of different Indian jujube (Ziziphus mauritiana Lamk.) cultivars" during the National Seminar of Plant Physiology on Physiological and Molecular Approaches for Development of Climate Resilient Crops" Organized by Department of Crop Physiology, Acharya. N. G. Ranga Agricultural University, Rajendranagar, Hyderabad and Indian Society for Plant Physiology, New Delhi during 12-14 December, 2012.

Dr. S. M. Haldhar

Attended International Conference on Insect Science organized by UAS, Bangalore during 14-17, February, 2013.

Attended global conference on Horticulture for food, nutrition and livelihood options organized by ASM foundation, New Delhi and OUAT, Bhubaneswar, Orissa during 27-31, May, 2012.

Attended national workshop on "Foresight and future pathways of agricultural research through involvement of youth in India" at NASC complex, New Delhi during 1-2, March, 2013.

Dr. B. R. Chodhary

XXth Biennial Workshop of AICRP on Weed Control held at KAU, Trissur from 17-18 April, 2012.

Global Conference on Horticulture for Food, Nutrition and Livelihood Options held at OUAT, Bhubaneswar from 28-31 May, 2012.

Participated in International Conference on Sustainable Agriculture for Food and Livelihood Security held at PAU, Ludhiana from 27-29 November, 2012.

Lectures

Dr. B. D. Sharma

B. D. Sharma (2012) Integrated nutrient and water management in Kinnow mandarin fruit crops in Rajasthan. In: Training programme Season long training programme on Kinnow/Citrus family fruit crop on 26th December 2012, CIAH, Bikaner.

B. D. Sharma (2013) Phal evm Sabjeyon mein urvarak and sichai prabandhan. Training programme on improved cultivation techniques of fruit and vegetables during 19-23rd February 2013, CAZRI RRS, Bikaner.

B. D. Sharma (2013) Phal evm Sabjeyon mein urvarak and sichai prabandhan. Training programme on improved cultivation techniques of fruit and vegetables during 19-23rd March 2013, CAZRI RRS, Bikaner.

B. D. Sharma (2013) Integrated nutrient management in fruit and begetable crops. Training programme on Cultivation techniques of fruit and vegetables during 5-6 October 2012. CIAH, Bikaner.

Dr. R. S. Singh

Importance of Horticulture & Improved Techniques of Fruits Cultivation in Agriculture Education day programme on 17.7.2012 at CIAH, Bikaner.

Scope and importance of Exotics underutilized fruits in hot arid region on 06.9.2012, Production techniques of Fig on 14.9.2012, Production technology of fruits with minimum inputs use and Flowers cultivation in Arid region on 22.9.12, in 21 days Winter school on Exploitation of underutilized Horticulture crops for Sustainable production at CIAH, Bikaner from 5th to 25th September, 2012.

Improved Technology for Fruits Cultivation in Arid region in Farmers Innovation Day programme on 9.10.2012 at CIAH, Bikaner.

Cultivation of underutilized fruit and vegetables in training programme for women at CAZRI, RRS, Bikaner 21.2.2013.

Importance of Horticulture in development of arid region in Training cum Awareness programme

on PPV&FRA, held at CIAH, Bikaner on 08.3.2013.

Production technology of Date palm in Celebration of Horticulture Day programme at CSF, Jetsar, Sri Ganganagar on 25.3.2013.

Dr. D. K. Samadia

Dr. D. K. Samadia delivered invited lecture "Production technology for horticultural exploitation of khejri and moringa" in winter school organized by CIAH, Bikaner form 05 - 25 September 2012.

डॉ. डी. के. समादिया द्वारा गर्म शुष्क क्षेत्र में सब्जी फसलों के उत्पादन की तकनीक पर व्याख्यान प्रक्षेत्र नवोन्वेषक दिवस पर केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर में दिनाँक 09 अक्टूबर 2012 को दिया गया।

Dr. Dhurendra Singh

Singh, D; Meena, S. R.; Maheshwari, S. K.; Sivalingam, P. N. and Sharma, S. K. (2012). Hi-tech propagation of horticultural crops- A methodology for water saving in arid region. Paper presented as oral in International Conference on "Extension Education in the Perspectives of Advances in Natural Resource Management in Agriculture (NaRMA-IV)" held on December 19-21, 2012 at SKRAU, Bikaner, Abs. p. 50 (No. A 100).

Dr. S. K. Maheshwari

Delivered a lecture on "Integrated disease management in underutilized arid fruit crops" in winter school entitled 'Exploitation of Underutilized Horticultural Crops for Sustainable Production' held on 5-25 September, 2012 at CIAH, Bikaner, Rajasthan.

Delivered a lecture on "Phal evam sabji wali phaslo me rog prabandhan" in training on 'Improved cultivation techniques of fruits & vegetables' held on 19-23 February, 2013, at RRS, CAZRI, Bikaner.

Delivered lectures on "Improved agro-techniques for vegetable production" during summer season" in off-campus farmer's training programme held in Chak No. 489 near Khara and Rashmi Farm, Kanasar, Bikaner district on 25-02-2013 and 01-03-2013, respectively.

Dr. Hare Krishna

Delivered lecture on 'Shashya chakron mein phal aadharit baagwani' in Women farmer's training on 'Improved cultivation techniques of fruits and vegetables' on 19-02-13 organized by CAZRI-RRS, Bikaner.

Delivered lecture on 'Shashya chakron mein phal aadharit baagwani' in Women farmer's training on 'Improved cultivation techniques of fruits and vegetables' on 20-03-13 organized by CAZRI-RRS, Bikaner.

Delivered lecture on 'Importance of DUS testing in reference to farmer's rights' during PPV&FRA sponsored training cum awareness programme at CIAH, Bikaner on March 08, 2013.

Delivered lectures on topics 'Nursery management and propagation of underutilized fruit crops', 'Antioxidants and value addition of underutilized temperate horticultural crops' and 'Physiology of canopy management' during the ICAR sponsored winter school 'Exploitation of underutilized horticultural crops for sustainable production' held at CIAH, Bikaner from September 05-25, 2012.

Delivered a lecture on 'Developing DUS test guidelines in ber (Ziziphus sp.)' as a speaker in Session III (Development of DUS guidelines) during the 7th Review Meeting of DUS Centers at IIVR, Varanasi on March 01, 2013.

Dr. S. M. Haldhar

Lecture delivered to women farmers on 'Integrated Pest Management (IPM) in fruit and

vegetable pests' in "Women Farmers Training" organized by CAZRI, RS, Bikaner during 19-23 February, 2013.

Lecture delivered on "Identification of Insect-pests of Kinnow/Citrus fruit crops" under the 'Season long training programme on Kinnow/citrus family fruit crops from 26th December 2012 to 24th January 2013' organized by Central Integrated Pest Management Centre, DPPQ&S, Sri Ganganagar, Rajasthan.

Lecture delivered to farmers on 'Insect-pests of arid fruits and vegetables and their management' in "Farmer Innovators Day" organized by CIAH, Bikaner during 09 October, 2012.

Oral presentation on 'Investigating allelochemical resistance traits of muskmelon (Cucumis melo L.) against fruit fly (Bactrocera cucurbitae (Coquillett)) in hot arid region of Rajasthan' in "International Conference on Insect Science" organized by UAS, Bangalore during 14-17, February, 2013.

Dr. B. R. Chodhary

'Cultivation of vegetable crops' on 24-01-2013 in a training programme organized by KVK, Bikaner.

'Seed production of fruits and vegetables' on 23-2-2013 in a training programme organized by CAZRI RSS, Bikaner.

'Seed production of fruits and vegetables' on 22-03-2013 in a training programme organized by CAZRI RSS, Bikaner.

Training Imparted

Dr. R. S. Singh

Organized Agricultural Education Day programme at CIAH, Bikaner on 17.7.2012

Organized 21 days ICAR sponsored winter school on "Exploitation of underutilized Horticulture crops for Sustainable production" at CIAH, Bikaner from 5th to 25th September, 2012.

Organized one day training-cum -awareness programme sponsored by PPV& FRA, New Delhi for farmers/extension workers/students on 8.3.2013 at CIAH, Bikaner

Training attended

Dr. Dhurendra Singh

Dr Dhurendra Singh a attended meeting regarding date palm tissue culture held at AAU, Anand on 21.11.2012.

Dr. P. N. Sivalingam

Attended foreign training on Transcriptome profiling during abiotic stress and gene discovery" at The Samuel Roberts Noble Foundation, Ardmore, Oklahoma, USA from 15th September to 15th December 2012 funded by NAIP under the project on "Bioprospecting of genes and allele mining for abiotic stress tolerance".

Dr. S. M. Haldhar

Attended (21 days) winter school training course on "Modern approaches in diagnostics and management of pest and diseases in vegetables crops under protected conditions" from November 05 to November 25, 2012 at Indian Institute of Vegetable Research, ICAR, Varanasi.

12

WINTER SCHOOL & DISTINGUISHED VISITORS

A winter school on ""Exploitation of Underutilized Horticultural Crops for Sustainable Production" was organized at Central Institute for Arid Horticulture, Bikaner during 05-25 September, 2012 which was sponsored by Indian Council for Agricultural Research, New Delhi. The winter school was attended by a total of 24 participants representing 10 states of the country from SAUs and ICAR institutes. The winter school was inaugurated by Dr. A.K. Dahama, Vice- Chancellor, S.K.RAU, Bikaner, Rajasthan on 5.9.2012. Dr. O.P. Pareek, Former Director, CIAH as special guest and Dr. N. V. Patil, Director, NRC on Camel and as Guest of Honour also addressed to the gathering of inaugural function of winter school course on 5.9.2012. A total of 60 lectures covering various aspects of arid horticulture, underutilized fruits were delivered during this period. Apart from the faculty of CIAH, Bikaner, prominent personalities from SAUs and ICAR such as Dr. M.M. Roy, Director, CAZRI, Jodhpur ,Dr. Manjit Singh, Director, Directorate of Mushroom Research, Solan, H.P., Prof. Vishal Nath, Director, National Research Centre on Litchi, Muzafferpur, Bihar, Dr. O.P. Pareek, Ex-Director, CIAH, Bikaner, Dr. S.N. Pandey,, Former ADG (Hort), ICAR, New Delhi; Dr. J.P. Singh, Head, CAZRI, RRS, Jaisalmer, Dr. S.K. Malhotra, P.S.,(Hort), ICAR, New Delhi, Dr. Manoj Srivastava, Registrar, PPV&FRA, New Delhi, Dr. V.B. Singh, Prof. (Hort), Nagaland University, Medziphema,Dr. B.L.Attri, Officer In-charge, ,RRS. CITH, Mukteshwar, Dr. N. N. Reddy, Principal Scientist, CRIDA, Hyderabad, Dr. Shridhar, P.S., Div. of Vegetable crops, IARI, New Delhi; Dr. N.D.Yadav, Head, CAZRI, RRS, Bikaner; Dr. P.N.Kalla, Director, Extention Education, SKRAU, Bikaner, Dr. Rajesh Sharma, Director, IABM, RAU, Bikaner; Dr. S. Gangopadhyay, ADR,, SKRAU, Bikaner, Dr. I.J. Gulati, Prof &Head, Deptt. of Soli Science, SKRAU, Bikaner, Dr. J.K. Gaur, Head, Deptt. of Agric. Engg, .SKRAU, Bikaner, Dr. M.K. Kaul, Prof Hort, & Addl. Director Research, SKRAU, Bikaner and Dr. Atul Chandra, Prof. Hort.& PC, KVK, SKRAU, Bikaner delivered the talks on different topics. The main themes covered were Introduction & SWOT analysis of Arid ecosystem, Exotic underutilized fruits, Production technology of underutilized fruits, Genetic Resource management, Role of NBPGR for introduction, Registration of elite material, Biotechnological approaches for improvement, production of planting material and nursery management, Crop diversification, Role of growth regulators to enhance productivity in fruit plants, adoptive mechanism in plants for drought tolerance, Soil and Water conservation, pressurized and micro- irrigation, Integrated nutrient management, Cropping systems, Canopy management, Enterprenual development, Underutilized fruits of temperate region, underutilized vegetable crops, IPR issues, Role of PPV&FRA, Integrated approaches for Disease and insects

Inauguration of Winter School by Dr. A.K. Dahama Vice Chancellor, SKRAU, Bikaner

Field/Nursery Visit to Village Kilchu, Bikaner

Address by Prof. A.K. Gehlot, Vice Chancellor, RAJUVAS, Bikaner in closing ceremony of Winter school

Farmers field visit

Distribution of certificates to the participants of winter school

management and Value addition and PHT in arid horticultural crops. The participants were also given on hand practical training in Nursery management, anti-oxidents, Value addition, estimation of nutrients, etc. The participants were also visited to farmer's field and nursery nearby Bikaner to acquaint about fruit crops cultivation, farming systems, nursery and water management, etc.

Prof. A. K. Gehlot, Vice Chancellor. Rajasthan Veterinary & Animal Science University, Bikaner was the Chief Guest of function, Prof. Vishal Nath, Director, NRC on Litchi, Muzarfarpur Special Guest of the concluding function held on 25th September, 2012 in which certificates to participants were distributed.

Distinguish Visitors

- Hon'ble VC, SKRAU, Bikaner, Dr. A.K. Dahama visited the Institute on 05.09.2012
- Dr. M.M. Roy, Director, CAZRI, Jodhpur visited the Institute on 14.09.2012
- Dr. Manjeet Singh, Director, NRC on Mushroom, Solan (H.P.) visited the Institute on 14.09.2012

- Dr. N.N. Reddy, Principal Scientist (Hort.), CRIDA, Hyderabad visited the Institute on 15.09.2012
- Dr. V.V. Singh, Ex-Dean, School of Agricultural Sciences and Rural Development, Medziphma, Nagaland visited the Institute on 22.09.2012
- Dr. S.N. Pandey, Ex-ADG (Hort.), ICAR, visited the Institute on 24.09.2012
- Dr. S.K. Malhotra, Principal Scientist, ICAR, KAB-II, Pusa, New Delhi visited the Institute on 24.09.2012
- Dr. Vishal Nath, Director, NRC on Litchi, Muzaffarpur (Bihar) visited the Institute on 24.09.2012
- Hon'ble Vice-Chancellor, Rajasthan University of Veterinary and Animal Sciences Dr. A.K. Gahlot visited the Institute on 25.09.2012
- Dr. D.S. Mishra, Joint Registrar, PPV & FRA, Ministry of Agriculture, GOI, New Delhi visited the Institute on 09.11.2012.
- Hon'ble Deputy Director General (Horticulture), Dr. N.K. Krishna Kumar visited the Institute on 18.11.2012.
- Dr. B.B Vashishtha, Ex-Director, NRC on Seed Spices, Ajmer visited Institute.
- Dr. R.V. Singh, Former Dean, GB Pant University of Agriculture and Technology, Pant Nagar visited Institute.
- Dr. Pritam Kalia, Head, Division of Vegetable Sciences, IARI, Pusa, New Delhi visited Institute on 16.02.2013

Godhra

- Dr.S.Ayyappan, Secretary, DARE, and Director General, ICAR, New Delhi visited the station on 02.06.2012.
- Dr.S.Maiti, Director, DMAPR, Anand visited the station on 02.06.2012 and 16.02.2013.
- Dr.R.N.Pal, Ex DDG (Horticulture), ICAR, New Delhi visited the station on 21.09.2012.
- Dr.Bijendra Singh, Project Coordinator (Vegetables) , IIVR, Varanasi visited the station on 12.10.2012.
- Dr.N.K.Krishnakumar, DDG (Horticulture), ICAR, New Delhi visited the station on 20.11.2012 and 16.02.2013.
- Dr.A.R.Pathak, Vice Chancellor, Navsari Agricultural University, Navsari visited the station on 20.11.2012 and 16.02.2013.
- Dr.B.S.Chundawat, Former Vice Chancellor , SDAU, Dantiwada visited the station on 12.01.2013.
- Dr. N.B. Singh, Former Agriculture Commissioner and Expert, NRAA, Planning Commision, New Delhi visited the station on 8.03.2013.

13

RAJBHASHA

संस्थान में दिनांक 14 सितम्बर, 2013 से 29 सितम्बर, 2013 तक हिंदी पखवाडा का आयोजन किया गया। दिनांक 14 सितम्बर को हिंदी दिवस का आयोजन किया गया। हिंदी पखवाड़े का उद्घाटन के अवसर पर बीकानेर के वयोवृद्ध हिंदी साहित्यकार डॉ. राम नरेश सोनी मुख्य अथिति थे। समारोह की अध्यक्षता संस्थान के निदेशक डॉ. एस. के. शर्मा ने की। हिंदी पखवाड़े के उद्घाटन के अवसर पर मंचस्थ मुख्य अतिथि डॉ. रामनरेश सोनी एवं सस्थान के निदेशक डॉ. एस. के. शर्मा ।

इस दौरान संस्थास के अधिकारियों एव कर्मचारियों में हिंदी में कार्य करने की रूचि जागृत करने हेतु दो प्रतियोगिताओं का आयोजन भी किया गया था। इनमें हिंदी श्रुति लेखन एवं हिंदी शब्द लेखन प्रतियोगिता प्रमुख रूप से थी। हिंदी श्रुति लेखन प्रतियोगिता में प्रथम– सुश्री पूजा जोशी, क.आशुलिपिक, द्वितीय– श्री स्वरूप चंद राठौड़, अवर श्रेणी लिपिक एवं तृतीय– डॉ. बालूराम चौधरी, वैज्ञानिक रहे। इसी प्रकार हिंदी शब्द लेखन प्रतियोगिता में प्रथम– श्री कुलदीप पांडे, सहायक, द्वितीय– श्री भोजराज खत्री, टी–4 एवं तृतीय– श्री संजय पाटिल, टी–6 रहे जिन्हें दिनांक 29.09.2012 को आयोजित समापन समारोह में हिंदी साहित्यकार डॉ. शंकर लाल स्वामी ने स्मृति–चिन्ह प्रदान कर सम्मानित किया।

विजेता प्रतिभागियों को स्मृति–चिन्ह प्रदान करते हुए मुख्य अतिथि डॉ. शंकर लाल स्वामी एवं संस्थान के निदेशक डॉ. एस. के. शर्मा ।

पखवाड़े के दौरान दिनांक 28.09.2012 को हिंदी कार्यशाला का आयोजन किया गया। जिसमें बीकानेर के वयोवृद्ध पूर्व हिंदी प्राध्यापक एवं साहित्यकार डॉ. मालीराम शर्मा का व्यानख्यान आयोजित किया गया। डॉ. मालीराम शर्मा खाड़ी देश इराक में हिंदी के प्राध्यापक भी रह चुके हैं।

दिनांक 27 जून 2012 को आयोजित हिंदी कार्यशाला में पूर्व प्राध्यापक एवं गृह मंत्रालय, भारत सरकार की हिंदी समिति के पूर्व सदस्य श्री रामनिवास शर्मा एवं संस्थान के निदेशक डॉ. एस. के. शर्मा

संस्थान में हिंदी के उत्ष्ट प्रदर्शन के लिए नगर राजभाषा कार्यान्वयन समिति, बीकानेर ने वर्ष 2011–12 के लिए संस्थान को प्रशस्ति पत्र प्रदान किया था।

अवधि के दौरान राजभाषा की प्रगति के मापदण्डों के अनुसार संस्थान राजभाषा कार्यान्वयन समिति की चार बैठकों (दिनांक 08.06.2012, 11.09.2012, 31.12.2012 एवं 15.03.2013) तथा हिन्दी की तीन कार्यशालाओं (दिनांक 27.06.2012, 28.09.2012, एवं 28.03.2013) का सफल आयोजन कर राजभाषा विभाग द्वारा निर्धारित लक्ष्यों को पूर्ण किया गया ।

उपकेन्द्र, बेजलपुर की हिंदी गतिविधियां

राजभाषा कार्यन्वयन समिति की बैठकें :

राजभाषा कार्यन्वयन समिति की तिमाही बैठकों का आयोजन क्रमशः दिनांक 29.06.2012 , 27.09.2012,

11.12.2012 एवं 23.03.2013 को किया गया। जिसमें केन्द्र की राजभाषा की प्रगति की समीक्षा की गई एवं कार्यान्वयन में आ रही कठिनाईयों को दूर करने के लिए विचार विमर्श करके हिन्दी की प्रगति को सुनिश्चित करने के लिए कदम उठाये।

हिन्दी कार्यशाला

केन्द्र में कार्यरत अधिकारियों को हिन्दी में कार्य करने की प्रेरणा के लिए राजभाषा विभाग के निर्देशानुसार दिनांक 15.09.2012 को "देश की एकता और अखंडता में राजभाषा हिन्दी का योगदान " विषय पर कार्यशाला का आयोजन किया गया।

दिनांक 14.09.2012 को हिन्दी दिवस का आयोजन किया गया। अन्य कार्यक्रमों के साथ ही एक रोचक कार्यक्रम का आयोजन किया गया जिसमें हिन्दी में व्याख्यान कैसे दिया जाए, विषय पर कार्यक्रम रखा गया। विभिन्न वक्ताओं ने इस अवसर पर व्याख्यान देने की विभिन्न शैली पर चर्चा कर इसकी उपयोगिता को बताया। उपकेन्द्र पर दिनांक 17.09.2012 से 22.09.2012 तक हिंदी सप्ताह का आयोजन कर हिन्दी की विभिन्न गतिविधियों का संचालन किया गया।


भारत सरकार

नगर राजभाषा कार्यान्वयन समिति, बीकानेर

प्रशस्ति-पत्र

वर्ष 2011-12 के दौरान नगर में राजभाषा के उत्कृष्ट प्रयोग के लिए [illegible] को यह प्रशस्ति पत्र प्रदान किया जाता है।

दिनांक 26-06-2012

किसान प्रशिक्षण

केन्द्र द्वारा समय–समय पर किसान प्रशिक्षणों आयोजित किए जाते है। इन किसान प्रशिक्षणों में केवल हिन्दी भाषा का ही प्रयोग किया जाता है

केन्द्रीय बागवानी परीक्षण केन्द्र वेजलपुर पर 26–27 जून, 2012 के दौरान आत्मा के सहयोग से दाहोद जिले के पीपलोद और वन्दार गांव से 38 पुरूष और महिला किसानों को " ग्रामिण विकास के लिए अर्ध–शुष्क बागवानी " पर दो दिवसीय प्रशिक्षण दिया गया।

संस्थान द्वारा वर्ष 2012–13 के दौरान राजभाषा हिंदी में प्रकाशित साहित्यः–

1. वार्षिक प्रतिवेदन 2011–12 (केशुबासं, संस्थान)
2. वार्षिक प्रतिवेदन 2011–12 (एक्रिप)
3. मरु बागवाणी– (वार्षिक राजभाषा पत्रिका 2011)
4. छः माही समाचार पत्र (दो अंक)
5. तौरई की वैज्ञानिक खेती (तकनीकी पत्रक)
1. शुष्क क्षेत्रीय फलों की प्रमुख बीमारियां एवं उनका प्रबंधन (तकनीकी पत्रक)


हिन्दी कार्यशाला के दौरान आमंत्रित साहित्यकार डॉ. मालीराम शर्मा एवं संस्थान के निदेशक डॉ. एस.के. शर्मा

हिंदी पखवाड़े के उद्घाटन के अवसर पर मुख्य अतिथि डॉ. रामनरेश सोनी एवं संस्थान के निदेशक डॉ. एस.के. शर्मा

दिनांक 27 जून 2012 को आयोजित हिंदी कार्यशाला में पूर्व प्राध्यापक एवं गृह मंत्रालय, भारत सरकार की हिंदी समिति के पूर्व सदस्य श्री रामनिवास शर्मा एवं संस्थान के निदेशक डॉ. एस.के. शर्मा

हिंदी पखवाड़े के समापन अवसर पर मुख्य अतिथि डॉ. शंकर लाल स्वामी एवं संस्थान के निदेशक डॉ. एस.के. शर्मा

दिनांक 8 जून 2012 को संस्थान के उपकेन्द्र पर आयोजित संस्थान राजभाषा कार्यान्वयन समिति की बैठक के आयोजन पर उपस्थित सदस्य एवं अधिकारीगण

2. पौधा किस्म एवं कृषक अधिकार संरक्षण अधिनियम– प्रशिक्षण एवं जागरुकता कार्यक्रम (प्रशिक्षण पुस्तिका, बीकानेर व वेजलपुर के लिए अलग– अलग प्रकाशन) कद्दूवर्गीय सब्जियों की प्रमुख बीमारियां एवं उनका प्रबंधन (तकनीकी पत्रक)।

14

PERSONNEL

CIAH (INCLUDING CHES)

Sr. No.	Designation	Sanctioned Posts	Posts filled	Posts vacant
1.	Director (RMP)	01	01	00
2.	Scientific	35	20	15
3.	Technical	43	40	03
4.	Administrative	23	18	05
5.	Skilled Support Staff	33	29	04
	Total	135	108	27

Krishi Vigyan Kendra

Category	Sanctioned Strength	In position
Programme Coordinator	01	01
Administrative	02	02
Technical	11	10
Supporting	02	02
TOTAL	16	15

A. CIAH, Bikaner – Headquarter

S. No.	Name	Designation/Discipline
I. RESEARCH MANAGEMENT POSITION		
1.	Dr. S. K. Sharma	Director
II. SCIENTIFIC		
1.	Dr. B.D. Sharma	Principal Scientist
2.	Dr. R. Bhargava	Principal Scientist
3.	Dr. R.S. Singh	Principal Scientist
4.	Dr. D.K. Samadia	Principal Scientist
5.	Dr. Dhurendra Singh	Principal Scientist
6.	Dr. S. K. Maheshwari	Senior Scientist
7.	Dr. Hare Krishna	Senior Scientist
8.	Dr. S.R. Meena	Scientist
9	Dr. B. R. Chaudhary	Scientist
10	Dr. P. N. Sivalingam	Scientist
12	Sh. Karuppaiah V.	Scientist – On study leave
13	Dr. S. M. Haldhar	Scientist
III. ADMINISTRATIVE		
1.	Shri Raj Kumar	Finance & Accounts Officer
IV. TECHNICAL		
1.	Dr. U. V. Singh	T-6 (Technical Officer)
2.	Shri P.P. Pareek	T-6 (Technical Officer)
3.	Shri Sanjay Patil	T-6 (Technical Officer)
4.	Shri M. K. Jain	T-5 (Technical Officer)
5.	Shri R. D. Rathva	T-5 (Technical Officer)
6.	Shri K. K. Vankar	T-5 (Technical Officer)
7.	Shri C. L. Meena	T-5 (Technical Officer)

B. CHES, Godhra – Regional Station

S. No.	Name	Designation/Discipline
I. SCIENTIFIC		
1.	Dr. Sanjay Singh	Principal Scientist & Head
2.	Dr. S.S. Hiwale	Principal Scientist
3.	Sh. H.K. Joshi	Scientist
4.	Dr. V.V. Appa Rao	Senior Scientist
5.	Dr. A.K. Singh	Senior Scientist
6.	Dr.V. Lenin	Senior Scientist
7.	Dr.Raja Shankar	Scientist

II. ADMINISTRATIVE		
1.	Smt. R. K. Shah	Assistant Administrative Officer
III. TECHNICAL		
1	Sh.D.K.Saraswat	T-9 (Technical Officer)
2.	Sh. Nihal Singh	T-6 (Technical Officer)
3	Sh. G.U. Trivedi	T-6 (Technical Officer)
4	Sh. M.N. Makwana	T-6 (Technical Officer)
5	Sh. A.V. Dhobi	T-5 (Technical Officer)
6	Shri G. R. Baria	T-5 (Technical Officer)
7	Sh.R.B.Baria	T-5 (Technical Officer)
8	Shri B. H. Patel	T-5 (Technical Officer)

KVK, Vejalpur

S. No.	Name	Designation/Discipline
I. PROGRAMME COORDINATOR		
1	Dr. (Mrs). Kanak Lata	Programme Coordinator
II. TECHNICAL		
1	Sh. J.K.Jadav	T-6 (SMS –Edu. Extn.)
2	Sh.Balbir Singh	T-6 (SMS –Animal Hus.)
3	Dr. Ajay Kr. Rai	T-6 (SMS- Soil Sci.)
4	Dr. Raj Kumar	T-6 (SMS – Hort.)
5	Dr. Shakti Khajuria	T-6 (SMS – Plant Prot.)

NEW ENTRANTS

Sl. No.	Name/Designation	Date of joining
1.	Miss Pooja Joshi, Stenographer Grade-III	25.5.2012

PROMOTION

Scientist

1. Dr.D.K.Samadia, Sr.Scientist promoted to the post of Principal Scientists under Career Advancement Scheme w.e.f. 1.1.2009.
2. Dr.Dhurendra Singh, Sr.Scientist promoted to the post of Principal Scientists under Career Advancement Scheme w.e.f. 1.7.2009.

Technical

The following technical staff of the Institute got assessment promotion: -

Sl. No.	Name and Present Grade/ Designation	Promoted to Grade/Scale	Date of merit Promotion	Present Place of Posting
1.	Sh.D.K.Samaraswat, T-7-8	T-9 (Technical Officer) Pay Scale Rs 12000-375-16500 (Pre-revise) w.e.f. 1.6.2006PB 3/ Rs 15600-39100 + GP 7600/-	01.01.2004	CIAH, Bikaner
2.	Sh. Sanjay Patil, T-5	T-6, Technical Officer PB-3 Rs 15600-39100 with GP 5400.00	30.11.2011	CIAH, Bikaner
4.	Sh.H.B.Patel, T-2	T-3 (Driver)PB-1 Rs.5200-20200 Grade Pay Rs.2800	29.6.2011	KVK, Vejalpur
5.	Sh.I.A.Pathan	T-3 (Driver) PB-1 Rs.5200-20200 Grade Pay Rs.2800	29.6.2011	KVK, Vejalpur

Administrative

1. Sh. Rakesh Kumar Swami, UDC promoted to the post of Assistant and posted at CHES, Godhra w.e.f. 1.4.2012.

Supporting

Nil

MODIFIED ASSURED CAREER PROGRESSION SCHEME (MACPS)

Sl. No.	Name of Official with designation	Existing pay band and grade pay	Date of grant of 3rd Financial Up-gradation and Pay Band + Grade Pay
1.	Sh. Mani Ram, Ex-Adm. Officer	PB-3/Rs 15600-39100 + RGP Rs 5400/-	1.9.2008 PB-3/Rs 15600-39100 + RGP Rs 6,600/-

PROBATION CLEARANCE & CONFIRMATION

Name with Designation	Date of Clearance of Probation
Dr. S.M.Haldhar, Scientist	14.12.2011
Sh. B.S.Khadda, T-6 (TO)/SMS (Animal Husbandry), KVK, Vejalpur	27.5.2011
Dr. Raj Kumar, T-6 (TO)/SMS (Horticulture), KVK, Vejalpur	3.6.2011
Dr. Shakti Khajuria, T-6 (TO)/SMS (Plant Protection), KVK, Vejalpur	26.7.2011
Smt. Poonam Kalash, T-6 (TO)/SMS (Home Science), KVK, Vejalpur**	24.8.2011
Sh. K.M. Parmar, T-3 / Programme Assistant (Computer), KVK, Vejalpur	28.7.2011
Sh. P.S.Gohil, T-3 / Programme Assistant (Lab.), KVK, Vejalpur	12.8.2011
Sh. V.R.Patni, Stenographer Grade-III, KVK, Vejalpur	27.7.2011
Sh. Akhil Thukral, P.A., CIAH, Bikaner*	3.10.2008
Sh. Rawat Singh, LDC, CIAH, Bikaner	11.11.2010
Sh. Gulla Ram, LDC, CIAH, Bikaner	30.11.2010

*Presently working as Asstt. Adm. Officer at Regional Station, CITH, Mukteswar.

**Transferred to KVK, CAZRI, Jodhpur

JOINING ON TRANSFER

Sl. No.	Name/Designation	Date of joining
1.	Sh. N.A.Patel, Assistant	13.3.2013
2.	Sh.H.S.Patel, UDC	13.3.2013

RELIEVING ON PROMOTION/TRANSFER

1. Sh.V.D.Bhivapurkar, A.O. has been transferred to National Institute of Biotic Stress Management, Raipur and relieved on 10.1.2013.
2. Dr.Hanif Khan Scientist transferred to DWR, Karnal and relieved from the Institute on 11.7.2012.
3. Sh. Akhil Thukral, P.A. has been promoted to the post of Assistant Administrative Officer, Regional Station, CITH, Mukteshwar and relieved on 21.4.2012.
4. Smt. Poonam Kalash, T-6 transferred to KVK, CAZRI, Jodhpur and relieved from the KVK on 15.9.2012.
5. Sh. D.K.Saraswat, T-9 transferred to CHES, Godhra and relieved from the Institute on 11.1.2013.

RESIGNATION/SUPERANNUATION

1. Dr.Sant Ram, Scientist has been resigned from the services of ICAR and relieved from the Institute 20.12.2012.

OBITUARY

1. Sh.Sanjeev Kumar Pandey, T-6 (Technical Officer) passed away 14.12.2012.

15

BUDGET

Plan expenditure 2012-13

Head	Bikaner	Godhra	Total
A. Grand in aid-Salary			
a. Salary	0	0	0
b. Wages	0	0	0
Total (A)	0	0	0
B. Grant in aid-Capital			
a. Equipment	16969	0	16969
b. Works	5039000	0	5039000
c. Library	369944	30048	399992
d. Furniture & Fixture	0	29000	29000
Total (B)	5425913	59048	5484961
C. Grant in aid-General			
a. O.T.A.	0	0	0
b. T.A.	499731	199993	699724
c. H.R.D.	83769	16500	100269
d. Contingency			
Res. & Operation	3841703	438749	4280452
Administrative Exp.	3119524	1081164	4200688
Misc. Exp.	2153746	80039	2233785
Total (d)	9114973	1599952	10714925
Total (C)	9698473	1816445	11514918
Grand Total (A+B+C)	15124386	1875493	16999879

Non-Plan expenditure 2012-13

Head	Bikaner	Godhra	Total
A. Grand in aid-Salary			
a. Salary	30840444	30666398	61506842
b. Wages	0	19446356	19446356
Total (A)	30840444	50112754	80953198
B. Grant in aid-Capital			
a. Equipment	143444	524685	668129
b. Works	225008	0	225008
c. Library	0	0	0
d. Furniture & Fixture	0	0	0
Total (B)	368452	524685	893137
C. Grant in aid-General			
a. O.T.A.	21301	0	21301
b. T.A.	257181	100257	357438
c. H.R.D.	0	0	0
d. Contingency			0
Res. & Operation	2178841	399800	2578641
Administrative Exp.	2087930	848269	2936199
Misc. Exp.	225029	68971	294000
Total (d)	4491800	1317040	5808840
Total (C)	4770282	1417297	6187579
D. Others			
a. Pension	1903883	6000	1909883
b. P Loan	54000	72000	126000
Total (d)	1957883	78000	2035883
Grant Total (A+B+C+D)	37937061	52132736	90069797

Revenue receipt 2012-13

Receipt	CIAH	CHES	KVK	Seed Project	Total
Receipt	271320	1041042	15641	268920	1596923
Sale of Farm Produce	901473	0	0	15498	916971
Interest on STD	518583	180	254		519017
Misc.	31998	3456	0	0	35454
Licence Fee	2320	480	0	0	2800
Water Charge	163000	0	0	0	163000
Tender Fee	54875	588	0	0	55463
Interest on P-Loans	285822	291104	0	0	576926
LS & PC	0	0	0	0	0
Guest House	19750	0	0	0	19750
Sale of Condmned Items		0	0	0	0
Total	2249141	1336850	15895	284418	3886304

16

METEOROLOGICAL DATA

Bikaner

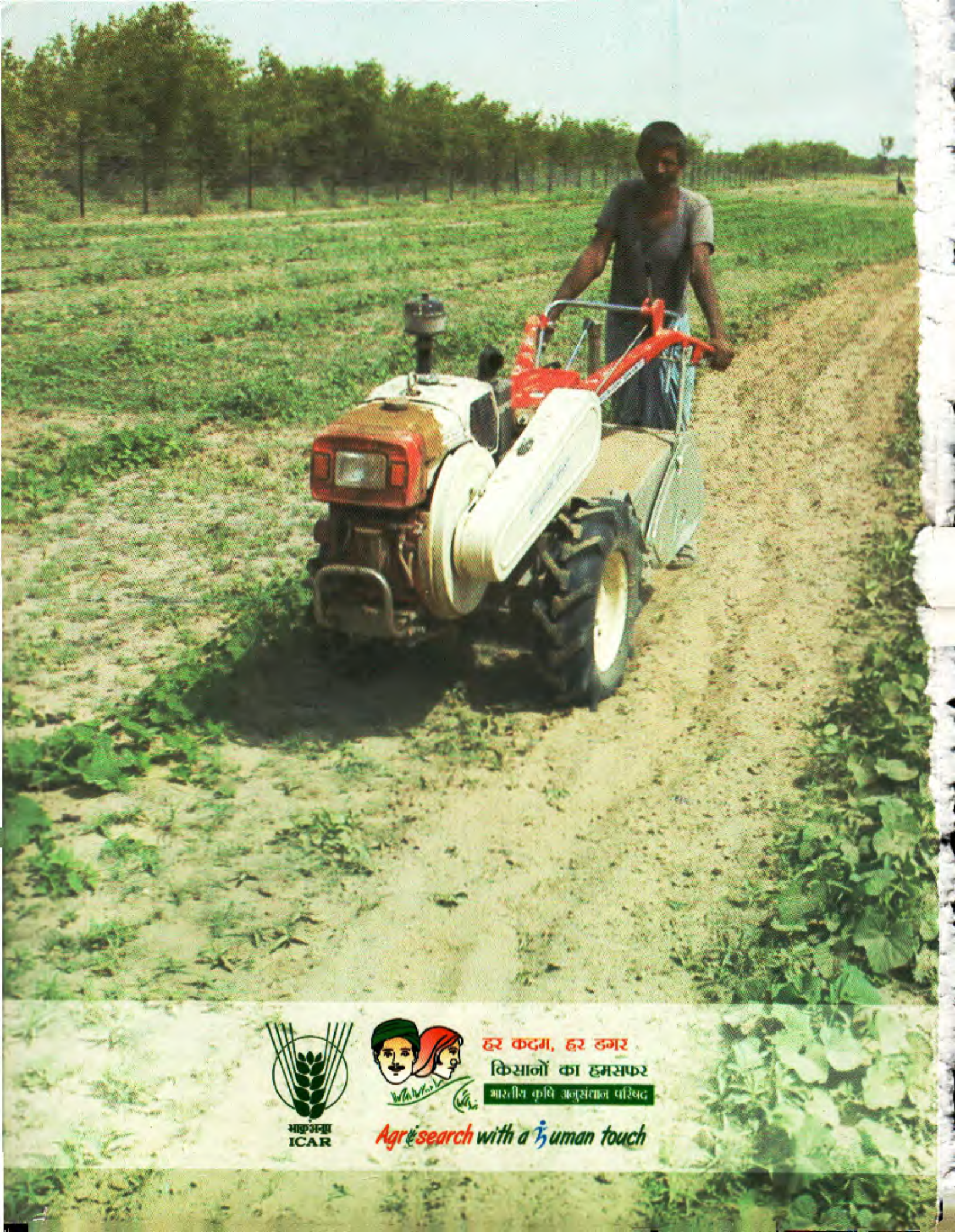
Sl. No.	Month	Temperature (°C) Max	Min	Rainfall (mm)	Rainy day	Wind speed (km)	Evaporation
1	April, 2012	37.08	21.60	–	–	6.60	7.90
2	May, 2012	41.50	25.10	–	–	7.90	7.80
3	June, 2012	41.50	30.60	10.40	2	12.30	12.30
4	July, 2012	40.00	29.20	–	–	10.10	11.00
5	August, 2012	35.80	25.60	153.0	7	5.40	–
6	September, 2012	35.50	24.60	47.0	2	6.00	–
7	October, 2012	35.10	20.30	–	–	3.55	–
8	November, 2012	27.90	15.20	06.0	1	2.85	–
9	December, 2012	22.60	8.07	–	–	3.22	–
10	January, 2013	22.70	5.53	–	–	3.39	2.70
11	February, 2013	24.10	9.17	–	–	3.25	3.56
12	March, 2013	32.0	12.40	–	–	4.65	5.44

Godhra

Sl. No.	Month	Temperature (°C) Max	Min	RH (%)	Rainfall (mm)	Rainy days
1	April, 2012	38.39	21.23	49.23		
2	May, 2012	40.56	24.18	48.39		
3	June, 2012	40.74	25.65	46.25	67.7	5
4	July, 2012	37.89	25.89	76.49	289.4	8
5	August, 2012	37.55	25.16	82.11	534.7	15
6	September, 2012	32.18	24.18	81.85	132.5	13
7	October, 2012	37.23	22.12	76.34		
8	November, 2012	35.69	20.12	60.23		
9	December, 2012	33.21	15.67	61.23		
10	January, 2013	28.28	9.31	59.23		
11	February, 2013	31.11	13.15	57.41		
12	March, 2013	34.38	15.23	54.23		

NOTES

NOTES


भाकृअनुप
ICAR
हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch