Annual Report
2011-12

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

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Correct Citation:
CIAH (2012) Annual Report 2011-12
Central Institute for Arid Horticulture
Bikaner, Rajasthan

Laser setting, desing, photography
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Detail of photograh: From top: Goma Yasmi (Bael), Khirni, Tamarind (Goma Prateek), Mango (Kesar), Chironji, Drumstick

Dr. S. K. Sharma
Director

Central Institute for Arid Horticulture
Beechwal, Bikaner-334006, Rajasthan

PREFACE

It gives me an immense pleasure in bringing out the Annual Report 2011-2012 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 diseases and pests, low population in 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 5 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. H. P. Singh, Deputy Director General (Horticulture) and Dr. S. Rajan, ADG (Hort.-I), ICAR, 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 Er. Bhoj Raj Khatri is appreciated.

Date: June, 2012, Bikaner

(S. K. Sharma)
Director

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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, 3 new accessions of ber, 3 of date palm, 1 each of aonla, mulberry and phalsa, 2 each of wood apple, mango amd khirni, 9 of bael and 4 of noni were collected and added to the germplasm gene bank.

During 2012, the incidence of fruit cracking was observed 2-8% in cultivars Gola, Seb, Mehrun, Badami, Maharwali, Bagwadi, Narikeli, Surati, BS-75-2, however, it was recorded to the tune of 60% in ripe fruits of variety Kathaphal. The severity of cracking increased with the advancement of maturity in ber varieties. The nature of cracking was predominantly radial combined with flesh cracking except in variety Surati, wherein the nature varied from skin cracking to transverse and oblique types of cracking.

Ber varieties were also assessed for their antioxidant activities. Out of 28 cultivars studied, the highest polyphenols were recorded in cv. Mehrun (140.93 mg/100g) followed by cv. ZG-3 (122.27 mg/100g). Likewise, the highest contents of other antioxidants such as flavonoids and flavonols were noticed in cv. ZG-3 (173 mg/100g) and Aliganj (70.59 mg/100g), respectively. The highest total antioxidant activity was noted in cv. ZG-3 (6.3 MTE/100g) followed by Thar Sevika (5.3 MTE/100g) and Gola & Illaichi (5.2 MTE/100g).

Bid area of district Sikar, Rajasthan was surveyed for collection of *ker* genotypes (05). Seeds collected from seemingly elite mother plants were sown to raise the segregating population. Likewise, a thornless type *ker* was also identified in district Nagaur. Upon quality assessment, it was found that *lasora* fruits are better than *ker* fruits in terms of polyphenol, flavanol, flavonoid, total antioxidant activity.

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.

Cactus pear clones (06) were planted at 2x2 m in the field for evaluation.

In bael, fruit weight varied from 0.80- 5.00 kg, fruit length 11.30-19.50 cm, fruit width 12.50- 21.00 cm, shell thickness 1.60-3.20 mm, number of seeds 60-202, pulp TSS 32.00 - 39.00°brix, mucilage TSS 40-49.25 °brix total sugar 16.00 - 22.70 per cent, vitamin C 16.50-22.00 mg / 100 fruit pulp in all the evaluated varieties of bael. The pulp content was found maximum in Goma Yashi followed by NB-5 and Pant Aparna. The seed content was recorded maximum in NB-17 followed by CISHB-1 whereas and mucilage was recorded maximum in Pant Aparna. A genotype collected from Vill. Badalpatti , Jaunpur,UP was identified promising on the basis of horticultural traits like earliness, compact growth, medium height, very less spine, better yield with quality fruits having pleasant flavour with attractive colour of pulp.

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, kachri (68) germplasm was undertaken during 2011. Sufficient quantity of seeds of 68 lines was produced and deposited for conservation both at CIAH and NBPGR, RS, Jodhpur.

Sixty eight germplasm maintained at the institute were evaluated during rainy season of 2011 for trait specific characterization. A wide range of variations were recorded for growth, flowering, fruit set and yield component characters. The kachri lines were categorized and also screened for incidence of diseases and fruit fly infestation. Based on maturity, fruit size, shape, yield potentials and over all performance the kachri lines namely AHK-119, AHK-200, AHK-411, AHK-564 and AHK-572 were found to be most potential for utilization in breeding programmes.

During 2011-12, the potential genotypes of palak (AHLP-1), bathua (AHLB-1), carrot (AHDC-1) and sehjna (AHMO-1) were characterized and maintained by multiplying the seeds to fulfils the national indents as unique and trait specific lines. During the period, potential lines (>20) of arid zone vegetable crops were supplied to national institutes, SAU's and state agencies for performance studies and use in breeding programmes as genes for drought hardiness and tolerance to high temperature conditions.

During 2011-12, the parental lines, F_1 and F_2 progenies of round melon developed under breeding for high temperature tolerance and fruit quality were evaluated for selection breeding. The F_1 combinations such as AHRM-2a x AHRM-1a and AHRM-2a x AHRM1b yielded good quality fruits at marketable stages. A good amount of variations for growth, flowering and fruiting behaviour and fruit and seed characters were recorded from F_2 progenies. Similarly in rainy season, six long fruited progenies of bottle gourd developed with a breeding objective for high temperature tolerance were evaluated for growth, flowering, fruit set, fruit quality and yield component characters.

During the 2011, thirteen advanced progenies of muskmelon were raised along with check for evaluation and screening the lines under the breeding objective for high temperature tolerance and fruit quality in arid conditions. Similarly, to assess the uniformity and stability of the developed material for high seed content in mateera, advanced progenies of AHW RSS–1 was evaluated and detailed observations were recorded to characterize the material under absolute rainfed and abiotic stresses of arid environment.

In brinjal, progenies of CIAH-1, CIAH-2, CIAH-12, CIAH-16, CIAH-21, CIAH-22 and CIAH-67 were evaluated for screening lines against biotic and abiotic stresses during summer season of 2011 and further selections were made based on early flowering and fruit set, reduced infestation of FSB, high marketable yield and consistent fruit quality under high temperature conditions. Besides, the developed line CIAH-1 and CIAH-16 were characterized under large scale testing and both the lines showed stability and uniform performance from seedling stage to fruit and seed harvest stages.

Advanced breeding lines of tomato were evaluated during spring-summer and rainy-winter season of 2011-12 for uniformity, stability, quality and yield characters under high temperature conditions. Out of 20 lines, four lines were found promising and selection and selfing was done to advance the generation.

During the rainy–winter season of 2011–12, two varietal trials of Indian bean were conducted under AICRP on vegetable crops at CIAH, Bikaner. Among ten entries of pole type, two were from CIAH such as AHDB–03 (Thar Maghi) and AHDB–16 (Thar Kartiki) and were tested alongwith checks (Pusa Early Prolific and Swarna Utkrist). The institute varieties Thar Maghi and Thar Kartiki exhibited superiority for pod yield 101.25 q/ha and 103.15 q/ha till the onset of frost, respectively under extremes of arid environmental conditions.

Sixteen genotypes of khejri were characterized by morphological characters to assess the stability components. 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 varying situations and to assess the performance over the years.

Crop Management and Agrotechniques

The growth, yield, physiological and fruit quality parameters were recorded in seven 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 fenugreek. The highest yield of aonla was recorded in aonla-kinnow (50.7 kg per plant) system followed by aonla- mulberry (45.3 kg/plant), aonla- ber (36.4) and aonla- khejri (36.8), while the lowest was recorded in aonla- moringa (35.1 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.

Integrated Nutrient and Water Management

In drip and micro sprinkler irrigation system moisture distribute uniformly in the soil profile up the 60cm vertical depths while in pipe irrigation system more moisture remains in lower strata. Maximum moisture (60%) depletion occurs between 20 to 40cm vertical depth as well as horizontal distance from the main stem of the tree. At lower strata changes in soil moisture is only in the tune of 10-15%.

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 demonstrated that bottle gourd crop receiving poultry manure gave highest yield (21.2 t/ha) followed by vermicompost (1.72 t/ha) and FYM (13.7 t/ha). Similarly, maximum soil nitrogen, phosphorus and potassium concentration was observed in plots treated with poultry manure.

Organic farming

Application of biofertilizers showed that soil properties in terms of bulk density, hydraulic conductivity, pH and EC were improved.

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

Crop Physiology and Biotechnology

The seeds of water melon were primed with 5, 10 and 15% solution of KNO_3, NaCl, 15, 20 and 30% solution of KH_2PO_4 and PEG for 1 to 7 days. Results demonstrated that seeds primed with 10% KNO_3, 20% PEG and 15% KH_2PO_4 gave improvement in germination percentage, germination index and seedling growth.

Primers for PCR amplification with DNA of five cultivars of date palm were screened and it was observed that OPF 3, OPF 4, OPF 5, OPF 6 and OPF 7 gave good results.

PCR compatible, genomic DNA isolation protocol standardized.Molecular level of 25 RAPD primers out of 50 were found polymorphic.Three clusters were identified (two major clusters and one minor cluster) and no duplicates identified among these lines.Markers associated with leaf and fruit characters were also identified.

Attempts were made to produce somatic embryos from fruit and leaf tissue. Some success

was obtained in developing somatic embryos from these tissues. Attempts were also made to induce rooting in somatic embryos.

In case of lasora (*Cordia* myxa) out of 50 RAPD primers, 25 were polymorphic. Average polymorphism among these accessions was 69.8 % with an average PIC of 0.43. Genetic diversity revealed by Jaccard's co-efficient was between 0.44 and 0.94, and three major clusters were identified. RAPD markers associated with leaf size and pulp:stone ratio were also identified.

Post Harvest Technology

In order to utilize the date fruits, the powder was prepared dron fruits at doka stage and they were mixed with flour to prepare biscuits. It was observed that date biscuits having date powder @10% was found to have more acceptability.

Crop Protection

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

Major insect pests affecting aonla, ber, lasora, ker, pomegranate and cucurbits were identified.

Agricultural Extension

The information on traditional vegetables grown, their use and marketing system, change in cropping patterns and socio-economic characteristics of farmers 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 2011-12.

Similarly, KVK functioning at CHES, Godhra organized different training programmes on cultivation of horticultural crop in arid and semi-arid regions. A number of front line demonstrations were also laid for transfer of technology.

Externally funded projects

At CIAH, Bikaner and its regional Station CHES, Vejalpur (Godhra) four 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.

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 ane evaluation of collected material was undertaken and conserved at Vejalpur, Godhra.

The leaf morphomatrix, fruit and quality attributes were studied. Under the project, Isolation and characterization of high lycopene mutant under heat stress" it was recorded that morphological characters showed higher phenotyfric value compared to their corresponding genotypic variance indicating that every character had been influenced by environment.

1

प्रस्तावना

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.
5. To coordinate network research with State Agricultural Universities and line departments and to act as a centre for Human Resource Development in arid horticulture.
6. To provide consultancy in research and development of arid horticulture.

Mission/objectives

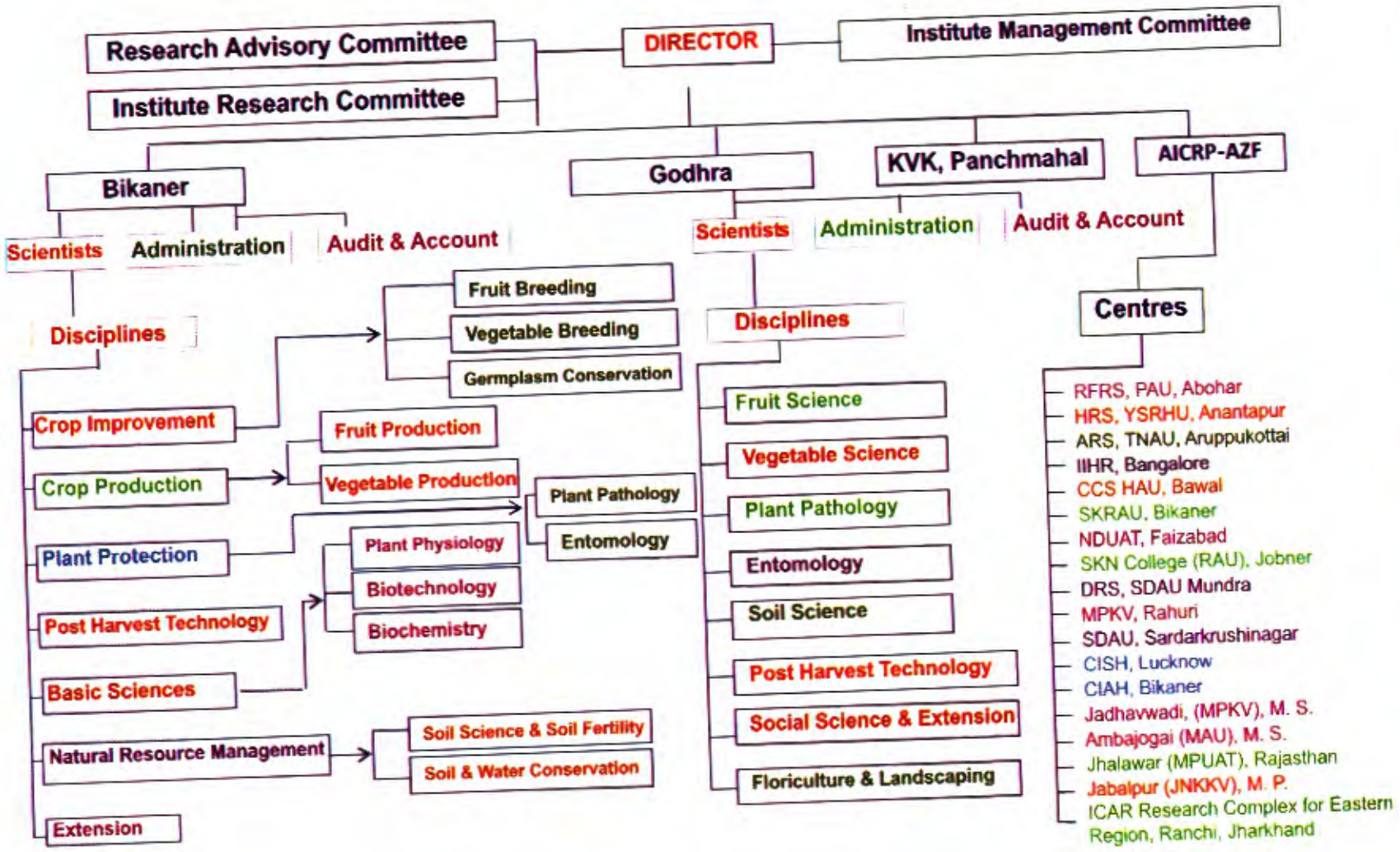
- To introduce, collect, characterize, conserve and evaluate the biodiversity of horticultural crops under arid and semi arid environment.
- To utilize the available biodiversity and improve the target fruit crops such as ber, pomegranate, *aonla*, date palm, sapota, custard apple, tamarind, fig and 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 2010-11 and the significant results obtained in different projects are presented hereunder.

ORGANIZATIONAL SETUP



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अनुसंधान उपलब्धियां

RESEARCH ACHIEVEMENTS

Genetic Resources

Fruits

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

Ber (*Ziziphus mauritiana* Lamk)

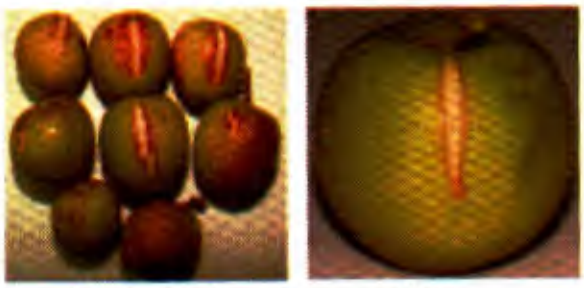
Ber accessions available in the field repository were evaluated for growth, fruit set and effect of low temperature and frost on fruits and shoots. The various spells of low temperature and cold wave from last week of December, 2011 to second week of February, 2012 affected terminal parts of shoots and immature fruits in ber genotypes. However, extent of low temperature/frost injuries varied in different species of genus *Ziziphus*. The germplasm of ber which mostly belongs to *Ziziphus mauritiana* is susceptible to frost. *Ziziphus mauritiana* var. *rotundifolia and Ziziphus nummularia* showed tolerance to frost injury. Ber genotype Tikadi was unaffected from low temperature and frost injury, however fruit set in this genotype was low and quality of the fruit was also poor due to low pulp/stone ratio, spiny stone and unfavourable taste.

Varietal trial under AICRP on AZF at CHES , Vejalpur on cultivars Umran, Goma Kirti, CIAH Hybrid-1, CIAH Selction-1, Narendra Selection –1, Narendra Selection –2 and Chhuhara are coming up well. Data on growth parameters revealed that maximum mean plant height was recorded in cv. Narendra Sel.-1 (1.71m) and minimum in cv. Goma Kirti (0.97m). Stock and scion diameter was maximum in cv. Narendra Sel.-1 (76.9 and 59.7 mm, respectively). Stock and scion diameter was minimum in cv. Goma Kirti (29.9 and 23.4 mm, respectively).

The intensity of fruit cracking, a physiological disorder was recorded in different genotypes of *ber*. The incidence of fruit cracking was observed in all the major varieties of *ber* such as Gola, Seb, Mehrun, Badami, Maharwali, Bagwadi, Narikeli, Surati, BS-75-2 etc. The occurrence varied from 2-8% in ripe fruits. However, it was recorded to the tune of 60% in ripe fruits of variety Kathaphal. The severity of cracking increased with the advancement of maturity in ber varieties. The nature of cracking was predominantly radial combined with flesh cracking except in variety Surati, wherein the nature varied from skin cracking to transverse and oblique types of cracking (Fig.1).

Ber varieties were also characterized for their antioxidant activities. Among the 28 cultivars studied, the highest polyphenols were recorded in cv. Mehrun (140.93 mg/100g) followed by cv. ZG-3 (122.27 mg/100g). Likewise, the highest contents of other

antioxidants such as flavonoids and flavonols were noticed in cv. ZG-3 (173 mg/100g) and Aliganj (70.59 mg/100g), respectively. While, the lowest contents were registered in cv. Mundia (76.01 mg/100g) and cv. Seb (25.24 mg/100g), respectively. The highest total antioxidant activity was noted in cv. ZG-3 (6.3 MTE/100g) followed by Thar Sevika (5.3 MTE/100g) and Gola & Illaichi (5.2 MTE/100g).



Kathaphal Seb

Mehrun Surati

Fig 1: Cracking pattern in ber

Aonla (*Embelica officinalis*)

Seeds of one elite genotype (wild type) of *aonla* was received from NBPGR, Regional Station, Thrissur (Kerela). This elite genotype is characterised as self-fruitful, yield potential 25-28 kg/tree and fruit weight 6-8 g.

Fruit samples of *aonla* were analysed for physico-chemical attributes, the fruit weight varied from 5.94-39.39 g, fruit length 19.84-38.69 mm, fruit width 22.17-42.49 mm, TSS 8.6-23.6 °brix, reducing sugar 3.22-3.70%, total sugars 4.2-6.03% and ascorbic acid 524-656 mg/100g pulp. During the year 2011-12, *aonla* germplasm were affected adversely by low temperature/frost injury. The plants >10 ft. height and situated near to wind break were little affected, whereas plants below 10 ft. height were affected severely and almost all foliage has been affected by frost injury/ cold waves. Likewise, small fruit bearing genotypes were prone to less injury by frost as compared to large size fruit bearing type.

In the varietal trial under AICRP on AZF at CHES, Vejalpur on *Aonla* cultivars viz. Goma Aishwarya, BSR-1, Gujarat *Aonla* –1, NA-20, and NA-10, data on growth parameters in the third year revealed that plant height was maximum in NA-7 followed by Chakaiya (2.47 and 2.28 m, respectively) with mean minimum in NA-20 followed by Goma Aishwarya (1.55 and 1.92 m, respectively). Stock diameter was found maximum in NA-7 followed by BSR-1 (82.45 mm and 72.76 mm, respectively), minimum in NA-20 followed by Goma Aishwarya (52.8 and 67.16 mm, respectively). Scion diameter was found maximum in BSR-1 followed by NA-7 (64.2 and 58.3 mm, respectively), and minimum in NA-20 followed by Goma Aishwarya (44.9 and 49.36 mm, respectively). Data on plant spread indicated that North South spread was highest in BSR-1 followed by NA-7 (2.06 and 1.65 m, respectively), and was least in NA-20 followed by Goma Aishwarya (1.12 and 1.25 m, respectively). Plant spread in East West direction was highest in BSR-1 followed by NA-7 (2.15 and 1.57 m respectively), it was least in Goma Aishwarya followed by NA-20 (1.06 and 1.12 m respectively).

Bael (*Aegle marmelas* Correa.)

17 bael germplasm were maintained in the field repository at CIAH, Bikaner and

evaluated for growth, flowering, fruiting and frost/low temperature tolerance.

The vegetative growth of plants varied from 1.30 to 4.25 m under hot arid conditions. The maximum height 4.25 m and spread (3.40m N-S and 3.60m E-W) was recorded after 9 years of planting in a collection made from Pushkar, Ajmer. The trunk diameter varied from 4.0 to 15.4 cm among germplasm. The flowering and fruiting was observed in three genotypes but flowers dropped due to poor soil moisture conditions while at CHES, Godhra flowering and fruiting were observed in 12 germplasm out of 31 maintained in repository. During 2011-12, effect of frost on bael germplasm was very less. One elite type late maturing seedling was identified. The fruit weight was 800-900g, round in shape, pulp colour yellow, TSS 28-30° brix and sweet in taste.

In situ budding was done but success percentage varies from 30-50 per cent during July–August, 2011. However, slow initial growth in young plants and frost injury was observed during winter season, 2012.

At CHES, Vejalpur, forty eight bael genotypes including twelve varieties were maintained in field repository at the Station. 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 attribute under rain fed conditions of hot semi-arid ecosystem during the year 2011-12 (Fig. 2 - 7). Besides, thirty six genotypes have been evaluated for growth parameters under rain fed conditions of hot semi-arid ecosystem. Out of which, flowering and fruiting were noticed in five genotypes. A genotype collected from Badalpatti village of Jaunpur district of Uttar Pradesh during 2006 was identified and found promising on the basis of horticultural traits.

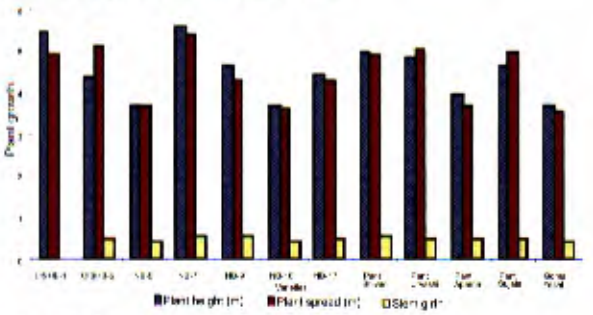


Fig. 2: Variability in plant growth

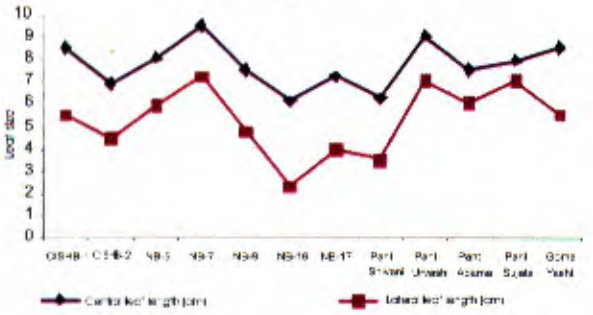


Fig. 3: Variability in central and lateral leaf length

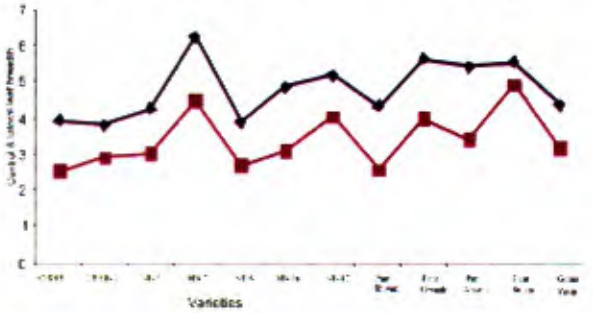


Fig. 4: Variability in central and lateral leaf breadth

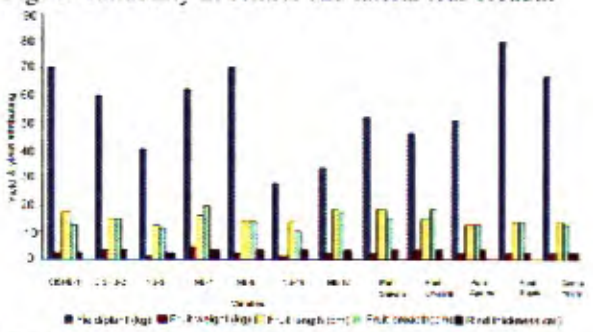


Fig. 5: Yield and yield attributing characters

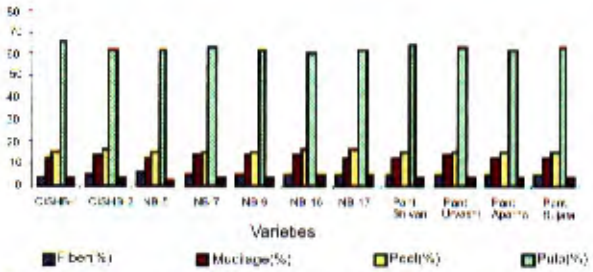


Fig. 6: Physiological composition of fruit of bael varieties

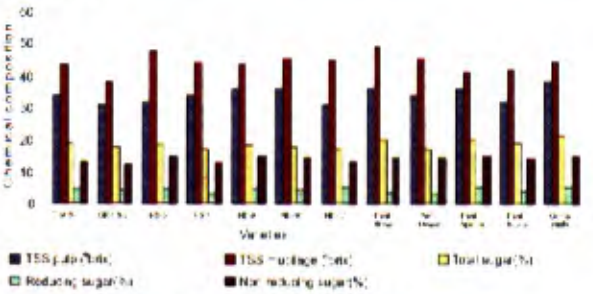


Fig. 7: Chemical composition of bael varieties

Plant height (5.64m) was recorded maximum in NB-17 followed by CISHB-1 (5.50 cm) and it was recorded minimum in Goma Yashi (3.66 m). Stem girth varied from 0.42 m to 0.57m and it was recorded maximum in NB-7 followed by NB-9, whereas central leaf size and lateral leaf size were recorded highest in NB-7 and it was recorded lowest in NB-16 among the varieties evaluated for growth characters. Similarly, plant spread and leaf area was also recorded maximum in NB-7 followed by NB-17.

All the genotypes (36) exhibited significant differences for growth characters. Annual growth extension in terms of plant height was recorded maximum in CHESB-11(49.20cm) and minimum in CHESB-27, whereas girth of stem (3.42cm) was recorded maximum in CHESB-31 and it was minimum in CHESB-19 among the genotypes evaluated for growth under rainfed conditions of semi-arid ecosystem.

Studies on floral morphomatrics of different genotypes revealed that the flower bud emergence started from 24th April and continued up to 28th June. Flower bud initiation was recorded at the earliest in CISHB-5 (24th April) followed by CHESB-2 (29th April) and CHESB-9 (2nd May). Flowering pattern was observed different in all the genotypes.

Fruit attained maximum size up to September and then 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 first fortnight of March, varieties Pant Aparna and Pant Sujata in the second fortnight of March, varieties NB-17 and Pant Urvashi in first fortnight of April, varieties NB-7 and NB-9 in second fortnight of April, varieties NB-5 and CISHB-2 in first fortnight of May under rain-fed conditions of hot semi-arid ecosystem.

Yield per plant among different varieties of bael varied from 27.00 -78.59 kg during 2011-12. Fruit weight varied from 0.76-4.23 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 64-198, pulp TSS 31.00 - 38.00 °brix, mucilage TSS 41- 49 °brix, total sugar 17.00 - 21.25 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 maximum in Pant Aparna.

Apart from the 12 varieties, 36 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 rainfed conditions of semi-arid ecosystem. All the genotypes showed wide variation in growth characters. Flowering was noticed in five genotypes during the year 2011.

An identified promising genotype CHESB-5 was collected from Badalpatti village of Jaunpur district of Uttar Pradesh 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 and plant spread was recorded 4.2 m, 29.42 cm and 4.1 m, respectively during 5th year of orchard life. Average yield was 29 kg in 5th year, fruit weight 1.71 kg, fruit size 22.20 cm x 15.50 cm, fruit girth 46.21 cm, shell thickness 0.20 cm, total number of seed 152, seed weight 0.16 g, total seed weight 31 g, fibre weight 69 g, shell weight 280 g, locules in cross section 14-15, pulp 70%, TSS pulp 35 °B, TSS mucilage 49 °B, acidity (0.30%) and vitamin C 20 mg / 100 g pulp were recorded. This genotype is less affected by sun scald owing to compact growth of plant.

Varietal trial under AICRP-AZF at CHES, Vejalpur on bael was started during 2007 with eight varieties (NB-5, NB-9, NB-16, NB-17, CISHB-1, CISHB-2, Pant Aparna and Pant Sujata) which were replicated four times considering two plants/unit for comparative evaluation with respect to their morphomatrix. Results on vegetative growth characters revealed that the plant height (3.30 m), stem girth (25.78 cm) and plant spread (3.18 m) were recorded maximum in NB-17, CISHB-2 and CISHB-1, respectively. Terminal leaf size (8.50 x 4.32 cm) was recorded the highest in NB-17, whereas it was recorded lowest in NB-16 (7.00 x 2.42 cm). Lateral leaf size (7.00 x 4.23 cm) was recorded maximum in Pant Sujata and it was recorded minimum in Pant Aparna (5.30 x 2.55 cm). Flower length and bud length was recorded maximum in CISHB-2.

Date palm (*Phoenix dactylifera* L.)

Sixty date palm varieties/ genotypes including exotics were maintained in the field gene bank. The offshoots of cvs. Degletnoor, elite seedling, Barshi and Thoory from RFRS, Abohar and Zagloul, Sakloti and Agloni from DRS, Bikaner were collected and planted for evaluation.

The plant height varied from 2.80 - 7.10 m after 12 years of planting. The maximum height and plant spread (N-S, E-W) was observed in cv. Muscat, followed by Halawy and Tayer.

The spathe emergence started from second week of February and completed in first week of March. The emergence of spathe varied among germplsam from year to year due to climatic conditions and genetic characters of genotypes. The spathe emergence/opening and fruiting were observed in 26 genotypes out of 60 germplasm. There was no effect of frost /low temperature on date palm.

The average number of bunch 3 -11 per palm and 7 -32 kg/plant fruit's yield varied from among germplasm. Better fruiting was observed in cvs. Halawy, Sabiah, Sewi, Dayari, Zahidi, Bikaner Local and Khadrawy. The maximum number of bunch/plant was observed in Medjool (09) followed by Muscat, Shamran, Dayari (08). The number of berries (20-28 per strand) was observed in cvs. Shamran followed by Halawy and Bikaner local. Average maximum bunch weight (5.0

to 8.5 kg) was also recorded in cvs. Sabiah, Halawy and Medjool. The early doka stage was observed in cvs. Halawy, Muscat, Tayer and Khuneizi. Fruit drop was maximum in Muscat, Tayer, Sayer, Sedami and Khalas. The maturity of fruits (doka stage) occurred in maximum varieties by the end of July. Maximum berry weight (14.4 g) was observed in Medjool followed by Dayari, Sewi, and Khalas (12.2 g). About 7-10 days delay in maturity was observed due to delay in emergence/ opening of spathe. The cultivars Medjool, Sewi and Dayari were harvested late. During the year, pind (Tamer) stage was not attained in any genotypes.

Varietal trial consisting cvs. Halawy, Khalas, Zahidi, Medjool and Khadrawy were carried out for plant growth, fruiting, yield and fruit quality under drip irrigation system. Better plant growth in respect of height of palm, spread was observed in cv. Khalas and Halawy than that of other cultivars.

Tissue culture plants of cv. Barhee and KCS-143 were evaluated for growth and flowering under arid environment. Vegetative growth in respect of height (90 to 115 cm) and spread (E-W 110 x150 cm) (N-S 126 -183 cm) and number of leaves 8-12 per plant was observed after two years. However, spathe emergence was observed in Barhee plant within three years of planting. The growth of Barhee plant was better than KCS-143.

The seedlings were evaluated for growth, sex ratio, and flowering/fruiting behavior under hot arid environment. The seedlings growth was slow during early stage in both nursery as well as field conditions. However, initiation of spathe was observed after 5-6 years of planting in seedlings. The ratio of male and female was 50%.

A study was initiated to see the effect of IBA treatments on rooting, survival and growth in small size suckers. Suckers were dipped in solution of IBA 5000 ppm for 30, 60 and 90 minutes and planted in the nursery. Under nursery conditions, suckers of all treatments survived up to 5 months and after that dried due to lack of development of proper roots. Ariel suckers were also treated with 5000 ppm IBA paste in lanoline and it was observed that rooting was not enhanced.

Pomegranate (*Punica granatum* L.)

Maintenance of 154 germplasm at CIAH, Bikaner and 45 at CHES, Vejalpur, Godhra was done during the year. The germplasm were evaluated for growth, fruiting and fruit quality parameters and effect of low temperature under arid conditions.

The maximum plant height was recorded in Jodhpur Red followed by Muscat, Basin Seedless, Jalore Seedless and Kandhari. Fruiting in Ambe bahar (March) was observed in plants affected by frost. Fruiting in germplasm was 20-40 fruits/plant but development of aril colour was poor in ambe bahar crop and cracking was low up to May month. Sunburn was noticed due to high temperature during summer.

Studies on fruit cracking: The evaluation of germplasm against fruit cracking showed that all germplasm were susceptible to cracking but percentage varied from 10-40% among germplasm. Better flowering/fruiting were observed in ambe bahar but proper aril colour was not developed because of high temperature. Fruit cracking was low but quality of fruits was not good with respect to colour of arils, juice and sweetness.

Anardana type: Cuttings of 5 genotypes were collected from Phagli during April month, but

dried after sprouting. Out of 17 types, 12 collections started flowering and fruiting. Average plant height varied from 1.5 – 3.0 m. Fruiting was observed in ambe bahar and the size of fruits was small having below 100 g weight and number of fruits/plant varied from 10 to 30. The aril was small and hard in all anardana types.

Jamun (*Syzigium cuminil*)

At CHES, Vejalpur the promising genotypes (26 No.) of jamun were evaluated for growth, flowering, fruiting and fruit quality attributes. The average plant height ranged between 2.90 m –5.50 m, plant spread i.e. N-S- 3.12 m – 5.30 m, and E-W-3.15 m – 5.70 m, and stem girth 45.00 cm- 95.00 cm in different genotypes

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 was recorded in Goma Priyanka, closely followed by GJ-8.

Peak period of ripening was recorded in the month of June. Maximum fruit yield per plant was recorded (52.50 kg) in Goma Priyanka. Fruit weight (19.50 g), pulp content (86.50 %) and TSS (17.50 °Brix) was also recorded maximum in Goma Priyanka, closely by GJ-8 under rainfed conditions of hot semi-arid ecosystem.

Further, 40 genotypes including Konkan Bahadoli, Gokak 1, Gokak 2, Gokak 3, Seedless and Seeded jamun have been established in the field and evaluated for growth, flowering, fruiting and fruit quality attributes.

GJ-8 was collected from Ode village of Anand district of Gujarat. Peak period of flowering was recorded in the month of March. It ripened in the second week of June and recorded 19.00 g average fruit weight, 84.00 % pulp, 15.40 °Brix TSS, 0.37 % acidity, 11.50 % total sugar and 46.60 mg/100g vitamin C.

Mango

At CHES, Vejalpur, efforts were continued to collect the variability in mango cv. Kesar to identify superior types particularly in respect of fruit size and color. Two new collections were made and grafted in the nursery. In the forthcoming season they will be planted in the field. The earlier collections planted in the field have been established well and are in vegetative phase.

Karonda (*Carisa carandus*)

Karonda genotypes (7) were maintained under field condition and evaluated for plant growth, flowering and fruiting under hot arid conditions at Bikaner. Flowering was observed but fruit set was less due to improper soil moisture. It was observed that none of karonda genotypes were tolerant to frost. The growth features of germplasm were of bushy type.

At CHES, Vejalpur, a total of 40 genotypes were evaluated in karonda and variable percentage of anthesis was registered in different genotypes. Peak period of anthesis was recorded from 3-6 PM in all the genotypes. Anthers dehisced between 4-7 PM on the same day. Peak period of maturity of different genotypes of karonda was recorded in the month of August- September. Konkan Bold recorded maximum fruit weight (14.90 g) and TSS (10.10 °Brix) but fruit yield was 2.5 kg per plant only. Minimum acidity (0.45 %) was recorded in Konkan Bold during ripening. Maximum fruit yield (10.00 kg/ plant), fruit

weight (5.10 g) and TSS (6.10 °Brix) was recorded in CHESK-2, closely followed by CHESK-3 at the time of maturity. CHESK-1 recorded 4.80 g fruit weight, 8.20 kg yield/ plant and 6.00 °Brix TSS. The fruit colour of CHESK-2 and CHESK-3 was recorded red and purple respectively at the time of maturity.

Badhal (*Artocarpus lakoocha*)

At CHES, Vejalpur, two genotypes of badhal were evaluated. They are growing well. Plant height of CHESB-1 was recorded 5.10 m, while it was noted 4.70 m in CHESB-2.

Cactus pear (*Opuntia ficus indica* L.)

Cactus pear genotypes were maintained in the nursery mother block. The clones 1308, 1269, 1270, 1271, Mexican (seedling) and Mount Abu collection were planted in field and evaluated for survival and growth. The clone 1269 and 1308 sprouted early than other clones. The three-four cladodes formed when planted during the month of March. It was observed that vegetable types-1308 can be grown under irrigated arid conditions. The growth of clone 1269 was also found better than other clones for cladodes production purpose.

Chironji (*Buchanania lanzan*)

At CHES, Vejalpur the thirty promising genotypes of chironji were evaluated for growth, flowering, fruiting and fruit quality attributes. The average plant height ranged between 1.50 m – 3.35 m, plant spread i.e. N-S 1.20 m – 2.30 m and E-W 1.40 m – 2.34 m and stem girth 22.15 cm- 52.10 cm in different genotypes. After evaluation, CHES-7 and CHESC-2 were found promising.

CHES-7 was collected from Kada Dam of Panchmahal district, Gujarat. It has semi-spreading growth habit, thick trunk, evergreen, dense foliage and drooping branches. Peak period of ripening time was May. It recorded 1.12 g fruit weight, 24.20 °Brix TSS, 13.00 % total sugar and 48.00 mg/100g vitamin C, 0.14 g kernel weight and 32.10 % kernel protein.

CHESC-2 is having upright growth habit. Peak period of ripening time was May. It recorded 1.10 g fruit weight, 23.10 °Brix % TSS, 12.10 % total sugar and 47.12 mg/100g vitamin C. Kernel protein was recorded 31.20 %.

Custard apple (*Annona squamosa*)

Varietal trial under AICRP on AZF at CHES, Vejalpur on cultivars viz Balanagar, Arka Sahan, AKP CS–1, Sindhan local and Raydurg are coming up well under rainfed conditions. The data on growth parameters recorded revealed that plant height was maximum in cv. Arka Sahan (2.60 m) and minimum in cv. Balanagar (1.56 m). Maximum stock diameter was recorded in cv. Arka Sahan (73.4 mm) and minimum in Balanagar (50.30 mm). Scion diameter was maximum (62.9 mm) in cv. AKP-1 and minimum (40.10 mm) in cv. Balanagar. In the third year of growth, there was flowering on one plant each in Arka Sahan and AKP CS-1 with maximum no of flowers in cv. AKP CS-1followed by Arka Sahan, however, there was no fruit set in both the plants. Crossing with local type was successful. In cv. Balanagar least number of flowers /plant were recorded with a fruit set 4-5 fruits per plant.

Fig (*Ficus carica*)

Varietal trial under AICRP on AZF at CHES, Vejalpur on plants of different cultivars

of fig viz. Poona fig, Dinkar, Dianna, Black Ischia and one local collection of deshi type was collected from various centers and planted in the field. Observations on growth parameters recorded on one and half year old plants indicated that maximum annual shoot length and diameter was recorded in cv. Dianna (1.66 m and 28.94 mm respectively.). It was found advantageous to have multistem plants to keep the plants short and in manageable condition. In cv. Dianna maximum stems per plant were recorded (10.4) compared to other varieties, where it ranged from 7.4 to 8.8 numbers. Data on number of leaves on the annual extension growth and leaf area per leaf revealed that number of leaves in Dianna ranged from 23 to 45 per shoot compared to Dinkar (27-30 /shoot) followed by Poona Fig (range 20-22 / shoot). However leaf area per leaf was highest in Poona Fig (552 cm^2) and was least in Dianna (246.5 cm^2).

Khirni (*Manilkara hexandra*)

At CHES, Vejalpur the 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. Variable percentage of anthesis / dehiscence was registered in different genotypes. Peak period of anthesis was recorded between 8-11 AM in all the genotypes. None of the genotypes showed anthesis before 3 AM and after 12 noon. Anther dehiscence commenced after opening of flowers i.e. at 5 AM and continued till 2 PM. Peak period of dehiscence was recorded between 10 AM to 1 PM in all genotypes. Peak period of ripening was recorded in the month of April and May in all the genotypes. Maximum fruit weight (5.10 g) and TSS (24.80 °Brix) was recorded in CHESK-10, closely by

Fig. 8: Large variation in fruit size of *ker*.

Fig. 9: Evergreen type *ker*

CHESK-1, CHESK-6, CHESK-11, CHESK-12 and CHESK-16.

CHESK-10 was collected from Parwadi village of Panchamahal district, Gujarat. The peak period of flowering was recorded in the month of December. It ripens in third week of May and recorded 5.10 g fruit weight, 24.80 °Brix TSS, 26.50 mg/100 vitamin C.

Ker (*Capparis decidua L.*)

A huge variability was noted in terms of fruit size in *ker* collected from district Sikar and consequently, some large fruited *ker* genotypes were collected from *Bid* area of Tehsil-Fatehpur, District-Sikar. These fruits were used to raise the segregating population of *ker*. Two evergreen types of *ker* genotypes have been identified from the seedling population, which even under severe winter remained green. On the other hand, the rest of the seedling population showed bronzing of leaves during winters. Likewise, a thornless type of *ker* has also been identified from the district Nagaur (Fig. 8 & 9).

Mahua (*Bassis latifolia*)

At CHES, Vejalpur, the promising genotypes (30 No.) of Mahua were evaluated for growth, flowering, fruiting and fruit quality attributes. The average plant height ranged between 2.90 m –4.95 m, plant spread i.e. N-S 1.50 m – 3.10 m, and E-W 1.10 m – 3.30 m

and stem girth 15.20 cm - 40.21 cm in different genotypes.

The highest total soluble solids, total sugar and vitamin C content were recorded in flowers of MH-10. However, juice content was found to be highest in MH-18. Maximum fruit weight (28.10 g) and seed weight (12.10 g) was found in MH-10, while MH-14 recorded 27.10 g fruit weight and 11.20 g seed weight. These genotypes would be exploited as potential parents to develop high yielding stable genotypes having horticultural traits.

Manila tamarind (*Pithecelobium dulce*)

To enhance germination and seedlings growth, seeds of manila tamarind were pre-treated with growth regulators for 12 hours and sown in the nursery. It was observed that pre-treated seeds with 50 ppm BA and GA_3 enhanced the germination percentage, seedlings growth and biomass production. The genotypes (collected from Jodhpur, Bikaner and Aruppukottai) were maintained under field conditions and it was observed that plants were susceptible to frost/ low temperature.

Tamarind (*Tamarindus indica*)

At CHES, Vejalpur, promising genotypes (24 No.) of tamarind were evaluated for growth, flowering, fruiting and fruit quality attributes. The average plant height ranged between 2.80m –4.95 m, plant spread i.e. N-S- 3.15 m – 5.85m, and E-W-3.20 m - 5.80 m and stem girth 37.40 cm- 60.85 cm in different genotypes. The maximum number of fruits per panicle was recorded in Pratisthan (3.50), closely followed by Goma Prateek (3.20), Sweet type (3.10) and T-263 (2.50).

Peak period of ripening time in majority of genotypes was recorded in the month of March. Maximum fruit yield per plant (62.10 kg) was recorded in Goma Priyanka during 10th year of orchard life under rainfed conditions of hot semi-arid ecosystem, closely followed by T-10 (32.50 kg/ plant), while minimum was recorded in PKM-1 (12.20 kg/ plant). Goma Priyanka recorded maximum pod weight (24.10 g), pulp percent (51.20 %) and TSS (72.00 °Brix). 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 were collected from Aruppukotai, Tamil Nadu. Two new genotypes were also collected from Panchmahal, Gujarat.

Varietal trial under AICRP-AZF at CHES, Vejalpur on eleven tamarind varieties viz. Pratisthan, T-263, PKM-1, Ajanta, DTS-1, SMG-4, Red Type, Sweet Type, Bantoor, Urigum and T-13 were planted in randomized block design with four replications and observations on growth pattern were recorded.

Plant height of Bantoor was observed maximum i.e. 66.80 cm while least plant height was recorded in Sweet type. The difference in trunk girth was found to be non significant. Plant spread was also found maximum in Bantoor (E-W 65.30 cm and N-S 62.50 cm).

Wood apple (*Feronia limonia*)

Two germplasm of wood apple were maintained under field condition. The initial growth of plant was slow in all genotypes and was also found susceptible to low temperature /frost.

At CHES, Vejalpur, the growth parameters of wood apple recorded in different lines indicated that there were significant differences with respect of plant height where

as, stock, scion diameter and plant spread were found to be non significant. Plant height, stock, scion diameter and plant spread (EW) were maximum in line CHES 7 (5.36 m, 22.55 mm, 19.50 mm and 4.73 m, respectively).

Flowering fruiting and yield: In the seventh year of planting few plants started flowering and fruiting. Observations recorded on annual shoot growth indicated that shoot length varied from 39.2 to 63.6 cm and shoot diameter from 5.6 to 7.28 mm. All the flowering, fruiting and yield parameters revealed significant differences between the lines. Number of flower cluster per shoot varied from 7.9 to 18.6, number of male flowers per shoot varied from 112.8 to 195.4, number of female flowers per shoot varied from 2.8 to 12.8 with a variation in male female ratio of 10.60 to 43.14. Number of fruit set per shoot ranged from 1.4 to 9.8 and number of fruits retained per plant from 21 to 66.25, resulting in the yield variation of 6.77 to 23.65 kg per plant.

Physico-chemical analysis: There were significant differences among all the Physico chemical characters except acidity, pH of juice and Vitamin C content. Data on fruit weight indicated that it varied from 303.00 g to 463.00 g with maximum in line CHES 3 (463.0 g). Fruit length, diameter was highest in the same line (85.25 and 93.5 mm, respectively). Smaller fruit size (75.82, 78.5 mm) and weight (303.0 g) was recorded in line CHES 7. Though the pulp weight per fruit was maximum in line CHES 3 (211.0 g). Skull weight, skull thickness and seed number were least in line CHES 3. Except TSS there were non significant differences in acidity, pH and ascorbic acid content of wood apple fruit. Highest TSS (12.0 °Brix) was recorded in line CHES 6 and least in CHES 4. Acidity was highest in line CHES 3, where as pH and Vit. C content were maximum in line 2.

Other exotic fruits

During the year, exotic fruit species (Chinese jujube, Argan, Marula nut) were maintained. Effect of frost was observed on upper top portion of leaves/tender shoots. Marula nut (*Sclerocarya birrea* subsp. caffra) and Argan (*Argania spinosa*) plant is growing well under field conditions. Carob and Chinese jujube is growing well in nursery mother block.

For multiplication of Argan plants, semi-hard wood cuttings treated with aqueous solution of 1000 and 2000 ppm IBA was planted in nursery during July, August and September months. The sprouting was observed 20 days after planting and the IBA 2000 ppm treatment was responsive for better sprouting (33%) cuttings. The root development in cuttings was very poor and dried after two months.

Vegetable crops

Cucurbitaceous vegetables

Realizing the importance of cucurbit vegetables in the arid region, the germplasm collection was started since 1994 at CIAH and a large number of 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. During the period under report, 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, kachri (68) was undertaken during rainy season of 2011-12 and also evaluated for identification of trait specific lines under abiotic stresses and rainfed conditions. On the basis of germination and seed vigour, the seed storage studies revealed that the kachri 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 68 germplasm lines has been produced and deposited for safe conservation both at CIAH and NBPGR, RS, Jodhpur.

Maintenance of kachri germplasm: Kachri, a non–dessertic form of *Cucumis melo* is most potential 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 600 accessions were collected at CIAH and evaluated in phase manner as well altogether in 2001 for seed enhancement and conservation. Of them, 68 germplasm lines maintained at the institute were evaluated during rainy season of 2011 for trait specific characterization and seed enhancement for conservation. A wide range of variations were recorded for days to appearance of first male flower (36.2 – 53.1 DAS), node to first male flower (1.6 – 4.2), days to appearance of first female flower (41.5 – 60.4 DAS), node to first female flower (2.9 – 5.2), days to first harvest (74.3 – 88.6 DAS), fruit weight (15.7 – 138.3 g), fruit length (3.28 – 9.21 cm), fruit diameter (2.39 – 5.52 cm), number of fruits/plant (4.5 – 27.5), fruit yield/plant (0.097 – 2.026 kg), seed length (0.41 – 0.78 cm), seed width (0.17 – 0.38 cm), weight of seeds/fruit (0.502 – 3.897 g), seed yield/plant (3.291 – 52.993 g), weight of 100 seeds (0.507 – 1.559 g), vine length (1.65 – 3.35 m) and number of branches/plant (5.6 – 14.5). The data on variability components are presented in Table-1

The kachri germplasm lines were categorized based on fruit size (very small, small, medium, large and very large) and shapes such as oval, round, oblong-round, flat-round, oblong to long having obovate, ovate or pyriforms. The rind or skin of mature fruits was very tight and thick to very loose and thin, and also possess different forms of dots (scattered or in lines). The rind or skin colour of fruits was greenish-white, whitish-yellow, yellowish, saffron or blackish-green mottled. (Fig. 10) Under absolute rainfed conditions of arid environment, these lines exhibited wide range of variations for number of branches/plant, vine length and over all plant growth performance and thus, lines were categorized as poor, moderate, good and very good types. These were also screened for incidence of diseases and fruit fly infestation, and in general, categorized as low, moderate, high and very high levels. Based on maturity, fruit size, shape, yield potentials and over all performance the kachri lines namely AHK-119, AHK-200, AHK-411, AHK-564 and AHK-572 were found to be most potential for utilization in breeding programmes (Fig. 11).

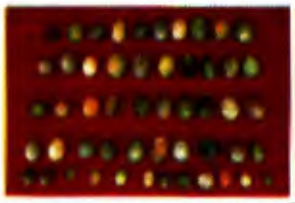


Fig. 10: Fruit variability in evaluated kachri germplasm lines

Fig. 11: Fruits of promising kachri germplasm lines

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 starged 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.

Fig. 12: Evaluation and seed enhancement of palak genotypes

Fig. 13: Evaluation and seed enhancement of bathua genotypes

Germplasm maintenance and exchange: During 2011-12, the seed enhancement of potential genotypes of palak (AHLP-1), bathua (AHLB-1), carrot (AHDC-1) and sehjna (AHMO-1) was done. These were characterized and maintained by multiplying the seeds to fulfil the national indent of these unique and trait specific lines. During the period, potential lines (>20) of arid vegetable crops were supplied to national institutes, SAU's and state agencies for performance studies and use in breeding programmes as genes for drought hardiness and tolerance to high temperature conditions (Fig. 12 & 13).

Table 1. Genetic variability component of kachri germplasm lines evaluated during rainy season of 2011

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)	36.2	53.1	41.81	0.73	1.09	7.87	7.95	98.10	6.72	16.07
Node to male flower	1.6	4.2	2.77	0.53	11.94	10.67	16.02	44.41	0.40	14.65
Days to female flower (DAS)	41.5	60.4	49.22	0.70	0.88	7.03	7.09	98.44	7.07	14.37
Node to female flower	2.9	5.2	3.99	0.52	8.18	7.93	11.40	48.47	0.45	11.38
Days to first harvest (DAS)	74.3	88.6	79.59	2.65	2.06	2.81	3.49	64.94	3.71	4.66
Fruit weight (g)	15.7	138.3	59.91	7.06	7.30	42.31	42.94	97.11	51.47	85.90
Fruit length (cm)	3.28	9.21	6.04	0.26	2.72	22.62	22.79	98.57	2.79	46.28
Fruit diameter (cm)	2.39	5.52	4.12	0.21	3.27	14.56	14.93	95.19	1.20	29.28
Number of fruits/plant	4.5	27.5	12.00	1.91	9.88	34.35	35.74	92.35	8.16	67.99
Fruit yield/plant (kg)	0.097	2.026	0.713	152.77	13.26	52.18	53.84	93.93	743.25	104.18
Seed length (cm)	0.41	0.78	0.56	0.05	6.14	8.65	10.61	66.49	0.08	14.53
Seed width (cm)	0.17	0.38	0.26	0.04	10.06	9.61	13.92	47.72	0.03	13.68
Weight of seeds/fruit (g)	0.502	3.897	1.718	0.01	0.64	43.76	43.76	99.98	1.54	90.14
Seed yield/plant (g)	3.291	52.993	20.415	3.22	9.77	50.12	51.07	96.34	20.69	101.35

Evaluation and maintenance of sehjna line: During 2011, Sehjna (AHMO-1-4s) genotype maintained in the field was evaluated for pod quality and yield component characters (Table-2&3) (Fig. 14). The enhanced seeds of the genotype is now, maintained as seeds for conservation.

Table 2. Performance of *Moringa* genotype AHMO-1 during 2011

Characters	Average
Number of buds/cluster	23.54
Number of open flower/cluster	18.66
Number of pod set/cluster	08.86
Number of tender pods/cluster	06.55
Number of mature pods/cluster	04.95
Number of pods for seed/cluster	02.96
Number of seeds /pod	14.52

Table 3. Pod characters of *Moringa* genotype

Stages	Pod character	Range	Average
Stage I: Immature - very tender for vegetable use	Pod length (cm)	29.5-38.4	34.18
	Pod diameter (cm)	0.32-0.53	0.39
	Pod weight (g)	2.88-3.85	3.62
Stage II: Semi-mature - marketable quality for vegetable use	Pod length (cm)	38.8-46.5	43.55
	Pod diameter (cm)	0.72-1.28	0.94
	Pod weight (g)	14.75-42.32	21.77
Stage III: Mature - seed purpose	Pod length (cm)	36.2-58.5	48.43
	Pod diameter (cm)	2.12-2.23	2.17
	Pod weight (g)	78.84-80.23	128.74

Maintenance and characterization of cluster bean line: During rainy season of 2011, the identified cluster bean genotype AHG-20 maintained at the institute as drought tolerating line for vegetable type was raised for seed enhancement and conservation. A sufficient quantity of seeds was produced under absolute rainfed conditions and the genotype was evaluated for uniformity and stability and also characterized for growth, flowering, pod quality and seed component characters (Table-4 & Fig. 15). The light green colour tender pods are medium in quality, sickle shape and small sized.

Fig.14: Stages of tender pods of *Moringa* genotype

Fig. 15: Tender pods of cluster bean - AHG 20

Table 4. Performance of cluster bean line AHG-20 during rainy season of 2011

Character	Range	Average
Days to first harvest (DAS)	-	75.5
Plant height (cm)	45.5-68.5	57.5
Number of branches/plant	1.2-4.4	2.5
Number of clusters/plant	5.2-9.3	7.25
Number of pods/cluster	2.4-5.1	3.5
Tender pod length (cm)	5.7-7.1	6.28
Tender pod width (cm)	0.6-0.8	0.71
Tender pod weight (g)	0.72-0.99	0.85
Number of seeds/pod	6.5-10.8	9.1
Weight of 100 seeds (g)	4.42-4.58	4.46
Tender pod yield/plant (g)	12.8-32.8	21.8
Grain yield/plant (g)	12.5-26.3	15.8
Fodder yield/plant (g)	36.6-51.2	42.8

Crop Improvement

Improvement of arid and semi arid fruit and vegetable crops

Fruit crops

Ber

Self incompatibility crossability studies in ber genotypes: Twenty five genotypes of ber were evaluated for self incompatibility

assessment during ber flowering and fruit season of 2011-12. The study of 25 ber genotypes for self incompatibility was repeated to confirm the results of previous years study which found no fruit set in thirteen genotypes upon selfing. Crossability studies was undertaken between *Ziziphus mauritiana* var. Gola and one genotype of each of *Ziziphus nummularia*, *Z. spinacristi*, *Z. mauritiana* var. *rotundifolia*, Chinese type and Tikadi. The crosses between above mentioned combinations were not successful.

Vegetable crops

Brinjal

Screening of brinjal lines for biotic and abiotic stresses and evaluation of promising lines during summer season: Initially large number of germplasm, landraces and cultivars of brinjal collected through assemblage, survey and exploration were evaluated for their performance under different seasons. On the basis of evaluation, selection and advancement for five generations, seven elite lines were found promising. These lines are CIAH-1, CIAH-2, CIAH-12, CIAH-16, CIAH-21, CIAH-22 and CIAH-67 (Table 5). These were selected for early flowering and fruit set, reduced infestation of fruit and shoot borer (FSB), high marketable yield, and consistent fruit quality under high temperature conditions. No infestation of FSB was observed under spring-summer season of 2011, however loss of lustre in fruits was observed during month of June in CIAH-2, CIAH-22 and CIAH-67. The seed content in the fruit set in the month of June was higher as compared to fruit set in the month of April and May. Leaves of CIAH-1 and CIAH-12 showed curling under high temperature conditions. In the month of June discolouration of leaves and reduced fruit set was observed in CIAH-16 and CIAH-67 lines.

Table 5. Mean performance of promising breeding lines of brinjal (average of five seasons)

Genotypes	Days to flowering (DA)	Days to first harvest	Average fruit	No. of fruits /plant	Fruit yield/ plant (kg)	Fruit colour and Shape
CIAH-1	28	46	39.8	79.5	3.16	Dark purple, oblong
CIAH-2	31	52	54.8	51.4	2.82	Greenish-purple, round
CIAH-12	42	61	62.3	48.1	2.99	Purple, round
CIAH-16	39	60	76.3	29.7	2.27	Greenish-brown, long
CIAH-22	32	51	49.7	73.6	3.66	Greenish-purple, round
CIAH-67	31	52	78.2	25.3	1.98	Purple, oblong

All the lines were homogenous and did not show any segregation for major morphological traits. The individual plants of six lines were selfed for further purification to achieve uniformity and homozygosity.

Characterization of brinjal lines for uniformity: Two elite lines developed from brinjal breeding programme at CIAH were subjected to large scale evaluation in plot size of 500 sq m each for uniformity, morphological characterization for growth, fruit quality and yield characters during rainy-winter season of 2011-12 (Table 6, Fig. 16 &17).

Both the lines showed stability and uniform performance from seedling stage to fruit and seed harvest stages. Infestation of fruit and shoot borer (FSB) was found more in the month of September-October. The seed content in the CIAH-16 was lower and relatively requiring longer period to maturing the seed. The plants of the genotypes are semi erect and non-spreading. The leaves of the CIAH-16 were also infested by FSB.

Table 6. Characterization of developed brinjal genotypes under hot arid environment

Characters	CIAH-1	CIAH-16
Pedigree	F_8 generation from cross ofAHB-04 x PPC	Selection from KSB-78
Days to flowering (DAT)	29.4	43.5
Days to first harvest (DAT)	47.2	62.4
Plant height at 90 days (cm)	61 .2	79.5
Number of branches/plant	5.8	7.3
Number of flower /cluster	4.8	3.5
Leaf length (cm)	11.9	19.2
Leaf width (cm)	8.3	13.2
Tender fruit length (cm)	5.23	17.2
Tender fruit diameter (cm)	4.31	3.63
Marketable fruit weight (g)	42.4	73.2
Number of marketable fruits/plant	93.8	30.7
Marketable fruit yield/plant (kg)	3.98	2.25
Fruit yield (tonnes/ha)	63.5	39.8
Fruit weight, mature (g)	63.2	154.1
Number of seeds/fruit	607.5	570.2
Weight of seeds/fruit (g)	1.767	1.468
Weight of 1000 seed (g)	2.91	2.576
Flower colour	Whitish-purple	Whitish-purple
Leaf colour	Purple	Green
Pubescence	High	Low
Fruit colour	Dark-purple	Greenish-brown
Fruit shape	Oblong-round	Long
Seed colour	Light brown	Brown

Fig. 16: Tender fruits of CIAH-1

Fig. 17: Tender fruits of CIAH-16

Bottle gourd

Breeding for high temperature tolerance and marketable yield in long fruited bottle gourd: During the rainy season of 2011, six long fruited progenies developed at the institute were evaluated for growth, flowering, fruit set, fruit quality and yield component characters (Fig. 18 & 19). Detailed observations were recorded to screen the material under high temperature and abiotic stresses, and also advancement of generation. The performance of progenies from cross combination of AHLS–24 x BOGVAR–3 is given in Table–7.

Fig. 18: Promising bottle gourd line.

Fig. 19: Fruit shape in evaluated bottle gourd progenies

Cluster bean

Performance of cluster bean var. Thar Bhadavi: To assess the potentiality of developed cluster bean variety Thar Bhadavi, large scale testing was conducted adopting innovative production site management approaches under four situations (rainfed or one, two and three irrigations if required). During the rainy season of 2011, the crop was taken under absolute rainfed situations and no life saving irrigation was given due to good rains and its distribution over the crop season. Observations on plant growth, tender pod, seed yield and total bio–mass production were recorded and presented in Table 8. Excellent results on plant growth, pod quality and yield potential of the variety was recorded under absolute rainfed situations where the crop was sown on 11/07/2011 with good rains for crop sowing on 10/07/2011. During 2011, very good pre-monsoon rain was observed on 21/06/2011 and thereafter preparation of fields was started as per scheduling developed (Fig. 20-25). After the crop sowing, good numbers of rainy days were recorded (12) in crop production site and these were well distributed up to first week of September. The crop received 12 rainy days (14/07, 28/07, 31/07, 08/08, 11/08, 14/08, 19/

Table 7. Performance of bottle gourd (F_3 generation) progenies, rainy season 2011

Line	Days to male flower (DAS)	Days to female flower (DAS)	Days to first harvest (DAS)	Number of fruits/ plant	Tender fruit weight (g)	Tender fruit length (cm)	Tender fruit diameter (cm)
F3/1	56.5	60.8	70.4	5.5	585.5	26.5	6.1
F3/2	57.4	61.4	69.5	3.7	744.4	29.3	7.3
F3/3	57.2	61.1	68.8	6.1	729.6	33.8	6.7
F3/4	57.1	61.2	69.7	5.0	750.8	21.3	7.7
F3/5	57.3	61.5	74.2	4.7	625.3	29.5	6.6
F3/6	54.7	59.9	66.9	4.7	590.9	23.9	6.8

Table 8. Performance of cluster bean var. Thar Bhadavi as seed crop under absolute rainfed situations during 2011 at CIAH, Bikaner.

Characters (Plot size: 5m x 5m)	Range	Mean
Plant height (cm) at 90 DAS	90.5 – 164.4	130.6
Number of clusters/plant	5.4 – 12.1	7.9
Number of pods/cluster	5.2 – 9.4	7.3
Tender pod yield/plant (g)	28.0 – 76.5	46.8
Seed yield/plant (g)	-	8.2
Fodder yield/plant (g)	-	26.5
Tender pod yield/plot (kg)	-	11.6
Seed yield/plot (kg)	-	2.96
Fodder yield/plot (kg)	-	8.12
Leaf litter/plot (kg)	-	4.95

Fig. 20: Preparation of khejri based production site for cluster bean production

Fig. 21: Preparation of field by cross harrowing after pre-monsoon rains with the end of July

Fig. 22: *In-situ* rain water harvesting in the ready field before crop sowing

Fig. 23: Field view of cluster bean after first interculture operations (38 DAS) under rainfed conditions

Fig. 24: Field view of cluster bean variety Thar Bhadavi under innovative production technology

Fig. 25: Harvesting of seed crop of cluster bean

08, 24/08, 02/09, 03/09 and 05/09). The quantity of rain received were of light to heavy from pre-monsoon field preparation to crop harvest and accumulates about 312 mm from June to September 2011.

Chilli

Evaluation of Chilli lines under abiotic stresses of summer season: In order to find out performance of chillies as offseason crop during spring-summer season to harvest green fruits under arid conditions, 22 genotypes including popular types and sweet pepper were evaluated under field conditions for three years (2009-2011). Three lines of chilli were evaluated for growth, flowering, fruit set, yield and fruit quality during summer season 2011. A luxurious vegetative growth was observed in the evaluated genotypes under open field conditions. Very high percentage of flower drop was recorded under maximum temperature range of 40-48 °C during April to June. The fruit set during this period was very low and poor in marketable quality. All the genotypes depicted sensitivity to high temperature condition and fruit burning was recorded (Fig. 26).

On the basis of performance studies over the years it is concluded that due to extremeness of high temperature conditions in the arid region, marketable quality yield in chilli could not be achieved under spring summer season. Among the germplasm lines evaluated AHM-197 alone showed good fruit set during month of May (Fig. 27), however, the fruit maturity and quality was affected due to very high temperature during fruit development period. The line showed fruit set with viable seeds at high mean temperature (42°C) and resulted in to small (6.7 cm length and 0.83 cm width) red ripe fruits (27.4 per plants).

Fig. 26: Tip burning in fruits of sweet-pepper due to high temperature

Fig 27.: Fruit set and maturity in AHM-197 under high temperature of summer season

Evaluation and purification of Mathania type during rainy winter season 2011-12: Six progeny lines of Mathania type chilli were under purification and characterization for four consecutive seasons. The selfed Mathania type seeds from previous year were subjected to field evaluation under biotic and abiotic stresses conditions of arid region during rainy-winter season 2011-12. The selections of Mathania type from the breeding material showed low variability as compared to earlier generation which indicated progress towards uniformity and homozygosity in the line. Genetic gain in the yield and component characters was observed to be low on generation ad-

Table 9. Performance of Mathania type chilli line in rainy-winter season 2011-12

Character	Mean	Min.	Max.
Plant height (cm) 75 DAT	73.5	67.1	87.4
Number of branches/plant	4.55	4	6
Days to flowering (DAT)	62	58	63
Days to harvest green fruits (DAT)	109	103	116
Fruit length green (cm)	16.35	13.2	18.9
Fruit diameter (cm)	2.15	1.74	2.41
Number of fruit/plant	32.7	15	71
Fruit weight (g)	18.7	15.4	24.0
Green fruit yield/plant (g)	611	278	1458
Number of seeds/fruit	73.3	62.1	85.5

vancement. Fruit set period was restricted to the November and effect of low temperature and frost was recorded on the breeding line. The Mathania type chilli was characterized for vegetative and fruit characters. It bears long to very long fruits which are broad at upper and middle end and tapered at lower end. Fruits are fleshy, wrinkled, dark green, glossy and mild in pungency. The seeds per fruit were low-medium (62-85) and yellow coloured (Table 9). The plants were observed for aphid population and leaf curl symptoms. The seedlings were healthy vigorous and branching started 35 days after transplanting.

Faba bean

During the year, 20 lines of faba bean were collected from NBPGR, New Delhi and 10 local collections were made from eastern Uttar Pradesh. These genotypes were evaluated during winter season for yield and its contributing traits (Table 10 & Fig 28). Among the genotypes, HB-18 showed the best overall performance in respect to days to first flowering (58.80-64.07), days to first pod harvesting (68.73-74.80), pod length (4.21-5.30 cm), pod diameter (1.08-1.21 cm), pod weight (4.17-4.60 g), number of pods per plant (37.87-43.93) and pod yield per plant (120.75-162.30 g). The seed of all the lines was maintained as active collections for further utilization (Fig. 29).

Table 10. Morphological and yield parameters of faba bean genotypes

Character	Range
Days to first flowering	58.67-73.20
Days to first pod harvest	74.87-85.53
Pod length (cm)	3.12-6.60
Pod diameter (cm)	0.81-1.22
Pod weight (g)	2.37-5.40
No. of pods per plant	26.27-45.93
Pod yield per plant (g)	40.28-110.80
Plant height at last harvest (cm)	35.36-58.51
No. of branches per plant at last harvest	5.07-10.58
100 seed weight (g)	19.20-42.52

Fig. 28:Variation in pod length and bearing pattern

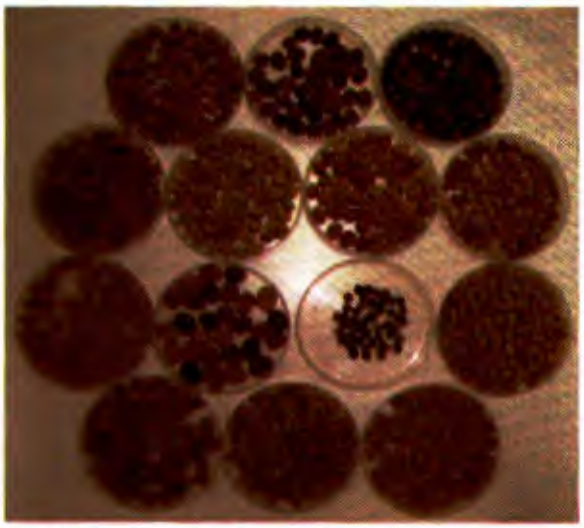


Fig. 29:Variation in seed colour and size

Selection of superior lines

Three best performing lines HB-18, EC-361482 and AHF-6 were selected for further evaluation. Based on overall performance, five single plant selections were made from AHF-6 to develop pure lines.

Indian bean

Varietal trial of Indian bean: During the rainy–winter season of 2011–12, two varietal trials of Indian bean (pole and bush type) were conducted under AICRP on vegetable crops at CIAH, Bikaner. Among ten entries of pole type, (Table 11 & Fig. 30) two were from CIAH such as AHDB–03 (Thar Maghi) and AHDB–16 (Thar Kartiki) and were tested alongwith checks (Pusa Early Prolific and Swarna Utkrist). During the crop period, the minimum sub–zero temperature dips down during first week of January 2012 and at the same time severe frost conditions resulted to complete

Fig. 30: Field evaluation of Indian bean pole type

crop damage in Indian bean trials. Therefore, the data on experimental trial up to 2 January 2012 were compiled. Among the pole type, very low pod harvest was recorded in most of the entries due to late maturing group where first pod harvesting was started after second or third week of December 2011. The early maturing entries (second or third week of October to first week of November) recorded good harvest till the onset of frost in January. The institute varieties, Thar Maghi and Thar Kartiki, exhibited superiority for pod yield 101.25 q/ha and 103.15 q/ha till the onset of frost, respectively under extremes of arid environmental conditions.

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 (Table 12 & Fig. 31). During the crop period of 2011–12, 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

Table 11. Performance of Indian bean (pole type) genotypes during 2011-12

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/ plant (kg)	Pod yield (q/ha)
10/ DOLPVAR - 1	89.2	113.2	11.53	3.46	10.8	1.121	92.52
10/ DOLPVAR - 2	108.5	130.8	7.33	2.03	5.23	0.312	21.55
10/ DOLPVAR - 3	110.5	134.3	7.7	2.16	4.48	0.251	22.61
10/ DOLPVAR - 4	118.2	138.2	13.43	1.38	7.5	0.182	17.54
10/ DOLPVAR - 5	82.5	108.7	13.46	1.32	8.80	1.125	91.25
10/ DOLPVAR – 6	90.5	112.8	13.76	1.26	8.21	1.142	101.25
10/ DOLPVAR - 7	106.7	139.6	12.26	2.23	9.72	0.312	22.53
10/ DOLPVAR - 8	108.6	128.5	8.46	1.56	6.05	0.554	35.85
10/ DOLPVAR - 9	76.5	88.8	9.43	1.62	4.94	1.235	103.15
10/ DOLPVAR - 10	123.7	140.9	14.46	2.96	10.86	0.015	1.42
Swarna Utkrist (Check)	118.2	140.4	10.33	1.83	5.51	0.254	21.51
Pusa Early Prolific (Local check)	82.4	97.6	10.36	1.26	4.54	0.412	38.53

Table 12. Performance of Indian bean (bush type) genotypes during 2011-12

Variety	Days to flower (DAS)	Days to first harvest (DAS)	Pod length at tender (cm)	Pod width at tender (cm)	Tender pod weight (g)	Marketable pod yield/ plant (kg)	Pod yield (q/ha)
10/ DOLBVAR - 1	38.5	79.2	10.16	1.36	2.86	0.235	39.25
10/ DOLBVAR - 2	47.2	91.4	6.41	1.81	2.15	0.225	40.25
10/ DOLBVAR - 3	52.5	82.3	8.56	1.33	2.98	0.315	58.46
10/ DOLBVAR - 4	79.4	92.2	6.76	1.66	1.82	0.452	62.78
10/ DOLBVAR - 5	67.8	92.2	12.66	1.06	3.22	0.255	32.78
10/ DOLBVAR - 6	113.2	126.4	10.73	1.16	4.65	0.251	33.55
10/ DOLBVAR - 7	106.3	123.1	8.43	1.26	3.32	0.268	32.57
Arka Jay (Check)	67.4	87.1	9.40	1.26	3.38	0.255	35.78

Fig 31: Field evaluation of Indian bean bush type

flowering varieties. The bush type varieties depicted low temperature injury (<5 ^{0}C) observed from third week of December 2011 which increased in last week of December when temperature dips down below 3 ^{0}C in night. Therefore, the data on experimental trial up to December 2011 were compiled. The crop was completely damaged with the onset of the frost in January 2012.

Khejri

Evaluation of khejri genotypes: Fourteen elite genotypes maintained clonally in khejri germplasm plot for *ex situ* conservation were maintained and evaluated during 2011–12. Crop regulation by pruning the trees in the month of June was attempted for harvesting of both products (sangri and loong) annually from the plantations. Sixteen genotypes of khejri were characterized by morphological characters to assess the stability components. 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 varying situations and to assess the performance over the years.

Growth and development studies: To develop khejri based cropping system models 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 2011–12, the plant growth and development observations were recorded throughout the year and no significant differences were observed in growth characters

of khejri variety Thar Shobha under varying planting system models.

Mateera

Breeding for high seed content in mateera: To assess the uniformity and stability of the developed materials, advanced progenies AHW RSS–1 were evaluated with mateera varieties (Thar Manak and AHW–65) during rainy season of 2011. Detailed observations were recorded to characterize the material under absolute rainfed and abiotic stresses of arid environment.

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. During the summer season of 2011, thirteen advanced progenies were raised alongwith check for screening. The crop was initially evaluated for growth, flowering and fruit set characters.

Ridge gourd

A total of 41 genotypes of ridgegourd including IC lines, local germplasm and released varieties were evaluated for earliness, bearing habit, fruit yield and yield related attributes during summer season of 2011. During rainy season, a total of 26 genotypes were again assessed for their performance. The selection for desirable genotypes was made from local collections and IC lines on the basis of overall phenotypic performance. Generation advancement and maintenance of selected lines was done through selfing. The seed of all the lines were maintained through inbreeding for further utilization. A wide range of genetic variability was recorded for growth, flowering and yield related parameters (Table 13). Fruit shape varied from round to long and bearing habit was found to be solitary to cluster (Fig. 32).Majority of the lines were monoecious in sex form except IC-105571 (andromonoecious) and AHRG-56, AHRG-57, AHRG- 58 (hermaphrodite).

Table 13. Variability among ridgegourd genotypes

Character	Range
Vine length (m)	2.16-6.33
No. of primary branches/plant	3.53-6.33
Inter-nodal length (cm)	6.47-17.00
Days to first female flower	41.67-53.60
Node at which first female flower appeared	4.93-21.73
Ovary length (cm)	1.53-8.27
Fruit length (cm)	3.67-28.60
Fruit diameter (cm)	2.53-4.42
Days to first fruit harvest	48.27-61.23
No. of marketable fruits/plant	16.60-59.47
No. of fruits on nodes	1.00-8.60
Fruit weight (g)	18.25-115.50
Marketable yield/plant (kg)	1.09-2.33

Fig. 32:Variation in ovary and fruit traits

Identification of round fruited genotype

Among the evaluated genotypes a round fruited line (AHRG 57-1) with hermaphrodite flowers in clusters was identified during summer season of 2011 and single plant selection for superior type was made (Fig. 33). The selected genotypes were again raised during rainy season for generation advancement. It produced Ist hermaphrodite

Fig. 33: Round fruited AHRG 57-1

flower in 41.87-45.20 days after sowing, gave 52.80-59.47 fruits/plant with fruit weight ranging from 18.59 to 30.81 g. The stability of this will be again validated against yield, earliness and mosaic virus.

Selection of superior lines

Among long fruited ridgegourd genotypes AHRG 29-1 and AHRG 41-1 were found to be promising and selected for further evaluation. AHRG 41-1 was found promising in respect of days to I[st] female flower (44.33-51.13), fruit length (19.27-21.33 cm), fruit weight (102.53-112.93 g) and other horticultural traits.

Fibre content analysis in ridgegourd

Samples of 15 genotypes of ridgegourd were analysed for fibre content in fresh fruits and it was found to vary from 7.06 to 25.89 per cent in deferent genotypes.

Round melon

Breeding for high temperature tolerance and fruit quality: Round melon commonly known as tinda is potential arid zone cucurbit. 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 (40^0 – 42^0 C) and abiotic stresses, besides, the plant exhibited slow growth at initial stages, susceptible to mites, viral diseases and high level of fruit fly infestation.

The work on evaluation and purification of germplasm was started as early as from 1997 by screening varieties (Arka Tinda, KPT-3 and S-48) and local types (AHRM-1and AHRM-2). In addition, 14 germplasm from NBPGR, Jodhpur were also evaluated during 2002. The generated data of crop germplasm evaluation over the years were compiled and it was realized that there is very narrow range of variations for desirable characters. The available varieties/lines were poor performing and susceptible to environmental stresses of arid region both during summer and rainy season crop cultivation.

Simultaneously, the local landraces were purified for uniformity and stabilization of desirable characters such as marketable fruit quality from AHRM-1 and tolerates to prevailing environmental conditions from AHRM-2 for utilization in hybridization. During 2009, seven F_1 cross combinations were developed from the progenies of AHRM-1 and AHRM-2 (AHRM-1a x AHRM-2a, AHRM-2a x AHRM-1a, AHRM-2b x AHRM-1a, AHRM-2c x AHRM-1a, AHRM-2a x AHRM-1b, AHRM-2b x AHRM-1b and AHRM-2c x AHRM-1b) and these were

evaluated in 2010-11. During 2011-12, the parental lines, F_1 and F_2 progenies were evaluated for screening and further selection breeding. The parental lines exhibited similar trends for fruit quality characters and susceptibility/tolerance towards the high temperature conditions. Very low levels of heterolic values were observed for fruit weight and number of fruits/plant. The F_1 combinations such as AHRM-2a x AHRM-1a and AHRM-2a x AHRM1b yielded good quality fruits at marketable stages (Fig. 34).

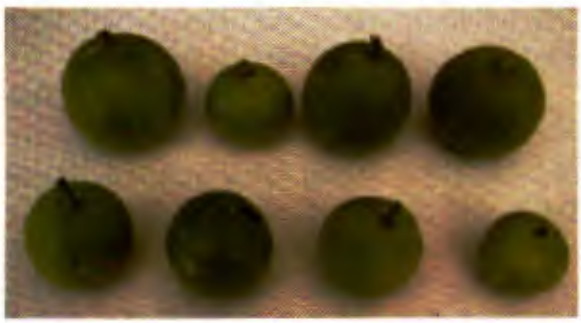


Fig. 34: Tender fruits of F_1 hybrids of round melon

However, a good amount of variations for growth, flowering and fruiting behaviour and fruit and seed characters were recorded from F_2 progenies (Fig. 35 & 36). Selfing was done in identified plants of the selected progenies for advancement of generation. The generated information is presented in table 14.

Fig. 35: Fruit variability in F_2 generation of round melon

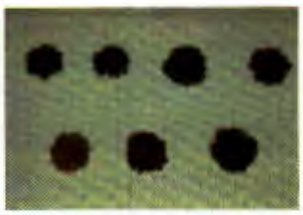


Fig. 36: seed variability in F_2 generation of round melon

Tomato

Breeding for high quality tomato yield under hot arid environment: Nineteen advanced breeding lines of tomato were evaluated during spring-summer season of 2011 for uniformity, stability, quality and yield

Table 14. Performance of round melon progenies over the season (2010 & 2011)

Characters	Parental lines		F_1 generation		F_2 generation	
	Range	Mean	Range	Mean	Range	Mean
Days to male flower (DAS)	27.4-37.3	30.9	25.6-27.8	27.5	24.6-37.8	29.4
Node number to first male flower	1.9-3.2	2.5	2.1-3.4	2.5	2.2-3.7	2.7
Days to female flower (DAS)	30.7-43.4	37.3	30.4-35.7	30.5	29.5-42.8	32.5
Node number to first female flower	3.3-4.3	3.5	4.5-5.8	5.2	4.2-6.9	5.4
Days to first harvest (DAS)	45.4-55.8	48.5	43.1-56.5	47.2	41.3-55.1	48.2
Tender fruit weight (g)	64.4-97.6	86.6	43.5 - 187.2	103.6	44.7-205.3	97.7
Tender fruit length (cm)	4.34-5.08	4.84	3.85 - 6.80	5.17	3.59-6.75	5.09
Tender fruit diameter (cm)	5.14-6.10	5.79	4.52 - 7.34	5.92	4.34-7.87	5.82
Mature fruit weight (g)	395.6-463.8	429.9	148.7-333.5	234.0	120.2-481.5	209.4
Mature fruit length (cm)	7.52 - 9.51	8.21	5.81 - 8.63	7.13	4.93-9.12	6.76
Mature fruit girth (cm)	30.12-40.23	34.65	22.90-29.65	26.28	22.24-32.73	25.64
Weight of 100 seeds (g)	6.02 - 7.51	6.68	5.02 - 9.33	7.37	2.29-9.79	7.10
Seed length (cm)	1.09 - 1.21	1.14	1.02 - 1.24	1.13	0.72-1.33	1.09
Seed width (cm)	0.52 - 0.62	0.58	0.53 - 0.71	0.61	0.42-0.72	0.59
Tender fruit colour	WG, G, DG		WG, G, DG		WG, LG, G, DG	
Fruit shape	Flat, round, oblong-round, flat-round		Round, flat, flat-round		Round, flat, oblong-round, flat-round	
Seed colour	Blackish-brown, blackish-green		Blackish-brown, blackish-green		Grey, blackish, brownish, blackish-green	

characters under high temperature conditions. The minimum, maximum and mean temperature during fruit set, development and ripening was recorded. Maximum temperature in the month of May and June reached up to 48.5°C. The genotypes evaluated were semi-determinate and determinate type. Out of 19 breeding lines, 11 lines showed uniform performance for yield and component characters. Three semi-determinate type lines showed good fruit and colour development

Fig. 37: Tomato promising line in bearing

Table 15. Analysis of variance for yield contributing characters in tomato

Character	Mean	Range	SE	GCV	PCV
Days to flowering (DAT)	20.84	23-28	0.674	8.89	9.27
Days to first harvest (DAT)	56.23	52-59	0.621	3.81	3.99
Fruit weight (g)	42.14	36.2-87.2	4.263	32.40	33.92
Fruit length (cm)	3.80	3.45-4.58	0.165	12.20	12.48
Fruit diameter (cm)	4.68	4.22-6.02	0.191	11.55	12.08
Number of fruits/plant	49.28	32.5-74.3	3.227	24.03	26.02
Plant height at 75 DAT (cm)	72.4	58.5-95.3	4.129	16.42	18.03
Number of primary branches	6.38	5.2-8.3	0.428	18.86	20.16
Number of locules/fruit	3.66	3.40-5.05	0.432	15.82	17.15
Pericarp thickness (mm)	4.37	3.82-5.15	0.92	15.64	16.24
TSS° Brix	7.15	6.8-8.05	0.154	6.37	7.43
Fruit yield/plant (kg)	3.438	2.96-4.51	0.214	28.41	30.66

(Lycopene) under the high temperature condition of first fortnight of June. Individuals of eight lines were showing significantly different plant height, days to flowering, days to maturity, fruit size, TSS and pericarp thickness (Table 15). Selection on individual plant basis was done both from stable lines and segregating lines. The selected plants were selfed for further advancement of generation.

During rainy-winter season of 2011-12, twenty breeding lines of tomato were evaluated for their field performance, uniformity and stability. Three lines were found to be non-uniform, whereas remaining seventeen lines showed stable performance in the field. Fruit set was higher in the rainy season as compared to summer season. However, fruit size and pericarp thickness was relatively reduced in the rainy-winter season. On an average larger fruit size and more pericarp thickness was observed in summer season as compared to rainy-winter season crop. Besides, the number of fruits/plant and yield/ plant was higher in the rainy-winter season (Fig. 37). Fruit cracking percentage was observed to be higher in rainy-winter season as compared to summer season. Out of 20 lines, four lines were found promising and selection and selfing was done to advance the generation. Hybridization was also done among the stable performing diverse lines to increase the variability.

At CHES, Godhra

Pumpkin (*Cucurbita moschata*)

Advancement of promising hybrids derivatives of pumpkin for high yield and quality (F5 generation)

Five superior derivatives of CM16 x CM19, CM16 x CM17, CM19 x CM12, CM13 x CM15 and CM4 x CM22 cross combination was advanced to F5 generation under replicated yield trial was subjected to variability analysis for 13 characters. Partition of total variance into three components indicated that genotypes differed significantly for all the characters (Table 16). Considering the variation, the lowest node to first female flower appeared was observed in CM16 x CM19 as compared to CM19 x CM12. Similarly, the lowest fruit size (0.950 g) was also recorded in CM16 x CM19 against the largest fruit sized CM13 x CM15 (5.72 kg), however the number of fruits per plant was observed in opposite order of these derivatives, respectively. The quality parameter TSS was recorded highest (18.52 °Brix) in CM16 x CM19 as against the CM13 x CM15, which recorded the lowest value (13.92 °Brix).

Considering the genetic component analysis, the characters such as average fruit girth and average fruit length were recorded the highest values for genotypic variance (237.9 and 119.2%, respectively). The highest Genotypic and Phenotypic coefficient of variation was observed more than 50% in number of fruits per plant and average fruit weight. Where as the fruit flesh thickness exhibited the lowest values which was less than 10 per cent. The genetic gain indicated very lower values for earliness, fruit flesh thickness and TSS which showed values lesser than 30% as compared to other characters (Fig. 38).

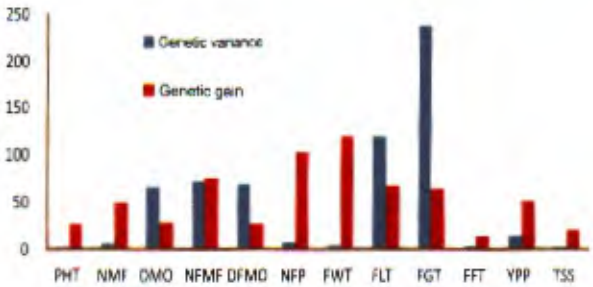


Fig. 38: Genetic variance and genetic gain for different morphological parameters of Pumpkin derivatives in F5 generation.

Table-16. ANOVA of different morphological parameters of hybrid derivatives of Pumpkin

Name of the characters	Replication Df=3	Treatment Df=4	Error Df=12	Total Df=19
Plant length (m)	0.01	1.99**	0.03	0.43
Node to male flower appeared	0.48	20.38**	0.38	4.61
Days to male flower anthesis	6.64	270.4*	5.93	61.73
Node to female flower appeared	4.19	289.1**	1.95	62.75
Days to female flower anthesis	0.58	281.7*	4.66	62.34
Number of fruits per plant	0.57	32.34**	0.81	7.41
Average fruit weight (kg)	0.09	16.46**	0.11	3.55
Average fruit length (cm)	2.23	478.8**	1.96	102.4
Average fruit h (cm)	2.55	956.4*	4.97	204.9
Fruit flesh thickness (cm)	0.08	0.46*	0.05	0.14
Yield per plant (kg)	2.31	56.79**	1.39	13.2
TSS	0.13	12.41*	0.34	2.85

Bottle gourd (*Lagenaria siceraria*)

Advancement of hybrid derivatives of bottle gourd for high yield and quality (F4 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. Among the superior lines, the LS3xLS2 showed the highest value for plant length (6.04m) and node to first male flower appeared and node for first female flower. Considering the fruiting parameters, the highest number of fruits per plant (19.42) was recorded in LS4xLS3-2 against LS20-1xLS14-1, which recorded the lowest value (7.72). Among the derivatives, the lengthiest fruit having cylindrical shape was recorded in LS28-1xLS20-2 (46.72cm) against LS4xLS3-2, which recorded the lower value with round shape. The highest protein and crude fiber was recorded in LS4xLS3-2 as compared to other derivatives (Fig. 39).

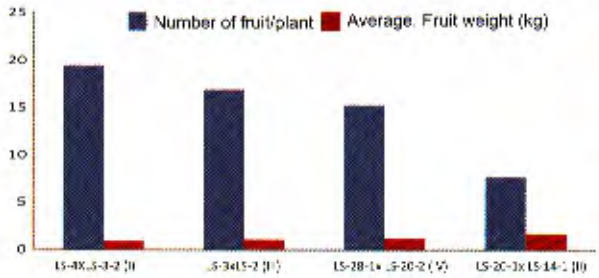


Fig. 39: Bottle gourd derivatives exhibiting variation for fruiting parameters. NFT= Number of Fruits per plant, FWT= Fruit Weight.

The variability analysis indicated significant difference for all the characters under study. Genetic component analysis indicated that the node to female flower appeared, days to female flower anthesis, number of fruits per plant showed higher values for genotypic variance, which was higher than 20 per cent as compared to other parameters. The higher heritability was observed for node to first female flower appeared and number of fruits per plant and average fruit weight which was more than 90 per cent. Among the characters, node to first female flower appeared and number of fruits per plant and average fruit weight and plant length exhibited higher values for genotypic coefficient of variation which was higher than 20 per cent (Fig. 40).

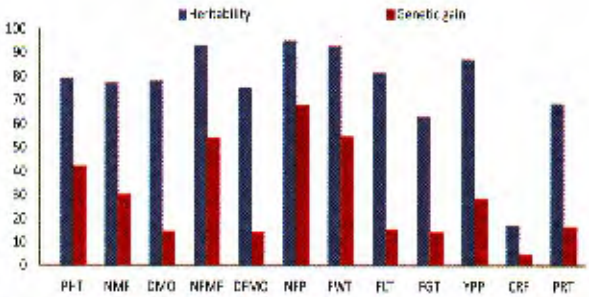


Fig. 40: Genetic component analysis for heritability and genetics gain for different characters of bottle gourd derivatives.

Crop management and agrotechniques

At Bikaner

Investigation on causes and their management of fruit cracking in pomegranate.

Screening of pomegranate germplasm in the field repository for fruit cracking

For Hasta bahar crop flowering was allowed in the month of October 2011 and maturity took place in the month of February 2012. The cracking pattern was observed only in commercial cultivars of arid region such as Ganesh, Jalore Seedless, Dholka, G-137 and Jodhpur Red, Mridula, etc. Data on fruit cracking in all bahars revealed the maximum

cracking (50-60 %) during *mrig bahar*, followed in *ambe bahar* (40 to 45 %) and minimum fruit cracking was observed in hasta bahar (30 to 35 %) in above said cultivars. The aril colour in hasta bahar is light pink while in mrig bahar the colour of arils was dark pink. In ambe bahar, the rind of the fruits became hard and dark brownish in colour

The observation on daily temperature and relative humidity were recorded for correlation studies. Correlation studies revealed that more ambient humidity reduces the fruit cracking and large variation in the maximum and minimum daily temperatures during fruit setting to fruit maturity also increased the fruit cracking in all cultivars. Among the different cultivars, the magnitude of cracking was almost similar.

Fruit cracking under different growing environments

In open field conditions, the maximum plant height was observed in Jalore Seedless and minimum plant height was recorded in Phule Arakta. The flowering was observed in Jalore Seedless, Bhagwa and Phule Arakta. In open field conditions, 20-30 fruits were retained on both the cultivars during mrig bahar. After one month of fruit setting, maximum (45%) fruits were found cracked in Phule Arakta while in Jalore Seedless cultivar, the cracking was 40 per cent. In other cultivars, flowering could not be initiated. The quantum of fruit cracking also increased as fruit development progressed. The sprinkling of the water during fruit development reduced the fruit cracking in Jalore Seedless and Phule Arakta. The close spacing plants of different cultivars also showed the same pattern of fruit cracking as it was observed in open field conditions. The experiment was terminated in 75 % shade net conditions since none of the cultivars flowered.

Response of growth hormones on fruit cracking in pomegranate cultivars

The application of NAA, GA_3 and Kinetin either as individual or in combinations with different doses have been applied in different pomegranate cultivars (Table 17 & 18). The results revealed the application of NAA through spray has reduced the extent of cracking while other hormones applications did not show any effect on pomegranate cracking in different cultivars. The application of 150 ppm NAA reduced the fruit cracking in Phule Arakta by 45 % and in Bhagwa by 42%,

Table 17. Spray schedule of growth hormones on pomegranate cultivars

Growth regulator	Chemical	Concen -tration (ppm)	Time of application
Auxin	NAA	100, 150, 200	Monthly
Gibberelin	GA3	100,150,200	Before flowering
Cytokinenis	Kinetin	100, 150, 200	Fruit set

Table 18. Effect of different growth hormones on fruit cracking in pomegranate

Hormone/concentration	% Fruit cracking		
	Bhagwa	Phule Arakta	Jalore Seedless
Auxin (NAA)			
100	46	50	55
150	42	48	52
200	40	48	52
Gibberelin (GA_3)			
100	62	65	70
150	60	62	70
200	60	64	70
Cytokinenis (Kitenin)			
100	58	55	68
150	55	55	65
200	55	55	65
Auxin (NAA) and Gibberelin (GA_3) and Cytokinenis (Kitenin)	50	52	55
100 + 100 + 100	40	48	55
150 + 150 + 150	40	48	55
200 + 200 + 200			
Control	65	70	75

while in Jalore Seedless the cracking was reduced to the tune of 20% only.

Response of micronutrients and secondary nutrients on fruit cracking in different cultivars of pomegranate

The spray schedules of zinc, boron, iron magnesium and calcium were deployed in different cultivars of pomegranate after 30 days of fruit setting and continued to 90 day. The results revealed that only application of boron reduced the fruit cracking by 30% in all cultivars while other nutrients did not show any impact on fruit cracking (Table 19).

Table 19. Effect of foliar application of secondary and micronutrients on fruit cracking in pomegranate

Secondary and micronutrients	% Fruit cracking		
	Bhagwa	Phule Arakta	Jalore Seedless
Calcium (%)			
0.10	65	70	75
0.20	65	70	75
0.30	65	70	75
Magnesium (%)			
0.10	62	65	65
0.20	65	70	65
0.30	62	65	65
Zinc (%)			
0.20	60	65	75
0.40	60	65	75
0.60	60	65	75
Iron (%)			
0.10	65	70	70
0.20	65	70	70
0.30	65	70	70
Boron (%)			
0.10	60	60	65
0.20	55	55	60
0.30	55	55	60
Control	65	70	75

Canopy Management

Jamun

Effect of pruning on fruit quality attributes of jamun

There were 3 levels of pruning intensity ie 25,50 and 75 % of annual extension growth and control. It was observed that pruning of 50 % annual extension growth after harvesting was effective to reduce the plant canopy and improvement in quality attributes. Maximum fruit weight (20.60 g) was recorded in 50 % pruning of annual extension growth, closely by 25 % pruning of annual extension growth. Topping of the main leader at 2.5 to 3.5 m height proved to be better to maintain ideal canopy under high density planting.

Planting Models

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 (Fig. 41 - 44).

There were 3 levels of pruning intensity i.e. 25, 50 and 75 % of annual

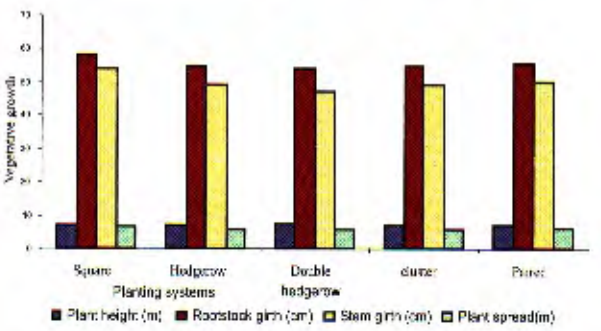


Fig. 41: Effect of planting system on vegetative growth.

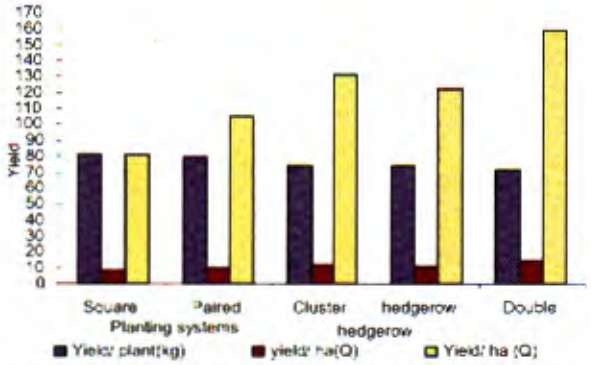


Fig. 42: Effect of planting system on yield of *Aonla*

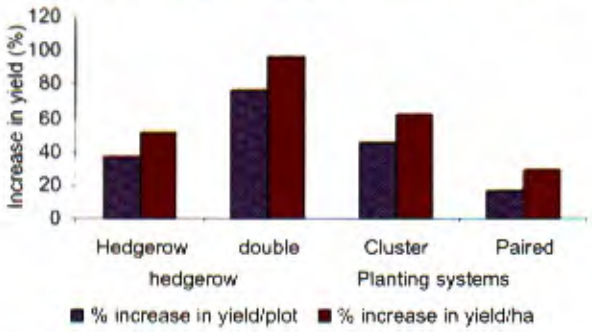


Fig. 43: Per cent increase in yield over square system.

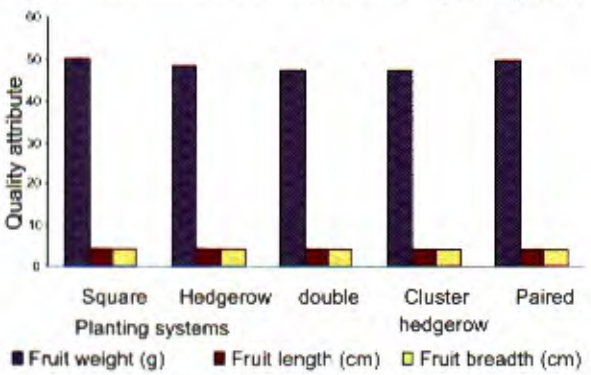


Fig. 44: Effect of planting system on fruit quality.

extension growth and control. It was observed that pruning to the tune of 50 % annual extension growth after harvesting was effective to reduce the plant canopy and improvement in quality attributes. Maximum fruit weight (20.60 g) was recorded in 50 % pruning of annual extension growth, closely by 25 % pruning of annual extension growth. Topping of the main leader at 2.5 to 3.5 m height proved to be better to maintain ideal canopy under high density planting.

Vegetative growth

Plant height was recorded significantly maximum (7.20 m) in double hedgerow planting system while it was recorded minimum in square system of planting (6.8 m). However, maximum values for rootstock girth (58.12 cm), scion girth (54.04 cm) and plant spread (6.58 m) were recorded in square system of planting and it was recorded minimum in hedgerow planting system. Study on nutrient status in the *aonla* shoots under various planting system revealed that the difference among various planting systems could not reach the level of significance.

Yield

Yield per plant (81.42 kg) was recorded highest in square system of planting by paired (78.97 kg), cluster (74.12 kg), hedgerow (73.95 kg) and double hedgerow planting system (71.84 kg), while yield per plot (14.36 q) was recorded in double hedgerow planting system by cluster (11.85 q), hedgerow (11.098 q), paired (9.49 q) and square (98.14 q). Yield per ha (159.48 q) was recorded the maximum in double hedgerow planting system by cluster (131.19 q), hedgerow (122.76 q), paired (105.03 q) and square (81.42 q). Yield per plot and per 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 (Fig. 44). Fruit weight (50.00 g), fruit length (4.22 cm), fruit breadth (4.32 cm) were recorded the maximum in the fruits of square system by paired, hedgerow and cluster, whereas it was recorded the minimum in double hedgerow planting system. The quality in terms of TSS (9.00 °B), total sugar (5.92 %) and vitamin C (503.00 mg/

Table 20. 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	2.06	1.03	8.00	5.48	2.17	165.20	484.75
Hedgerow	2.05	1.02	8.50	5.62	2.05	168.85	495.20
Double hedgerow	2.01	1.02	9.00	5.92	2.02	172.15	503.80
Cluster	2.04	1.02	8.50	5.68	2.05	169.68	490.23
Paired	2.05	1.01	8.00	5.52	2.11	165.12	488.00
C.D. at (5%)	NS	NS	0.50	0.21	NS	5.95	16.54

Table 21. ANOVA of planting densities on yield related parameters of drumstick

Parameters	D.F	Plant height (m)	Stem diameter (cm)	Number of branches per plant	Plant spread (m)		Number of fruits per plant	Avg. fruit length (cm)	Avg. fruit weight (cm)	Yield per plant (kg)	Yield per unit area (kg)
					E-W	N-S					
Block	3	0.07	0.53	0.24	0.07	0.11	128.9	4.02	29.74	3.65	1552.1
Treatment	4	1.61	5.88	2.04	0.23	0.76	898.4	14.27	84.65	21.9	8444.0
Error	12	0.03	2.00	0.14	0.09	0.06	116.9	1.57	31.82	3.11	700.4
Total	19	0.37	2.58	0.55	0.12	2.24	283.3	4.63	42.61	7.15	2465.1

100g) were recorded highest in double hedgerow system in all the evaluated planting systems (Table 20 & 21).

Crop regulation

Influence of different plant densities on yield of drumstick

In order to efficient utilization of natural resources such as space, five planting systems accommodating 20, 16, 15, 12 plants per unit area (10.5 x 10.5 m) in double hedge, hedge row, cluster planting, paired against control (square system) having 9 plants were attempted. A significant difference among the treatments was observed for growth parameters such as stem diameter and plant canopy. Square system of planting registered higher values for majority of parameters studied as compared to other high density treatments. Considering the fruit parameters, the highest average fruit weight and yield per tree was observed in square system (123.2g and 19.57 kg, respectively) as against the double hedge system which recorded the lowest value (110.3 g and 13.31 kg, respectively). However, cluster planting registered the highest pod yield per unit area (281.5 kg) followed by double hedge row (266.2 kg) against square system (176.1 kg) (Fig 45 & 46)..

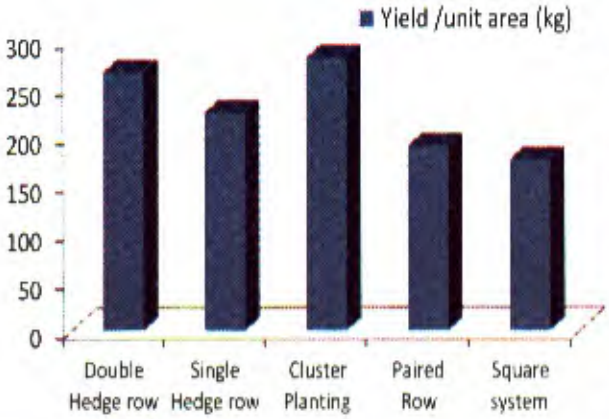


Fig. 45: Effect of planting system on yeild per unit area of Moringa (kg)

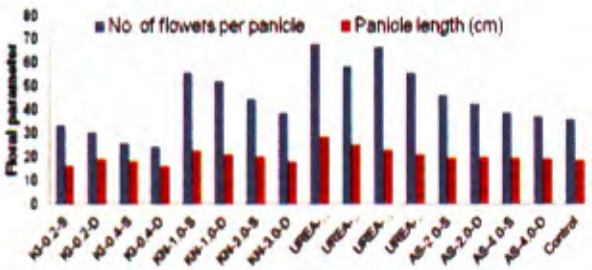


Fig. 46: Effect of chemicals on flowering parameters of Moringa

Cropping system

At Bikaner

Aonla based cropping system

Studies on growth and development of main and component crops

The experiment comprises of different cropping models such as *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-Karonda*-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 were recorded in already seven 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.

Plant height of *aonla* varied between 2.81 m in control to 4.14 m in model-3. The maximum plant height was observed in *khejri* i.e. 5.2 m (M-3) followed by *ber* 5.60 m (M-1), moringa 5.09 m (M-4), *bael* 2.60 m (M-2) and *karonda* 2.50 m (M-5). Stem girth varies in the order of *Khejri* 99.07 cm (control- 67.90 cm) > *ber* 84.52 cm (control-62.80 cm) > *aonla* 55.05 cm (control-34.62 cm)> *bael* 49.35 cm (control-31.75 cm) >moringa 34.62 cm (control-26.14 cm) > *karonda* 18.64 (control-15.81).

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, *methi* and cluster bean) was observed. This was further confirmed by laboratory assay through seed germination tests conducted on rhizospheric soils. However, slight inhibitory effect was recorded in *ajowain* on rhizospheric soils collected from moringa plants.

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*-

kinnow (50.7 kg per plant) followed by *aonla*-mulberry (45.3 kg/plant), *aonla-ber* (36.4) and *aonla-khejri* (36.8), while the lowest was recorded in *aonla*-moringa (35.1 kg/plant) (Fig. 47 - 50). 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 *karonda* was recorded up to 9.45 t/ha planted in between *aonla* plants. Likewise, the yield of *ber* cv. Seb was recorded to be 35.2 kg/plant in model M-1.

The yield of ground storey crops like mustard was recorded up to 4.74 q/ha in cropping model M-8, while in control 4.08 q/ha only. The higher yield in *aonla* based cropping model than in sole mustard crop could possibly be owed to synergistic effects of crop combination. The yield of sewan grass was recorded to be an average of 1.57 kg/m^2 on dry weight basis.

Fig. 47: Fruiting in *aonla* in *aonla-ber*-cluster bean-fennel (M-1) cropping model.

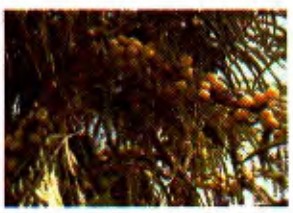


Fig. 48: Fruiting in *aonla* in *aonla-khejri*-cluster bean-*ajowain* (M-3) cropping model.

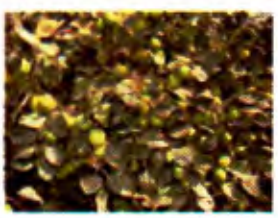


Fig. 49: Fruiting in *ber* in *aonla-ber*-cluster bean-fennel (M-1) cropping model.

Fig. 50: Fruiting in *karonda* as filler crop in *aonla-bael*-cluster bean-fennel (M-2) cropping model.

Physiological studies

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

Likewise, *karonda* leaves were observed to maintain the comparitively higher relative water content throughout the period under study followed by *khejri*, *aonla*, *bael*, and moringa while the lowest was noticed with *ber*. Likewise, with regard to the leaf water content, drumstick tree was observed to be highest while *aonla* tree the lowest.

Quality characteristics of *aonla* under different cropping systems

Aonla fruits were analysed for their quality characteristics like TSS, sugars, acidity, ascorbic acid, polyphenols, flavonoids, flavanols and total antioxidant activity. *Aonla* sole crop registered lowest contents for most of the parameters studied except TSS, acidity, and sugars. Not much variation was noted for different quality attributes in *aonla* among the various cropping systems. The total polyphenol, *o*-dihydric phenol, flavonoids and flavanols ranged from 54-57, 29-33, 147-218 and 13-14mg/100g, respectively in different cropping model systems.

At CHES, Vejalpur

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

Results of study on the *aonla* based cropping under rain fed conditions of hot semi-arid ecosystem revealed that the different types of intercrops (bottle gourd, bitter gourd, pumpkin, cucumber and sponge gourd) which

were sown in the interspaces left in between two rows of *aonla*, planted 10 m x 10 m during monsoon (2011) which were replicated four times in randomized block design. Economic analysis of *aonla* based cropping system revealed that maximum net return of Rs.68428.00 and Rs. 62990.00 was obtained in *aonla* + bottle gourd and *aonla* + pumpkin, respectively. B: C ratio was also recorded maximum in *aonla* + bottle gourd (2.19) by *aonla* + pumpkin (2.03) among the different inter crops tried under *aonla* based cropping system. The results indicate the *aonla*+ bottle gourd combination performed better in terms of yield / ha and net return under rainfed conditions of semi arid ecosystem.

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

Experiment was set on in randomized block designed which were 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 m X 10 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 rainfed conditions of semi-arid ecosystem. Growth pattern of the mango plants is satisfactory.

Organing farming

Effect of biofertilizers on *aonla*

A field experiment was conducted on *aonla* trees cv. NA-7, planted in 2003, and treatments were: T_1, standard dose of NPK, T_2, FYM + 50 % of recommended dose of NPK, T_3, FYM + *Azotobactor* + PSB, T_4, FYM + *Azospirillum* + PSB, T_5, FYM + *Azotobactor* + VAM, T_6, FYM + *Azospirillum* + VAM. Biofertlizers; *Azotobactor, Azospirillum*, PSB and VAM were applied @ 250g per tree/year soon after first rain during monsoon season. FYM @ 30 kg/tree and NPK @ 100, 75 and 50 g were applied during first year. The FYM @ 5 kg/ tree/ year and NPK doses were increased in same proportion every year. Thus, the dose of FYM was applied @ 75 kg per tree while chemical fertilizer *viz.* NPK were applied at the rate of 900, 675 and 450 g/ tree during 2011-12, respectively in two split doses (last week of June and first week of September).

Soil properties

Perusal of data indicated that the physico-chemical properties of soil were influenced significantly by use of different kind of sources of nutrients. 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 6.50, 6.60, 6.62 and 6.64 during 2011-12 with T_5, T_1, T_6 and T_4, respectively while pH of the basin soil was not influenced significantly with the application of NPK alone (T_1). The EC of the soil decreased from its initial value 0.13 dS m^{-1} to 0.11 and 0.10 dS m^{-1} being lowest in T_6, but the differences among the treatments were found to be non significant. In the tree basin, addition of farm yard manure and biofertlizers decreased the bulk density from its initial value 1.39 Mg m^{-3} to 1.23, 1.25, 1.26, 1.29 Mg m^{-3} in 2011-12 with T_5, T_3, T_4 and T_6, respectively, while bulk density was recorded maximum in T_1 (1.35 Mg m^{-3}). The organic carbon increased from its initial value 4.30 g kg^{-1} to 6.72, 6.55, 6.29, 6.25, 6.20 and 5.45g kg^{-1} in the treatment T_6, T_5, T_4, T_3, T_2 and T_1, respectively, which

were found to be 13.76 to 23.30 per cent increment from their initial value.

Available N was recorded maximum with the application of standard dose of NPK (T_1) followed by FYM+ 50 % of the standard dose of NPK (T_2), FYM + *Azotobactor* + VAM (T_6) and FYM + *Azotobactor* + PSB (T_3). Available P concentration increased from its initial value 11.00 kg per ha to 19.98, 18.00, 17.70, 16.82, 16.49 and 15.93 kg per ha with the treatments T_1, T_2, T_5, T_3, T_4, and T_6, respectively in 2011-12. The average increase in available K was observed the maximum in standard dose of NPK (T_1), whereas it increased from initial value 117.60 to 130.31, 125.25 and 122.87 kg per ha in T_1, T_2 and T_5, respectively.

Plant growth

The average annual extension of plant height (59.24 cm), rootstock girth (4.50 cm), scion girth (3.77 cm) and plant spread (47.85 cm) were recorded with T_1 followed by T_2, T_5 and T_3.The plant height (51.47cm), was recorded minimum in T_6 while root stock girth (3.25 cm), scion girth (2.84 cm) and plant spread (43.03 cm) were the minimum in T_4.

Yield

The mean yield per plant (68.45 kg), fruit weight (41.78 g), fruit length (4.05 cm) and fruit width (4.15 cm) were recorded maximum with standard dose of NPK (T_1) followed by FYM + 50 % of standard dose of NPK (T_2) and FYM + *Azotobactor* + VAM (T_5), while yield was recorded the minimum with T_4 (59.00 kg) followed by T_6 (61.13 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 was recorded 9.50 ^{0}B with the application of FYM + *Azotobactor* + VAM (T_5) followed by T_3, T_6 and T_4. However, treatments T_1, T_2, T_3 and T_6 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 (2.05 %) followed by T_3 (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 manure and fertilizers on mango cv. Kesar

A field experiment was conducted in mango cv. Kesar, planted in the year 2008 at 10x10m distance, The treatments were; T_1, Standard dose of NPK, T_2 FYM+ Standard dos of NPK, T_3 Neem cake + standard dose of NPK, T_4 Castor cake + standard dose of NPK, T_5 Std. dose of NPK + *Azotobacter* + PSB, T_6, FYM + std. dose of NPK + *Azotobacter* + PSB. T_7, Neem cake + standard dose of NPK + *Azotobacter* + PSB and T_8, Castor cake + standard dose of NPK+ *Azotobacter* + PSB. The dose of FYM was applied @ 20 kg and NP and K @ 300 g, 225 g and 225 g respectively whereas cakes were applied @ 3 kg per plant during 2011. 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 (1.9 m) was recorded in T_6 - FYM + std. dose of NPK + *Azotobacter* + PSB closely followed by T_8 - Castor cake + standard dose of NPK+ *Azotobacter* + PSB. Maximum TSS (20.40

°Brix) was also recorded in T_6, closely followed by T_8.

Organic farming in vegetables

In decomposition studies to prepare composts various leaves were inoculated and made compost. After 60 days the composts were sun dried and per cent decomposition was estimated. They were ranked according to their nature of decomposition. The composts which lost maximum organic matter was classified as easily decomposable and which lost less amount of organic matter was considered as more resistant for composting. *Pithacellobium dulce, subabul, neem, eucalyptus, tamarind* and *aonla* sapota, jamun, mahua and mango were in the decreasing order of their decomposable ability when powdered and whole leaves were decomposed maximum per cent of organic matter was decomposed in powdered samples when compared to whole leaves. There was no difference regarding inoculation of materials with micro organisms in long run. But initial stages more decomposition rate was noticed in inoculated composts. There was about 50% of organic matter loss during two months period in composts developed from dried powdered materials.

Integrated nutrient, soil and water management

Standardization of integrated nutrient management in arid horticultural crops

Effect of different INM treatments on microbial population

The microbial population consisting of bacteria, fungi and actinomycetes were measured at two soil depths (0 - 0.15 m and 0.15 – 0.30 m) in kinnow experimental orchard. Total microbial population were minimum (205 and 190 cfu $x10^4$ g^{-1} soil) in control treatments at both the depths. The maximum total population of microbes was in treatment comprising of RDF of NPK + FYM + PSB + *Azotobactor* + VAM which is followed in RDF of NPK +FYM +PSB + *Azotobactor* treatment. The data (Table 22)

Table 22. Effect of different INM treatments on microbial population (cfu $x10^4$ g^{-1} soil) in kinnow orchard

Treatments	0-15 cm depth				15-30 cm depth			
	Bacterial Population	Fungal population	Actinomycetes population	Total population	Bacterial Population	Fungal population	Actinomycetes population	Total population
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 NPK+ FYM	125	85	70	280	115	80	70	265
RDF of NPK+*Azotobactor*	120	65	55	240	120	60	50	230
RDF of NPK+ PSB	125	70	60	255	125	70	50	245
RDF of NPK+ VAM	110	100	75	285	110	110	75	295
RDF of NPK+FYM + *Azotobactor*	135	130	80	345	130	125	80	335
RDF of NPK+ FYM + PSB	130	125	80	335	125	120	75	320
RDF of NPK+ FYM + VAM	130	135	80	345	120	130	85	335
RDF of NPK+FYM +PSB + *Azotobactor*	140	145	85	370	135	140	80	355
RDF of NPK+ FYM + PSB + *Azotobactor* + VAM	140	150	85	375	135	140	80	355

revealed that addition of FYM has significantly increased the microbial population at both the depths. The microbial population was higher at upper horizon and lower in lower soil horizon.

The data presented in table 23 revealed that total microbial population was less in bael orchard in all INM treatments in comparison to kinnow orchard. The bael orchard was only 4 year old and received only small amount of FYM and biofertilizers. The soil remained dry for longer period due to high evaporation and congenial environment may not be available for microbial growth, however the pattern was

Table 23. Effect of different INM treatments on microbial population (cfu $x10^4$ g^{-1} soil) in bael orchard

Treatments	0-15 cm depth				15-30 cm depth			
	Bacterial population	Fungal population	Actinomycetes population	Total population	Bacterial population	Fungal population	Actinomycetes population	Total population
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

same as it was in kinnow orchard in respect of INM treatments.

Effect of different INM treatments on morphological parameter of kinnow

The data presented in table 24 revealed that maximum plant height (2.90 m) was recorded in RDF of NPK + FYM + PSB + *Azotobactor* + VAM treatment and minimum was in control (2.55 m). The pattern in plant height revealed that an 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 different 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 25 revealed that maximum fruit weight (255 g) was recorded in RDF of NPK + FYM + PSB + *Azotobactor* + VAM which was significantly at par with RDF of NPK + FYM + *Azotobactor* treatment. The minimum fruit weight was recorded in control treatment. The fruit yield was estimated and maximum fruit

Table 24. Effect of different INM treatments on morphological parameter of kinnow orchard (Average age of plant: 11 years)

Treatment	Tree height (m)	Tree Spread		Stem diameter (cm)
		N-S (m)	E-W (m)	45
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

Table 25. Effect of different INM treatments on yield and fruit quality paramenters of kinnow orchard (Average age of plant: 11 years)

Treatment	Fruit weight (g)	Fruit yield (t/ha)	TSS (°Brix)	Acidity (%)	Juice (%)
Control	135	45.00	9.50	0.80	42.00
RDF of N, P and K	185	75.00	10.00	0.75	48.00
RDF of N, P, K + FYM	235	85.00	11.00	0.75	50.00
RDF of N, P, K +Azotobactor	230	80.00	9.50	0.70	48.00
RDF of N, P, K + PSB	230	75.00	10.00	0.75	45.00
RDF of N, P, K + VAM	210	75.00	9.50	0.75	46.00
RDF of N, P, K +FYM + Azotobactor	245	95.00	11.00	0.70	50.00
RDF of N, P, K + FYM + PSB	240	85.00	11.00	0.70	52.00
RDF of N, P, K + FYM + VAM	230	85.00	11.00	0.70	52.00
RDF of N, P, K +FYM +PSB + Azotobactor	250	115.00	11.50	0.65	54.00
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	255	115.00	12.00	0.65	54.00

yield (115 t/ha) was recorded in RDF of NPK+ FYM + PSB + *Azotobactor* + VAM treatment and minimum yield was estimated in control treatment. The TSS was measured in mature fruits from all treatment and recorded in the range of 9.50 to 12.00 °B 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 42 to 54 percent and maximum juice (54 %)was recorded again in RDF of NPK+ FYM + PSB + *Azotobactor* + VAM treatment.

Effect of INM treatments on the status of macro and micro-nutrients of kinnow

The macro and micro-nutrient status was estimated in all INM treatments in kinnow leaf petiole. The data given in table 26 revealed that nitrogen contents varied from 2.30 to 2.65 % and maximum N content (2.65%) was recorded in RDF of NPK+ FYM + PSB + *Azotobactor* + VAM and minimum in control. The overall data revealed that addition of RDF of N, P and K increased the macronutrient status in the leaf petiole and addition of FYM increased the micronutrient status. The addition of *Azotobactor* biofertilizer increased

Table 26. Effect of INM treatments on the status of macro and micro-nutrients of kinnow

Treatments	Macronutrients (%)				Micronutrients (ppm)			
	Nitrogen	Phosphorus	Potassium	Calcium	Zinc	Manganese	Iron	Copper
Control	2.30	0.22	1.35	2.40	15.50	35.25	130.00	2.20
RDF of N, P and K	2.52	0.28	1.55	2.45	16.00	38.50	135.00	2.30
RDF of N, P, K + FYM	2.55	0.30	1.55	2.50	17.00	38.50	140.00	2.45
RDF of N, P, K +Azotobactor	2.55	0.30	1.55	2.50	16.50	39.00	140.00	2.50
RDF of N, P, K + PSB	2.55	0.35	1.50	2.50	17.00	38.50	145.00	2.50
RDF of N, P, K + VAM	2.50	0.35	1.55	2.45	17.50	40.00	150.00	2.50
RDF of N, P, K +FYM + Azotobactor	2.60	0.35	1.60	2.55	18.00	40.00	150.00	2.60
RDF of N, P, K + FYM + PSB	2.55	0.35	1.55	2.55	18.00	38.50	155.00	2.60
RDF of N, P, K + FYM + VAM	2.55	0.35	1.55	2.50	18.00	39.00	160.00	2.65
RDF of N, P, K +FYM +PSB + Azotobactor	2.60	0.40	1.60	2.70	18.50	39.00	155.00	2.65
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	2.65	0.40	1.65	2.70	19.00	38.50	160.00	2.70

the status of nitrogen in the petiole. The phosphorus content ranged from 0.22 to 0.40 % and PSB and VAM also increased the P status in the leaf tissues over addition of RD of phosphorus. The potassium and calcium contents were estimated in the range of 1.35 to 1.65 and 2.40 to 2.70 percent, respectively.

The micronutrient status in the leaf tissues was also recorded in kinnow under INM treatments. The data revealed that the zinc and manganese contents were recorded in the range of 15.50 to 19.00 and 35.25 to 40.00 ppm, respectively. Likewise iron and copper contents were measured to the tune of 130-

160 and 2.20 to 2.70 ppm. Overall pattern of micronutrients revealed that an addition of FYM increased the status in leaf tissues. It has also been observed that none of the samples were poor in the nutrient status.

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 27. The data revealed that maximum plant height (1.00 m) was recorded in RDF of NPK+FYM +PSB + *Azotobactor* and RDF of NPK+ 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.

At Godhra

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

Table 27. 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)	12
Control	0.60	0.20	0.20	15
RDF of N, P and K	0.80	0.25	0.20	15
RDF of N, P, K + FYM	0.80	0.20	0.20	14
RDF of N, P, K +Azotobactor	0.80	0.25	0.25	15
RDF of N, P, K + PSB	0.75	0.20	0.25	15
RDF of N, P, K + VAM	0.75	0.20	0.20	15
RDF of N, P, K +FYM + Azotobactor	0.85	0.25	0.30	18
RDF of N, P, K + FYM + PSB	0.85	0.30	0.25	15
RDF of N, P, K + FYM + VAM	0.80	0.25	0.25	15
RDF of N, P, K +FYM +PSB + Azotobactor	1.00	0.30	0.25	20
RDF of N, P, K + FYM + PSB + Azotobactor + VAM	1.00	0.30	0.30	20

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 (1.20 Mg m^{-3}) and it was highest in no mulch condition (1.39 Mg m^{-3}) by black polythene (1.37 Mg m^{-3}) rice husk (1.32 Mg m^{-3}). Significant differences could not be observed in between maize straw, grasses and *subabul* loppings in respect to bulk density. Hydraulic conductivity was recorded highest in paddy straw mulch (0.50 cm/ h) by maize straw (0.48 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 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 (19.12-28.14 %) closely by paddy straw (18.87 - 27.83 %) and it was recorded lowest under control (13.00 - 18.79 %) at 0 - 15 cm from soil surface. Among the organic mulches tried, paddy straw showed better response by maize straw and *Subabul* loppings.

Soil temperature

Different 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 – 29 °C in paddy straw while it was recorded 17.0 - 33.00 °C in control at 20 cm depth from soil surface (October-June).

Soil microbial population

Results of study revealed that the microbial population was improved by the application of mulches. Bacterial population was recorded highest in paddy straw mulch (119745) followed by maize straw (101260) and it was least in black polythene (25545). Actinomycetes population was recorded maximum in black polythene (76210) followed by paddy straw (70340) and it was recorded lowest in number in *Subabool* lopping (9741). Fungal population was recorded maximum in paddy straw (32305) followed by maize straw mulch (2623) and grasses (21263) while minimum was recorded in black polythene mulch (8940) in the month of October, 2011.

Vegetative growth

Vegetative growth was influenced significantly by application of different mulches. Plant height (7.05 m), root stock girth (54.87 cm) and scion girth (48.92 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 6.00 m, 54.10 cm and 48.25 cm with black polythene mulch, respectively. Differences among grasses, *Subabool* loppings and maize straw were found to be at par with respect to vegetative growth.

***Aonla* shoots (nutrient concentration)**

Nutrient concentration in *aonla* shoots was influenced considerably by the application of different mulches in tree basin. Nitrogen content was recorded highest in the plant treated with paddy straw mulch (2.88%) and it was recorded the minimum under control (2.25%). Similar trend was also observed with respect to P and K content in *aonla* shoots.

Calcium, magnesium and sulphur were recorded highest *i.e.* 1.49, 0.83 and 0.36 per cent, respectively, in the plants treated with paddy straw mulch followed by maize straw and it was recorded the minimum in control (no mulch condition), but the differences among the various types of mulches could not reach the level of significance.

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, 2011.

Yield

Average yield per plant (87.48 kg) was recorded maximum in paddy straw mulch followed by black polythene (85.60 kg), maize straw mulch (84.00 kg), grasses (80.37 kg) and rice husk (79.30 kg) and it was recorded lowest in control (76.29 kg) under rainfed conditions of hot semi-arid ecosystem.

Quality attributes

The fruit weight (49.00 g), fruit length (4.17 cm) and fruit breadth (4.28 cm) were recorded highest from the trees which were mulched with paddy straw closely followed by black polythene and maize straw, and minimum was recorded in control (weight 44.87 g, length 4.00 cm and breadth 4.18 cm). The quality in terms of TSS (9.50 ^{0}Brix), total sugar (6.00 %) and vitamin C (510 mg/ g) were recorded highest with paddy straw mulch and these parameters were recorded lowest in control.

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 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 19.60 -14.70, 20.10-16.20% in paddy straw and it was recorded 14.70-11.90, 15.90-13.20 % 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 black polythene followed by paddy straw mulch while minimum was observed in control.

Fruit yield and quality attributes

Plants treated with black polythene mulch recorded highest yield (65.10 kg/ plant), followed by paddy straw (53.40 kg/plant) and it was recorded minimum in control (42.50 kg/

plant). Maximum TSS (20.20 °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 plant growth and fruit yield (7.20 kg/ plant) was recorded in black polythene mulch followed by paddy straw mulch. Minimum fruit yield (4.00 kg/ plant) was recorded under control (no mulch).

Integrated nutrient management in vegetable crops

An experiment on integrated nutrient management was initiated in the year 2011 with chemical fertilizers, organic manures and biofertilizers. The organic manures were FYM, compost and vermi compost. In one treatment only chemical fertilizer was applied. In three treatments 50% N was applied in inorganic form and rest of the N was applied in form of organic manures namely FYM, compost and vermi compost. In other three treatments 50% N was applied through chemical fertilizer, 25% N was applied through organic form (FYM, compost, Vermi compost) and rest applied through biofertilizer (*Azatobacter*). One treatment was kept without any fertilizer or manure. In all, 50 kg P and 50 kg K per ha was applied. Brinjal and tomato were taken as test crops and randomized block design was with three replications.

In brinjal, among different treatments, the maximum yield (36.1 t/ha) was obtained in the treatment which received 50% N as chemical fertilizer and 25% N through FYM and 25% N through biofertilizer followed by the treatment which received 50% N and 25% N through compost and 25% N through biofertilizer. Minimum yield (17.5 t/ha) was obtained in control. Significant yield improvement was obtained in treatments which received organic manures than complete chemical fertilizer (26.5 t/ha). However the yields were further increased when biofertilizer was added in combination with organic manures.

In tomato also similar trend was observed and maximum yield (54.2 t/ha) was obtained in the treatment which received 50% N as chemical fertilizer and 25% N through FYM and 25% N through biofertilizer followed by the treatment which received 50% N and 25% N through compost and 25% N through biofertilizer. Lowest yield (13.8 t/ha) was obtained in control.

The leaf, stem and fruit samples of brinjal have been analyzed for their nutrient content. The nitrogen content of leaf ranged from 3.12% to 4.05%, stem ranged from 0.95% to 1.65%, fruit ranged from 2.38% to 3.56%. The phosphorous content of leaf ranged from 0.13% to 0.18%, stem ranged from 0.038% to 0.052%, fruit ranged from 0.32% to 0.52 %. The potassium content of leaf ranged from 0.612% to 0.972%, stem ranged from 0.38% to 0.73%, fruit ranged from 1.28% to 1.72%. The calcium content of leaf ranged from 2.63% to 3.61%, stem ranged from 0.32% to 0.79%, fruit ranged from 0.28% to 0.52%. The magnesium content of leaf ranged from 0.68% to 1.68%, stem ranged from 0.39% to 0.97%, fruit ranged from 0.82% to 1.65%. The sulphur content of leaf ranged from 0.22% to 0.53%, stem ranged from 0.03% to 0.09%, fruit ranged from 0.36% to 0.84%.

The leaf, stem and fruit samples of tomato have been analyzed for their nutrient content. The nitrogen content of leaf ranged from1.72% to 3.92%, stem ranged from 0.68%

to 2.15%, fruit ranged from 1.96% to 4.17%. The phosphorous content of leaf ranged from 0.1% to 0.45%, stem ranged from 0.04% to 0.1%, fruit ranged from 0.17% to 0.65%. The potassium content of leaf ranged from 0.74% to 2.18%, stem ranged from 0.43% to 0.76%, fruit ranged from 1.58% to 2.68%. The calcium content of leaf ranged from1.05% to 3.91%, stem ranged from 0.82% to 2.16%, fruit ranged from 0.59% to 1.38%. The magnesium content of leaf ranged from 0.92% to 1.89%, stem ranged from 0.69% to 1.98%, fruit ranged from 0.33% to 0.84%. The sulphur content of leaf ranged from 0.17% to 2.08%, stem ranged from 0.1% to 0.18%, fruit ranged from 0.19 % to 0.59 %.

Effect of irrigation schedule on growth, yield and quality for off-season production of drumstick

The impact of soil moisture at harvesting stage on yield was assessed as the fruit set after February won't reach to the marketable size, despite of heavy setting, due to shortage of moisture for pod development. A highly significant difference among the treatments was observed for majority of the characters studied. The results indicated that the highest plant height, shoot length, plant spread, floral and fruiting parameters was observed in regular irrigation at 20 days interval. However, irrigation at each stage such as, branching, flowering and fruit setting and its combination stages showed significant impact on yield. Irrigation at fruit setting stage (27.5 kg) alone reduced yield loss per plant significantly as compared to regular irrigation (37.6 kg). Where as the lowest total yield per tree was observed in un-irrigated plant (13.5 kg) indicating there was almost three fold yield reduction in rain fed crop (Fig. 51).

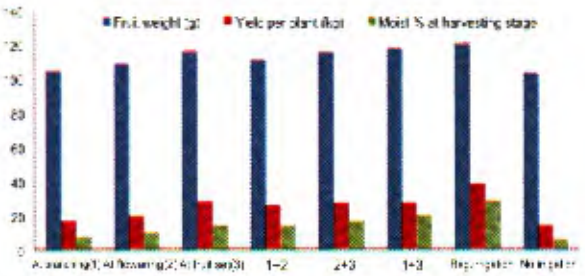


Fig. 51: Effect of irrigation on yield parameter of Moringa

Drip Irrigation

Studies on drip irrigation in *aonla*

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 the height of plant (0.50 m) was recorded from the plants which were irrigated at alternate day with 60 per cent wetted area. The annual increase in stem girth (2.00 cm) and plant spread (E-W- 0.45 m and N-S-0.42 m) were also observed maximum under the same treatment. Plants irrigated at alternate day with 60 per cent wetted area had also the highest percentage of N (2.75), P (0.29), K (0.93), Ca (1.37), Mg (0.79) and S (0.34) in the *aonla* shoots, whereas nutrient concentration in *aonla* shoots were recorded lowest under control.

Yield

Yield per plant (92.40 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 (75.93 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 (52.00 g), fruit length (4.30 cm), fruit width (4.40 cm) were recorded maximum from the plants irrigated at alternate day with 60 per cent wetted area. The quality in terms of TSS (8.00 ^{0}Brix), total sugar (5.70 %) and vitamin C (510.00 mg/ 100 g) were recorded highest in the fruits of alternate day irrigation with 60 per cent wetted area.

Crop physiology

To study the effect of priming treatment on growth and development of water melon seeds

An experiment was conducted to study the effect of priming treatment on the growth and development of water melon seeds. The seeds of water melon were given the priming treatment with 5, 10 and 15% solutions of KNO_3 and NaCl; 15, 20 and 30% solution of KH_2PO_4 and PEG for 1 to 7 days. The seeds were dried and stored at room temperature for 7 days. Subsequently, the seeds were germinated in distilled water and parameters such as germination percentage, seedling weight, time to 50% germination, germination index, mean germination time and seedling vigour were calculated. The data revealed that maximum seedling vigour was recorded with treatment KH_2PO_4 (20% for 5 days). This was followed by KNO_3 (10% for 1 day).

The results with respect to germination percentage revealed that maximum germination (90%) was recorded with treatment KH_2PO_4 (30% for 7 days) followed by 80% in treatments NaCl (5% for 3 days), NaCl (15% for 1 day), KNO_3 (10% for 1 day), KH_2PO_4 (15% for 1 day), PEG (15% for 5 days).

The minimum time to achieve 50% germination (1 day) was achieved with treatment KNO_3 (5% for 5 days) and PEG (20% for 3 days). This was followed (1.33 days) by PEG (30% for 5 days).

The data on germination index revealed that maximum germination index (>11.00) was observed with the treatments PEG 15% for 3 days and KNO_3 (5%) for 5 days. This was followed by treatment PEG 15% for 3 days with a value of 10.33.

Germination of water melon primed seeds under moderate water stress

The primed seeds of water melon were stored for 7 days and after that the seeds were germinated under moderate water stress developed by using 0.2 MPa PEG solutions. The data on germination percentage, seedling vigour and seedling biomass showed that seeds primed with at 10 days after sowing, the seeds primed with KNO_3 (5%) for 5 days gave the best performance.

Osmo-priming of musk melon seeds

An experiment was conducted to study the effect of priming treatment on the growth and development of muskmelon seeds. The seeds of muskmelon were given the priming treatment with KNO_3, KH_2PO_4 and NaCl treatment ranging from 24 hrs to 96 hrs. The seeds were then air dried and stored at room

temperature for 7 and 21 days. The seeds were then sown in water and data on final germination percentage, seedling weight, time of 50% germination, germination index and seedling vigour were recorded.

Perusal of data for seeds stored for 7 days revealed that maximum germination percentage (100%) was recorded with treatments KNO_3 1% for 1 day, KNO_3 15% for 1 & 3 days, KNO_3 5% for 3 days. This was followed by 90% germination of seeds under treatments KH_2PO_4 15% for 5 days, PEG 15% for 1 & 7 days, PEG 20% for 5 days, KNO_3 5% for 5 & 7 days, NaCl 10% for 1 & 7 days. In muskmelon primed with different agents gave good response and the germination percentage improved from 60% in control to more that 80% in treatments.

The data with respect to seedling dry weight revealed that maximum seedling dry weight (32.50 mg) was recorded in KNO_3 15% for 7 days followed by KH_2PO_4 1% for 5 days (28.25 mg) as compared to control which recorded 21.57 mg. The results revealed that priming improved the seedling weight in musk melon.

The data on time for 50% germination revealed that the minimum time for 50% germination (<2.5 days) was recorded in KH_2PO_4 1% for 1 day, PEG 15% for 67 days, PEG 20% for 3 days and PEG 20% for 7 days as compared to control which recorded time for 50% germination as 4.20 days. The above treatments also gave good results with respect to mean germination time and seedling vigour also.

The data on seeds stored for 21 days also revealed that 100% germination was recorded with treatments KH_2PO_4 15% for 5 days, KH_2PO_4 30% for 1 day, PEG 20% for 1 & 3 days, KNO_3 5% for 5 & 7 days, KNO_3 15% for 3 days, NaCl 5% for 1 day and NaCl 10% for 1 day. Similarly, w.r.t. seedling dry weight, the magnitude of seedling dry weight recorded in control was 18.46 mg. In comparison to this, the treatments KH_2PO_4 5% for 5 & 7 days, KH_2PO_4 10% for 5 & 7 days, KH_2PO_4 20% for 5 & 7 days, PEG 1% for 5 & 7 days, PEG 10% for 5 & 7 days, KNO_3 10% for 5 & 7 days, KNO_3 15% for 5 & 7 days, NaCl 1% for 7 days, gave better seedling dry weight than control. Similarly, for other parameters too, the above named treatments gave better performance as compared to control.

To develop ameliorating agents for frost

Frost is becoming the major constraint for production of horticultural crops in arid region. Thus, to ameliorate the effect of frost, various treatments such as 1% solutions each of thiourea, sulphuric acid, salicylic acid and KNO_3 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 and pomegranate, the damage was reduced by spraying 1% sulphuric acid and Thiourea.

Molecular characterization

Bael

DNA isolation and standardization of primers for bael cultivars

The DNA was extracted from a total of 10 cultivars/ germplasm lines of bael. These were Pant Urvashi, Pant Aparna, Pant Shivani,

Pant Sujata, Dhararoad, NB 5, NB 7, NB 9, Local 1 and Local 2. The DNA isolated from these cultivars was subjected to PCR amplification using (i) Master mix, (ii) Green master mix and (iii) PCR mixture prepared by mixing ingredients. It was observed that the use of Master mix gave the best results as far as amplification of DNA fragments is concerned.

Attempts were also made to evaluate the Primers which give best amplification with bael DNA. A total of 30 primers were tested and it was found that primers OPD 3, OPD 5, OPD 8, OPD 11, OPD 13, OPD 16, OPD 18 and OPD 20 gave best results.

Date palm

Identification of RAPD primers for date palm

The PCR procedure for amplification of DNA fragments was standardized during the period under report. A total of 20 primers of OPF were tested for polymorphism using DNA with 5 cultivars as test material. It was observed that in all the five cultivars, OPF 3, OPF 4, OPF 5, OPF 6 and OPF 7 gave best results. The DNA of a total of 38 cultivars of date palm has been extracted and development of polymorphic bands using above primers is in progress.

Biotechnology

Somatic emergence in fruit tissue

Explants consisting immature fruit tissues of Halawy, Khalas, Khuneizi and Medjool cultivars were collected from the field gene bank of CIAH and Date Palm Research Station, SKRAU, Bikaner. The explants were prepared and transferred to different media composition having MS medium containing different additives and different combinations of plant growth regulators such as 2,4-D + BA. Later these explants were subjected for sub-culturing on the same media at 3 week intervals for callus initiation (Fig. 52) and embryogenesis. The explants were incubated in dark. After three months of incubation, in some explants of Halawy cultivar cell dissociation at the mesocarp tissue was observed. In other cultivars, there was no such dissociation were observed. Even, after six months of culture a varied level of endophyte bacterial contamination was recorded in all the cultivars whereas the intensity of endophyte contamination was less in Halawy cultivar.

Fig. 52: Callus induction in fruit tissues

Among the cultivars undertaken for study the callus formation has been observed in cultivars, Halawy and Khuneizi. However, during this long culture period the emergence of endophyte contamination was also noted to cause serious damage to the explants. The overall frequency of callus initiation was obtained less than five per cent. The callus obtained under the study was subjected for new media composition for conversion into embryogenic condition.

Studies on callus induction in leaf explants

Based on the earlier success observed in callus induction and embryogenesis in leaf explants, the experiments were laid down to study the callus induction in leaf explants of

four cultivars namely, Halawy, Khalas, Khuneizi and Medjool. The source of leaf explants were unopened leaves from the 2-3 year old suckers attached to mother plant. The leaf explants were taken without destroying the shoot of the attached suckers of mother stock plants. Several factors such as size of explants, incubation conditions (dark and light & dark), different combinations of 2,4-D (0-10 mg/L) and BA (0-5 mg/L) were attempted. Simultaneously, primary study was also initiated on the control of tissue and media browning with leaf explants using different anti-oxidants such as citric acid, ascorbic acid and adsorbents such as PVP and activated charcoal. Among different combinations, the addition of citric acid (100 mg/L) + ascorbic acid (150 mg/L) + PVP (75 mg/L) to the media was found effective. Likewise, the activated charcoal (1.5-3.0 g/L) was found effective to control browning of tissue and media. The experiments are in progress by sub-culturing at four week interval.

During the culture period of three months no browning in leaf explants was noticed when the culture were incubated in completely dark or photoperiod of 16h light and 8 h dark. However, it was noticed that the activated charcoal is essential for tissue health and viability. Cultures are continuously sub-culturing at three to four week intervals on the same media. The occurrence of endophyte contamination was found less as compared to fruit tissue explants.

Studies on rooting in micro-shoots

The large quantity of micro-shoots obtained from earlier study of embryogenesis and organogenesis which were tried for root formation. However, a serious decline in cultures was recorded. During the review meeting of the project, the reason of decline of cultures were discussed in detail and again the cultures were subjected for higher concentration of auxin and different conditions of media (liquid or solid) and status of endophyte contamination. The cultures were subjected for revival and induction of rooting in liquid culture with 0.5 mg/L and 1.0 mg/L NAA. The number of roots substantially increased on the concentration of 0.5 mg/L. The rooted plants were transferred to pots for further evaluation on growth and development.

In order to standardize optimum concentration of auxin for better shoot and root development in the embryos, the study was undertaken with zygotic embryos of Halawy cultivar. Different concentration of NAA (0.0, 0.1 and 1.0 mg/L) were tried (Fig. 53-55). The better shoot and root growth was recorded with 0.1 NAA concentration whereas higher

Fig. 53: Root formation in date palm plants on MS medium + 0.1 mg NAA

Fig. 54: Multiple shoot induction in somatic embryogenesis derived plantlet

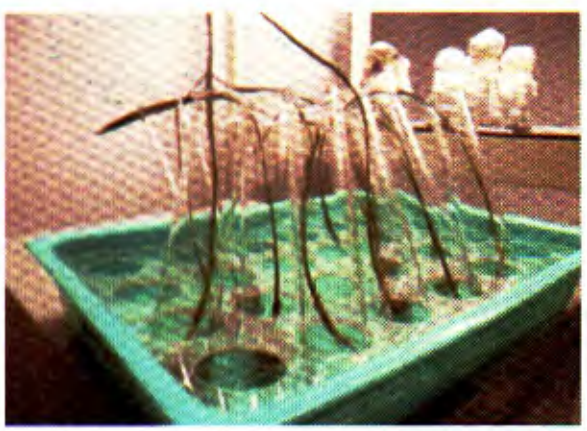


Fig. 55: In vitro hardening of plantlets in liquid media containing ½ strength of MS media with different concentration of NAA + 300 mg activated charcoal

concentration of NAA found to enhance root growth but observed detrimental to shoot growth. These results will be tried with somatic embryo germination studies.

Lasoda

Morphological and molecular diversity of lasoda (*Cordia myxa* Roxb.) germplasm from the arid region of Rajasthan

Morphological characterization of twenty two germplasm accessions of *Cordia myxa* of ten-year-old trees for 17 traits indicated wide variations among the accessions tested. Higher number of flowers per cyme was found in accession ACHM11 and higher pulp:stone ratio in AHCM25. Overall, AHCM22 was found to be a superior genotype for most of the horticulturally useful traits as it had higher percent of fruit set, pulp:stone ratio and fruit weight. High significant positive correlation was obtained between leaf, fruit characters and pulp:stone ratio. However, these characters were found to be negatively correlated with number of flowers per cyme. Out of 50 RAPD primers, 25 were polymorphic. Average polymorphism among these accessions was 69.8 % with an average PIC of 0.43. Genetic diversity revealed by Jaccard's co-efficient was between 0.44 and 0.94, and three major clusters were identified. RAPD markers associated with leaf size and pulp:stone ratio were also identified. This study shows the existence of high genetic diversity among these accessions based on DNA marker in *C. myxa* (Fig. 56 a & b).

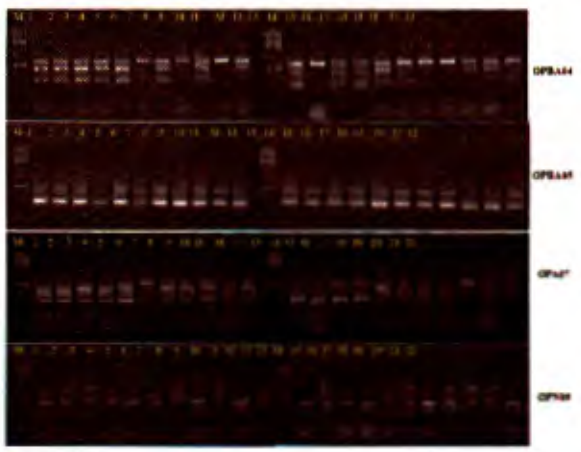


Fig. 56: (a)

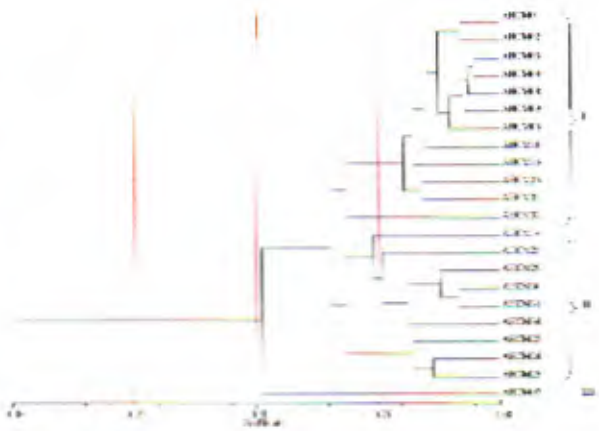


Fig. 56 (b)

Fig. 56: (a) Polymorphism among the twenty two accessions of *C. myxa* germplasm revealed by RAPD primers. Lane M- 1kb DNA ladder; lane1- AHCM01; lane 2- AHCM02; lane 3- AHCM03; lane 4- AHCM04; lane 5- AHCM06; lane 6- AHCM07; lane 7- AHCM08; lane 8- AHCM09; lane 9- AHCM11; lane 10- AHCM14; lane 11- AHCM16; lane 12- AHCM22; lane 13- AHCM23; lane 14- AHCM24; lane 15- AHCM25; lane 16- AHCM26; lane 17- AHCM29; lane 18- AHCM30; lane 19- AHCM31; lane 20- AHCM32; lane 21- AHCM33; lane 22- AHCM34

Fig. 56 (b) Phylogenetic tree constructed based on twenty two accessions of *C. myxa* germplasm analysed by RAPD primers by UPGMA method and Jaccard's similarity coefficient using NTSYSpc-2.02e version 2.0.1.5 software. Vertical distance is arbitrary and horizontal distance indicates genetic distance. Clusters / groups among twenty two genotypes are indicated by Roman letter.

In vitro clonal propagation of lasora (*Cordia myxa* Roxb.)

A protocol for *in vitro* propagation of *lasora* (*Cordia myxa Roxb.*) has been standardized using nodal segments. Single node cuttings, prepared from the new growth, were cultured on MS medium supplemented with 1.0, 2.0, 3.0 and 4.0 mg/l kinetin in combination with 0.01 mg/l NAA. The best response was observed with 4.0 mg/l kinetin. The regenerated shoots from shoot buds were separated aseptically and; thereafter, transferred to the rooting medium containing NAA and IBA along with 750 mg/l charcoal. Of the different combinations, medium supplemented with 2.0 mg/l each of IBA and NAA in combination with charcoal found superior over the other hormonal combinations with regards to rooting response. Later, rooted plantlets were successfully acclimatized under polyhouse conditions (Fig. 57).

Fig. 57: Different stages of *in vitro* propagation of *lasora*.

Post harvest management and value addition in arid horticultural crops

Date Biscuits

The date palm fruits of cv. Sedami were dried after cutting into pieces for making powder. Date pulp powder @ 10, 20 and 30 per cent was mixed with wheat flour for biscuit making. Biscuits were prepared in local bakery by adding pulp powder in ratio of 10, 20 and 30 per cent in wheat flour along with other ingredients like sugar, milk and ghee. Organoleptic score indicated that biscuits prepared from adding date pulp powder @10 per cent were suitable from taste, flavor, appearance, and acceptability point of view. The biscuits were kept up to 60 days in air tight glass jar under room temperature without any major change.

Date squash (DATIKA)

The doka stage fruits, which are astringent in taste, unfit for dry date, soft date (*pind khajoor*) preparation can be successfully utilized for the preparation of delicious drink.

Fruits were washed in water after sorting green, over ripe and infected berries and then they were cut in to halves for removal of seed and extraction of juice. Seeds were removed manually. The fruit pieces were boiled with water in pressure cooker for 6-8 minutes and filter using muslin cloth. Sugar 300 g per liter of extracted juice was added to maintain TSS (38 °Brix). The squash was prepared during last week of July and filled in clean sterilized bottle and kept in lab. A total of three treatments *viz.*, T_1-Date Squash, T_2-Squash added with 5g of ginger extract per litter of juice and T_3 added with preservative KMS (500 ppm) was made for further sensory evaluation. All the bottles of three treatments were kept under refrigerator conditions. One set of 100 ml was kept under room temperature to see the storage life. Organoleptic score revealed that squash can be prepared from doka stage fruits and utilized up to 30 days of storage under refrigerator. However, it fermented after

4 -5 days of storage under room temperature condition.

Value addition in semiarid fruits

Different product recipes have been standardized amongst them are solar dried *aonla* shreds treated with different salt concentrations, candy making in ber, *aonla*. Analysis of data of *aonla* shreds treated with different salt concentration ranging from 2 to 30 percent and storage at ambient temperature up to one year indicated that solar drying of *aonla* shreds after treating them with salt increased concentration of salt resulted in increased percent dry weight. It increased from 13.6 % in 2% salt treated shreds to 32% in 30 % salt treatment. pH was found to be non significantly influenced by salt concentration even after ambient storage for one year. 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 /100 g in 2 percent salt treated shreds to 94.13 g/ 100 g in 30 percent salt treated shreds indicating that as the concentration of salt increased ascorbic acid content of *aonla* shreds decreased. *Aonla* shreds treating them with 2 % salt helped in higher retention of ascorbic acid and acidity. Dry weight of the product increased with increasing salt concentration. In ber solar dried fruits of cv. Goma Kirti retained better vitamin C, sugar and minerals as compared to sun dried. Similarly in *aonla* candy after one year of storage, there was reduction in vitamin C content but retained sufficient amount for daily requirement of ascorbic acid.

Plant health management

Disease management

At Bikaner

Integrated disease management of cucurbits (watermelon and bottle gourd) and pomegranate under arid zone of Rajasthan

The field trials were conducted for screening of 14 watermelon genotypes viz., RW-177-3, RW-187-2, GP- 42, GP- 35, GP-20, Thar Manak, AHW- 19, AHW- 65, Durgapura Lal, Asahi Yamato, Sugar Baby, Arka Manak, Bikaner Local-1 and Barmer Local-1 and 17 bottle gourd genotypes such as Pusa Naveen, Pusa Samridhi, Udaipur Local, Pusa Santushti, Pusa Sandesh, PSPL, Chomu Local, Azad Harit, Panchmahal Local, Arka Bahar, Thar Samridhi, PN-22, DBG-5, DBG-6, Jodhpur Local, IC-567538 and Sriganganagar Local against diseases under natural conditions with normal cultivation practices during 2011. Out of 14 watermelon genotypes, none was found immune against mosaic and shoe-string diseases. Among watermelon genotypes, incidence of mosaic and shoe-string disease (Fig. 58 & 59) was found from 6.67 to 33.33% and 5.26 to 25.0%, respectively. Minimum incidence (6.67%) of mosaic disease and shoe-string (5.26 and 6.67% incidence) was found in variety 'Asahi

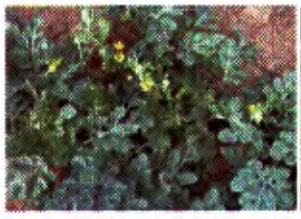


Fig. 58: Mosaic symptoms of watermelon

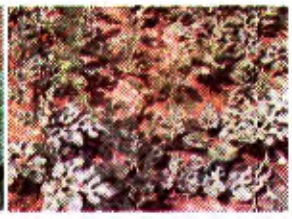


Fig. 59: Shoe-string symptoms of watermelon

Yamato' and 'Arka Manak' as well as 'Asahi Yamato', respectively.

Likewise, of 17 bottle gourd genotypes, none was found immune against *Alternaria* leaf blight, *Cercospora* leaf spot and powdery mildew diseases. Disease severity of *Alternaria* leaf blight in bottle gourd was found from 5.25 to 28.75% (Fig. 60). Disease severity of *Cercospora* leaf spot was recorded between 6.70 to 39.25%. Only 04 varieties *viz.*, Pusa Naveen, Pusa Santushti, Pusa Samridhi and Pusa Sandesh against this disease showed resistance with disease severity of 6.70%, 7.50%, 8.50% and 9.75%, respectively. Minimum disease severity (17%) of powdery mildew was also found in variety Pusa Naveen, followed by Pusa Santushti (22.0% disease severity) while maximum disease severity (58.5%) of powdery mildew was recorded in genotype 'Chomu Local', followed by variety 'Thar Samridhi' (39.5% disease severity).

Fig. 60: *Alternaria* leaf blight symptoms

Exploitation of PGPR for disease suppression, growth promotion and field establishment of planting material of arid fruit and vegetable crops

Fifteen cultures of PGPR (Plant Growth Promotion Rhizobacteria) were maintained by sub-culturing at one month interval on the King's B medium at Pathology laboratory of this Institute.

At Godhra

Powdery mildew of ber

The disease is caused by *Oidium ziziphi* fungus. This year, the disease appeared almost 4 weeks late i.e. in the middle of October, and its peak period was during November to first week of December. The symptoms were noticed on young leaves, inflorescence, and fruits, the pea size fruits were most susceptible. The disease was found to survive on collateral hosts, bud wood and on mite induced galls in various *Ziziphus* spp. including *Z.mauritiana. Z.rotundifolia, Z.nummularia and Z.glabra.*

Genetic Resistance against powdery mildew

The observations were recorded twice during the season at one month interval (in first week of November and first week of December). All the commercial cultivars were susceptible and recorded high disease incidence (Gola with PDI = 48.22, Umran PDI=61.5, Seb 39.2). But plants in the orchard developed from seedlings recorded low disease incidence (PDI= 2.55 to 25.33). BS-1 (Bawal Sel-1) recorded 12.12 to 21.27 mean PDI. Some highly susceptible local plants in the same vicinity recorded PDI above 60.0. But other resistant types showed low disease incidence. Two superior plant types were identified. These plants have low disease incidence and desirable fruit quality. One genotype bore fruits which had high TSS (18-22 °Bricks) with good fruit weight (12.49 g), size and flavour. Another genotype had purple shoulder colour, good bland of acidity (0.621%) with sweetness and good yield. They are being studied further and their clonal propagation is continued.

Fungicidal control of the Disease

The plants sprayed with Bayleton (0.1%) thrice during the season at fortnightly interval recorded lowest PDI (PDI = 1.22 to 3.21 in Gola and 1.03 to 7.25 in Umran). Sulfex recorded PDI 14.25 in Gola and 17.19 in Umran. Since Bayleton is costly fungicide and Sulfex has somewhat low efficacy, a spray schedule was developed to reduce the cost and to increase the efficacy.The recommended spray schedule (application of Bayleton soon after disease appearance in 3rd week of October by 2 sprays of Sulfex at fortnightly interval) showed low disease intensity (PDI) (5.8 in Gola and 7.6 in Umran) as compared to control (38.7 in Gola and 42.2 in Umran). Hexaconazole (0.1%) also recorded low disease intensity (in Umran 5.6). For control of fruit borer and fruit fly in ber, this year, a spray schedule involving first spray in first week of October with thiodon (+ Bavistin), second spray after a fortnight with fenavalerate + Bayleton and third spray with Fenvalerate + Hexaconzaole after 21 days performed very well.

Foliar spray with chemicals of non-fungicidal nature

Results obtained in experiments with var. Gola showed that all the 16 treatments recorded significant disease reduction, the best being Bayleton 0.1% + KH_2PO_4 (0.5%), (PDI= 3%), $CaCl_2$ (PDI = 9.88) and KH_2PO_4(0.5%) + Urea(1%) (PDI = 10.18) and DAP (PDI = 8) Ammonium carbonate (0.5%) (PDI = 11.18) and cow milk (PDI = 14.24) also recorded significant disease reduction. $NaHCO_3$ (0.5%) (PDI = 11.08) also showed very less disease intensity. Control plants had PDI= 24.59. Phenol had 10.96 PDI, while pot. metabisulphite had 8.73 PDI and $KMnO_4$ has 11.73 percent intensity. Acetyl salicylic acid had 13.95 PDI.

Management of cercospora leafspots (*Pseudocercospora punicae*) and anthracnose (*Colletotrichum gloeosporioides*) of Pomegranate.

The Cercospora leafspot caused by *P. punicae* were first seen during the last week of August and peak infection was seen in Sept-Oct. months. The anthracnose was also first seen in the September only. The symptoms and causal fungus were studied. During *Hasta bahar* season, flowering was delayed. Only leaf symptoms were there. Best fungicidal control was observed by two sprays with thiophanate methyl (0.1%) (PDI = 2.3), Hexaconazole (contaf 0.1%) (PDI= 2.7), Blitox (0.3%) (PDI = 5.2), Dithane M-45 (0.2%) (PDI =4.5) and Captaf (0.2%) (PDI= 4.8). Corresponding control plants had PDI = 24.65.

Amongst non fungicidal chemical sprays, KH_2PO_4 (0.5%), $MgSO_4$ (0.5%), Urea 1%, Ammonium bicarbonate (0.5%) and $NaHCO_3$ (0.5%) also showed low disease intensity (between 8.5 to 14.22).

Integrated disease control studies showed that avoiding *Mrug bahar* crop, taking *Hasta bahar*, spray with Blitox (0.3%), removal of infected debris, and spray with neem oil (0.5%) controlled the disease effectively, bringing down the PDI to 2.8. This also minimized the use of fungicide. Spray of foliar fertilizers or minerals like KH_2PO_4, $MgSO_4$ or $NaHCO_3$ also help to manage the disease.

Management of *Penicillium islandicum* fruit rot of *Aonla*

Preharvest sprays with KH_2PO_4 (0.5%), Bavistin (0.1%), $CaCl_2$ (1.5%) and Potasiumetabisulphite (0.1%) reduced the disease incidence in storage. Best fungicidal preharvest spray was chlorothalonil Bavistin (0.1%) and Blitox (0.3%).

The integrated disease management practices including avoiding injury to fruits during picking, transit and storage, dipping the fruits in 10% brine solution for 10-15 min., or dipping the fruits in 1.5% solution of $CaCl_2$ for 2-3 min. also showed minimum damage to fruits due to *P.islandicum*.

It is suggested to apply a preharvest spray of KH_2PO_4 (0.5%) 8-10 days before picking, which may be followed by careful picking, dipping the fruits for 10-15 min. in 10% brine solution, avoiding bruising of skin during storage and transist, time to time culling of infected fruits and storage at low temperature to minimize the disease incidence.

Diseases of Bael

Following diseases of bael were characterized:

Gummosis: Longitudinal cracks in bark accompanied by amber coloured gum exudation, resulting in yellowing of foliage leading to die back was noted as major symptoms. Gradually the trees dies. For its control, copper fungicidal pasting (Bordeoux paste) by sprays with $CaCl_2$ were found reduce to the disease intensity. The treatment saved the tree from the mortality.

Powdery mildew: The younger leaves show the first symptoms in form of white powdery patches of powdery mildew colonies. Older leaves show symptoms afterwards. The morphology of the pathogen shows *Pseudo-oidium* type conidiophores; conidia borne singly and not in chains. Sprays with Bavistin (0.1%) or Sulfex (02%) efficiently manage the disease.

Fruit rot: This is caused by *Aspergillus* sp. (*A. nidulens*). The fruit rind develops large, round discolouration and beneath this, the pulp turns black coloured and start rotting. Black, sooty powdery mass containing thousands of conidia are produced inside the fruit. For management, avoiding injurity to fruits, good venting and frequent manipulation of fruits in the basket is suggested. Culling of infected fruits should be done time to time.

Canker: Small, brownish spots with water soaked halo are seen on fruits rind. No control measure has been worked out so far at Godhra.

Dwarf Mistletoe *(Dendrophthe falcata)*: It was found on two trees. This is an angiospermic hemi-parasite which is also partial parasite on several hosts including bael. It produces inflorescence of white flowers and orange coloured fruits which attracts birds for their seed dissemination. Destroying the affected twig after cutting with a sharp knife and putting diesel oil on cut surface was for its management.

Management of diseases in Chillies

Management of diseases of chilli through foliar sprays of inorganic chemicals: Chilli anthracnose on var. Pusa Jwala was found to be reduced in KH_2PO_4, Pottasium metabisulphite and phenol treatments. Chilli powdery mildew was also found to be reduced in these treatments. Chilli powdery mildew was also reduced in $MgSO_4$, $KMnO_4$ and K_2HPO_4 treatments.

Disease Management in cucurbits

Management of Bottle gourd diseases: Bottlegourd leafspots due to *Cercospora laginariae* were not found to be controlled by foliar fertilizer sprays. However, powdery mildew was found to be reduced by

KH_2PO_4 phenol, potassium metabisulphite and $NaHCO_3$ (0.5%).

Cercospora leafspots were not found to be reduced by sprays with foliar fertilizers like (FFS) although KH_2PO_4 but were reduced in anti fungal compounds like phenol, $KMnO_2$ and K-metebisulphite.

Biological control of diseases of horticultural crops

Two superior strains of *Trichoderma* were identified and tested for their disease reduction ability in case of post emergence damping off of solanceous nursery and ginger rhizome rot. These strains belonged to *T.virens* and *T.viridae* groups. These are further multiplied on cheaper media like FYM and leaf litter. However, these strains did not have any resistance against fungicides.

Effect of VAM-fungal inoculation on maize growth

Maize plants, (when subjected to thick sowing which is practised for VAM-multiplication), showed 48.8% increase in height, 17.52 % increase in girth and 7.14% increase in root weight. However, this enhancement was recorded only during initial growth.

Multiplication on maize roots on mass scale

Fast organic matter decomposing fungi were used for decomposing leaf litter in a large pit. It decomposed the litter in about 200 days.AQ was observed on okra powdery mildew only in the end of season, hence it was not utilized for disease control.

VAM fungus

Procedure of VAM multiplication was standardized to multiply VAM fungus *Glomus mosseae* on maize roots for Panchmahals region.

Insect pest management

At Bikaner

Lasora

The tinged bug (*Dictyla cheriani*) was recorded for first time on lasora (*Cordia myxa*) at experimental farm of Central Institute for Arid Horticulture, Bikaner. The severe incidence of tinged bug was found in last one year and a major pest of lasora at present. The maximum incidence of tinged bug was recorded in the second fortnight of October on small leaves (25.00/ leaves) and broad leaves (9.00/ leaves) followed by first fortnight of November on small leaves (22.20/ leaves) and broad leaves (5.80/ leaves). It is damage to the leaves of lasora plant. Due to attack of this pest, the leaves turned yellow and finally dry (Table 28).

The body is oblong, pale testaceous with brownish or fuscous markings, with collar and hood yellowish brown, body beneath reddish dark with thoracic sterna darker. Labium is brownish with dark apex, reaching to base of mesosternum. Antenna is yellowish brown; 1/3 part of 4 segment blackish. Antenna is rather slender, segmental measurements: I, 0.12 mm; II, 0.09 mm; III, 0.80 mm; IV, 0.22 mm. Length of body is 2.25 mm and width 0.88. Hemelytra are wider than width of pronotum across humeral angles, longer than abdomen. Hind wings are longer than abdomen and hyaline (Fig. 61).

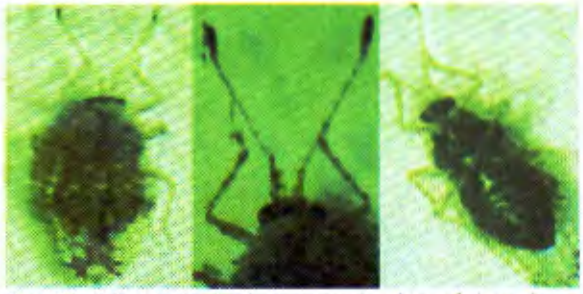


Fig. 61: Morphological characterization of tinged bug (*Dictyla cheriani*)

Table 28. Incidence of tinged bug (*Dictyla cheriani*) on lasora

Month	Broad leaves lasora Mean no. of bug/ leaves	Small leaves lasora Mean no. of bug/ leaves
August-I	6.20	15.80
August-II	6.80	17.60
September-I	7.30	18.50
September-II	8.00	22.00
October-I	8.50	24.40
October-II	9.00	25.00
November-I	5.80	22.20
November-II	3.90	20.70
December-I	2.50	13.50
December-II	2.00	9.40
January-I	0.00	5.40
January-II	0.80	7.80
February-I	1.60	8.00
February-II	1.90	8.50
March-I	2.50	9.80
March-II	2.60	10.20
April-I	3.20	12.40
April-II	3.40	12.80
May-I	4.50	13.90
May-II	4.10	12.80
June-I	3.50	12.10
June-II	3.10	11.70
July-I	4.40	13.10
July-II	5.10	14.40

The morphological linear measurements recorded are as:

Length of body up to genitalia	:	1.782 mm
Length of body up to wing tip	:	2.245 mm
Width of body	:	0.836 mm
Length of head	:	0.229 mm
Width of head	:	0.386 mm
Length of hemielytra	:	1.513 mm
Width of hemielytra	:	0.548 mm
Length of thorax	:	0.634 mm
Width of thorax	:	0.735 mm

Ker

The ker (*Capparis deciduas* Forsk.) was found to be heavily infested with *Anaphaeis aurota* Fabricius, commonly known as the Pioneer or Caper white, in various parts of arid region of Rajasthan. During the investigation it is found that the grown caterpillars of *A. aurota* Fabricius easily strip off the branches, devouring leaf after leaf causing great damage (Fig. 62).

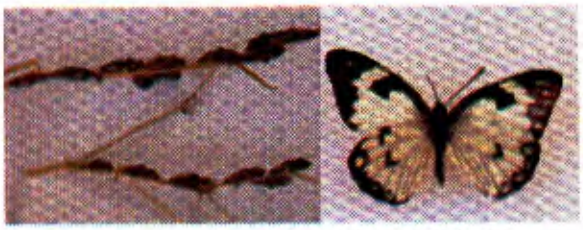


Fig. 62: Attack of pioneer butterfly (*Anaphaeis aurota*) on ker (*Capparis deciduas*)

The pupae of *A. aurota* Fabricius were found to be parasitized with *Brachymeria albicrus* (Klug). Parasitoid parasitizing *A. aurota* Fabricius infesting *C. decidua* (Forsk.) from Rajasthan. *B. albicrus* (Klug) has been earlier reported from southern India (Fig. 63).

The mean percent parasitism of the Pioneer by *B. albicrus* (Klug) was 49.5 and the mean percent emergence of the mature adult parasitoids from the parasitized pupae was 15.5 (Table 29). The pupae which did not yield either parasitoid or transformed to adults were later dissected and it was observed that from the localities such pupae contained malformed parasitoids which could not emerge out. The mean percent pupal malformation was 34.0.

Fig. 63: Parasitized pupae of pioneer butterfly and adult of *Brachymeria albicrus*

Table 29. Mean per cent parasitization of the Pioneer butter fly by *Brachymeria albicrus* (Klug)

Date of collection of pupae	Total no of *Anaphaeis aurota* Fab. pupae collected	Total no. of *A. aurota* Fab. pupae parasitized	Total no. emerged adult of *B. albicrus* (Klug)	Total no. of *A. aurota* Fab. pupae containing malformed parasitoids
01 Nov	50	30	8	22
15 Nov	50	22	7	15
01 Dec	50	21	7	14
15 Dec	50	26	9	17
Mean	50	24.75	7.75	17
Percent		49.50	15.50	34.0

Muskmelon

The crop was sown in the month of February, 2011 for screening of different variety/ genotype of muskmelon resistance against fruit fly (*Bactrocera cucurbitae*) at CIAH farm. The maximum incidence (79.70 % fruit damage & 25.30 larvae/ fruit) of fruit fly was recorded in variety Arka Rajhans and the lowest incidence (12.30 % fruit damage & 11.00 larvae/ fruit) of fruit fly was recorded in genotype AHMM/BR-1 followed by RM-50 (14.70 % fruit damage & 12 larvae per fruit) (Table 30, Fig. 64). The highest pH (5.90) was found in variety Arka Rajhans which variety was found highly incidence with fruit fly. The lowest pH (4.8) was found in genotype AHMM/BR-1 followed by RM-50 (pH-4.9).

Fig. 64: Damage symptoms of fruit fly (*Bactrocera cucurbitae*) in musk melon

The pH was positively correlated with fruit fly incidence.

At Godhra

Aonla

Hairy caterpillar, aphid and shoot gall maker were major pests whereas leaf twister (*Caloptilia* sp.) and aphid (*Cerciaphis*

Table 30. Screening of musk melon variety/ genotypes against fruit fly (*Bactrocera cucurbitae*)

S. No	Variety/ genotype	% fruit damage	Larvae/fruit	P^H
1.	Pusa Sarbati	47.70	20.30	5.3
2.	MHY-3	41.30	18.00	5.4
3.	MHY-5	26.00	16.70	5.1
4.	RM-43	66.00	21.30	5.6
5.	RM-50	14.70	12.00	4.9
6.	Kashi Madhu	71.30	21.70	5.7
7.	Durgapura Madhu	33.30	17.30	5.2
8.	Arka Jeet	57.30	20.00	5.5
9.	Pusa Madhuras	49.70	21.70	5.5
10.	Arka Rajhans	79.70	25.30	5.9
11.	GMM-3	76.00	23.70	5.7
12.	AHMM/BR-1	12.30	11.00	4.8
13.	AHMM/BR-2	18.30	13.30	5.2

emblica) were other problems. Aphid and mealy bugs attacked the *aonla* during summer months and were controlled by spray application of dimethoate (0.05%) alongwith soap solution. Aphid was most damaging to Chakaiya variety followed by Anand-2. Shoot gall maker pest was managed by removing affected shoots or by injecting dichlorvas in the gall.

Ber

The fruit fly (*Carpomya vesuviana* Costa) and fruit borer (*Meridarchis scyrodes* Meyr) were the two most important pests on ber during the year. In unsprayed plots, the infestation of fruit fly was 35-40 per cent whereas that of fruit borer was 65-75 per cent. A schedule of 3 sprays, first one with endosulfan (0.07%) during October first week followed by second sprays at 2-3 week interval with fenvalerate (0.005%) followed by third spray at triweekly interval with fenvalerate gave effective control of both these pests. Another schedule of control involving 2 applications of fenvalerate or endosulfan followed by 2 sprays of multineem (0.5%) also worked well. Girdler insect larvae were managed by sprays with dimethoate during last week of June.

Pomegranate

Thrips (*Scirtothips dorsalis* Hood) and anar butter fly (*Virachola isocrates* F.) were the two most important pests. To manage them, a schedule of spray application commencing from last week of September involving Dimethoate (0.005%) or endosulfan (0.07%) was successfully used.

Cucurbits

Fruit fly (*Bectrocera cucurbitae*) was managed by monitoring the adult population using a trap than application of insecides, dimethoate (Rogor, 0.15%).

At Bikaner

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

The survey was conducted in local area of Bikaner, Churu, Nagaur, Sikar, Jodhpur, Jaisalmer, Barmer, Sri Ganganagar, district of Rajasthan during 2011-12. During the survey, the information /data on the marketing system, horticultural crops grown, available resources, ITKs, SWOT points, potential resources for arid horticultural development, present sources and type of inputs, technical information, traditional vegetables grown, horti-based cropping / farming system practiced, value addition practices followed, motivational factors in growing horticultural crops and constraint faced in adopting same, suggestions (from farmers, field workers, and experts) to overcome these constraints and ideas develop to suitable extension models/ methodologies for betterment of transfer of technologies, were collected. Socio- psycho and economic characteristics of farmers, training needs / desires, different dimensions of horticultural development were also evaluated. Lastly, the supportive basic data/information related to arid horticultural crop production and their practices were also collected from secondary sources, past records, field workers, experts. After collecting these data/ information, they were coded, decoded, compiled, processed and the following inferences were observed.

Horticultural crops grown

In surveyed areas, some of the farmers grow fruit crops like *ber*, *aonla*, *lasora*, kinnow, lime/lemon, mosambi, date palm, pomegranate, etc. at small scale and vegetable crops like *khejri*, snap melon, *kachari*, *mateera*, brinjal, tomato, okra, bottle ground, ridge grourd, round melon, chilli, indian aloe, clusterbean, cauliflower/ cabbage, spinach, carrot, radish, fenugreek (leaves), chilli, pea, etc. are grown during different season of the year on small scale (0.10ha) to large scale (10 ha, mainly in mixed cropping system)

Marketing system/elements

Grading and packaging of produce: Most of the farmers don't bother about grading and good packing of their produce. They simply put their produce directly in gunny Bags, tractor trolley, jeep, etc., and sell them in local markets/ *mandies* as it is.

Transportation means and methods: Head loading, bicycle, motorcycle, camel cart, bullock cart, donkey cart, three wheeler, taxi, tractor, jeep, bus, mini trucks, truck, train, etc.

Marketing channels: The important marketing channels observed in surveyed areas were, producer to consumer, producer to traders / local merchants to consumers, producer to traders / local merchants/ assemblers to wholesalers to retailers or hawkers to consumers, producers to processors (for value addition purpose), producers to primary wholesalers to secondary wholesalers to retailers or shopkeepers/ hawkers to consumers, producers to traders / local merchants/ assemblers to primary wholesalers to secondary wholesalers to retailers or shopkeepers/ hawkers to consumers, etc.

Sources of marketing information

Fellow farmer, friend, relatives, local shop keepers, traders/local merchants/ assemblers, *mandi* agents, radio, TV, daily news papers, magazines, field workers, company agents, etc.

Traditional technologies

Some of the important traditional technologies/ indigenous technical knowledge used by the farmers for better production of fruit and vegetable crops in hot arid environment are as follows.

Traditional technologies for improving soil fertility and productivity: Mixing of *khejri* leaves into the soil to increase plant nutrient, soil organic matter which increase the fertility of the poor soil; application of oil cakes with wooden ash and FYM to increase the soil fertility and productivity; *in-situ* burning of crop residues and farm wastes to enriching the soil with micro-macro plant nutrients and minerals through burnt ash and reduce the infestation of termites, soil born pests and diseases;

Traditional technologies for soil and water conservation: Biotic and abiotic mulches like cover crops, crop residues, farm wastage, inter-cropping, grasses, crushing hard crust of soil, application of organic soil amendments, use of organic soil erosion retardants, etc. Nipple system of irrigation, an important traditional method of irrigation system used to save the irrigation water to a great extent and used, mostly, in orchard/fruit crop production like *ber*, *aonla*, pomegranate, kinnow, etc. *Jaldhara* method of irrigation techniques is used by farmers in gourds, melons, pumpkins, and other trailing vegetable crops grown in arid

regions where water is a scare resource. Using this technique, the farmers save about 70-80 percent of irrigation water in vegetable crop production in arid regions of Rajasthan. Spreading of kerosene or mustard oil on water bodies to reduce the evaporation loss of water from the surface of water bodies like farm ponds, *diggies* (open water tanks), reservoirs, water harvesting bodies, water ways, etc.

Traditional technologies for plant protection: Application of tobacco water to protect the vegetable seedlings from the attack of insect and pests in nurseries as well as in fields. Application of *Hukka* water for controlling attack of insect-pests in vegetable crops particularly at nursery and transplanting stage of the vegetable crops. Spraying of Kerosene oil and ash mixture to control the insect- pests and viral diseases in vegetable seedling and fruit crops. Dusting of cow-dung ash and FYM mixture to protect their vegetable seedling and crops from the attack of insect-pests, diseases and frost injury. Burning of mustard/ sesamum oil in crop fields to control the viral diseases like leaf curl disease of brinjal, tomato, okra, and attack of insects. Spraying of cow dung/goat/sheep excreta and kerosene oil solution to protect the fruit and vegetable crops from the attack of wild animal/ stray animals. Smoking and dusting of dry ash on fruit and vegetable crops to protect their crops from frost injury due to very low temperature during winter season. Application of butter milk or curd in individual pit of fruit plants to protect them from the attack of termites. Application of kerosene oil with irrigation water to fruit and vegetable crop fields to avoid the infestation of termites. Application of *neem* kernels powder in the soil used to control the attack of termites, soil born diseases and insect-pests on horticultural crops. Spraying of *hing* (asafoetida) solution over vegetable crops, mainly in cucurbitaceous vegetable crops (bottle ground, ridge ground, round melon, snap melon, *mateera*), chilli, brinjal, etc. to control the some diseases and pests attack.

Traditional technologies for plant growth, quality and yield: Seed soaking and softening practice is followed in vegetable crops like-bottle gourd, ridge gourd, *mateera*, snapmelon, okra, etc. for better seed germination. Pasting of cow dung on pruned part of the fruit plants for quick and more sprouting healthy and more buds/branches resulting higher fruit yield. Application of tea water in brinjal, cauliflower, cabbabge, tomato crop fields with the idea that it will increase the size, growth, quality, better look and yield of these vegetables. Application of mustard/sesamum oil cakes is followed mainly in brinjal, chilli and tomato crops to improve the fertility and moisture conservation of the soil. Soaking of vegetable seeds in butter milk to increase germination percentage of vegetable seeds like brinjal, tomato and chilli. Application of cow dung and cow urine mixture to improve the quality of pomegranate fruits.

Potential natural resources for arid horticultural development

During the survey various natural resources were 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. are potential germplasm which may be utilized for horticultural development in hot arid regions. Amongst the vegetables germpalsm like *Khinp (Leptodedia pyrotechnica), tumba, local mashroom, kankora, fog,* clusterbean, mothbean, cow pea, green gram, amaranth (*chandlai*), fenugreek, drumstick, chenopod (*bathua*), 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. are the major 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: 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: The peculiar agro-climatic conditions of the arid region imparts unique quality in fruits such as in ber, pomegranate, sweet orange, and in vegetables such as chilli, cumin, fenugreek, and cucurbitaceous crops, etc. The arid region is the only area where commercial date palm production is possible.

Water resources: Indira Gandhi Canal water, Well, tube well, ponds, *khadin, nadi, tanka, etc.*

Energy/ power sources: Vast solar energy, wind energy, biogas, human power, animal power, etc.

Animals resources: The large population of animals available in hot arid regions can be 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.

Traditional vegetables grown

Kankora, kundru, pods of *khinp (Leptodedia pyrotechnica),* amaranth (*chandlai*), fenugreek, drumstick, chenopod (*bathua*), 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. are the major traditional vegetables which are grown in hot arid regions and used as fresh in current season or through out the year after converting them in the form of value addition. Except these, *kachari*, *mateera*, snapmelon, round melon, etc. are the other major traditional vegetables which are used by the farmers / local peoples of the hot arid region as afresh in current season or in the form value added vegetables throughout the year.

Motivational factors in growing horticultural crops

The major motivational factors responsible for adoption and growing horticultural crops in hot arid regions are, comparatively less water requirement of arid fruit crops; comparatively low cost and less labour requirement; employment generation; increasing demand in market; cash income on daily basis; per unit income is more; supplementation to main income; best use of leisure time, slack period, and family labour; business mode and mind; health requirement; decreasing ground water / scarcity of water; Government's developmental programmes and schemes/ subsidies; encouragement enforced by Governmental and Non-Governmental personnel/ agencies; self motivation and contentment; social / occupational competition; symbol of advancement and leadership, a desire to change traditional cropping system; inspiration get from technological publicity/advertisement through individual contact/ mass media, etc.

Changing in farming system/ cropping system

During the survey, it was observed that the farmers want to change their cropping / farming system. The farmer's are turning from traditional cropping system / farming system 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 crops and have animals which can give immediate high return and profit. They do not think about their own nutritional value and environmental aspects, they want to catch only high market price and earning more and more money through their suitable farming system / crop production.

Major constraints in adoption of arid horticultural technologies / crops

The important constraints in adoption of improved technologies of arid horticulture as observed during the survey were, lack of reliable seeds and planting materials, limited supply of electricity, heat and frost injury, lack of awareness and knowledge about the technologies, scarcity of water, no minimum support price system for horticultural crop' produce, monopoly in markets, attack of wild animals/insects/diseases, lack of knowledge of insecticides- pesticides, high winds and wind storms, natural calamities, poor technical guidance, lack of true support system, ignorance of the farmers, misunderstanding amongst the farmers, lack of motivational agents/ factors, etc. During the survey, the ssuggestions/ ideas were also collected from innovative farmers, experts, field workers, programme/ scheme coordinators, scientists, etc. to overcome constraint being faced by

farmers in adoption of horticultural technologies.

Collection of innovative ideas and developing extension models/ methodology for TOT

On the basis of ideas collected from experts, scientists, KVKs personnel, field workers, progressive farmers, personal experience/ observations, etc., the following extension models/ methodology were designed / developed for betterment of transfer of technologies in arid regions: (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, 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). Cliental Participatory Technological Evaluation and Self Multiplication Model / Methodology, etc.

Felt Needs/ desires of the farmers

During the survey it was observed that improved seeds/ planting materials, irrigation water, electricity supply, creating awareness and knowledge about improved technologies, support system (credit, schemes, information, insurance, etc.), good price of products, in the market, storage facilities, techniques for value addition in the field of horticulture, etc. are the major felt need/ desires of the farmers in surveyed areas.

Technological interventions for arid horticulture development and its impact assessment

As per objectives and targets of the project, "*Technological intervention for arid horticultural development and its impact assessment*" various technological interventions/extension programmes were carried out / organized during 2011–12. Out of these; major interventions activities/ extension programmes carried out / organized during the year 2011 – 12 are being mentioned in short as under.

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 and farmer's trainings, visit to farmer's fields and organization of farmers interest groups organization 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.

Science day celebration

The Institute celebrated the Science Day on 28.02.2012 in the campus of the Institute in which more than sixty students, teachers, staff were participated and they were acquainted with several scientific facts and improved technologies of arid horticulture during the programme.

Inter Intuitional linkages/programmes organised/assisted

The Institute strengthened functional linkage with sister organization / Institutions of the ICAR, KVKs, ATIC and Directorate of extension of SKRAU, Bikaner, CAZRI regional station Bikaner, State Govt. Deptt. Of Agriculture/ Horticulture, CAD/IGNP organizations, 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 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.

Impact assessment

The impact assessment of arid horticultural technologies with respect to their socio-economic impact on farming community/ cliental system was also carried out. It was found that the farmers who have adopted improved varieties vegetables as released by the institute like- AHK- 119 (kachri) AHS-82 (snapmelon), Thar Mank (mateera) are getting net income of Rs. 48000 – 100000 per hectare per season depending on irrigation facilities, type of crop and variety, marketing demand, management practices, etc. They have started the production of these varieties at commercial scale. The farmers who have irrigation facilities grow these varieties both in rainy as well as summer season. The farmers who grow improved varieties of ber are getting net income of Rs. 44000 - 80000 per hectare per year depending on irrigation facilities, marketing demand and management practices. The farmers are very eager to grow improved variety of *khejri "Thar Shobha"* released by the institute. The farmers have adopted some of the technologies of water saving developed by the institute and save a lot of water using the same in their horticultural crop production.

At CHES, Vejalpur

Performance of varieties of brinjal

Ten brinjal varieties namely, Kashi Taru, Kashi Prakash, Kashi Komal, Kashi Sandesh, IVBL-9, 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 June 2011 to March 2012 at Central Horticultural Experiment Station. Kashi Sandesh yielded highest among 10 varieties tested with 6.7 kg of fruits per plant followed by Pusa Uttam (4.4 kg) and Kashi Prakash (3.9 kg). Doli-5 had highest number of fruits per plant (138) followed by Kashi Komal (89) and Pusa Shyamla (86). Doli-5 had highest

number of flowers per plant (57) followed by Pusa Uttam (42) and Pusa Shyamla (42). Pusa Uttam had highest number of leaves per plant (211) followed by Kashi Sandesh (185) and Kashi Komal (158). Pusa Uttam was tallest with a plant height of 60 cm followed by Kashi Sandesh (54.5 cm) and Kashi Komal (53.3 cm).

Survey of brinjal farmers

Three hundred vegetable farmers of Panchmahals district were surveyed. Cost: Benefit ratio of brinjal cultivation by the farmers of Panchmahals district is 1.6. The farmers earn a net profit of Rs.46200 by cultivating brinjal in an area of one hectare. The major constraint in brinjal cultivation is low sale price in the market. Among pests, shoot and fruit borer, little leaf and mite are the major problems faced by the farmers. Medium size, round type, purple colour brinjal fruits fetch higher price in Vadodara, Surat and Kalol vegetable markets. Medium sized, long type, black colour brinjal fruits fetch good price in Gogamba and Kalol vegetable markets.

Krishi Vigyan Kendra, Panchmahal, Vejalpur

Fifth Scientific Advisory Committee (SAC) meeting of the Krishi Vigyan Kendra, Vejalpur

The fifth scientific advisory committee meeting of Krishi Vigyan Kendra Panchmahals was held on 3rd May, 2011 at conference Hall of CHES Vejalpur. The meeting was chaired by Dr. S. K. Sharma, Director, C.I.A.H, Bikaner. Dr. Y. V. Singh, ZPD, Dr. Sanjay Singh Head CHES, Vejalpur, R. S. Singh, PS, CIAH, Bikaner, Dr. R. H. Patel, Associate Director (Research) AAU, Anand Gujarat, representatives of Different line Department of the district, Scientist and farmers also participate in the SAC meeting. Dr. (Smt.) Kanak Lata, Programme Coordinator, KVK, Panchmahals presented the annual report for the year of 2010-11 and activities carried out during the year of the KVK, Panchmahal.

Trainings (including FLDs)

83 Training Programs on Agricultural and allied fields were conducted. Altogether, 3271 farmers were benefited out of them 2477 were male and 894 were female as detailed below:-

Discipline	No. of courses	Total no. of participants		
		Male	Female	Total
Crop production	14	1306	457	1763
Extension education	08	135	26	161
Animal science	17	384	103	387
Plant protection	20	370	94	464
Horticulture	13	270	10	280
Home science	11	12	204	216
TOTAL	83	2477	894	3271

Seed Production

Revolving fund scheme of ICAR funded seed project

For quality and high seed yield potentials in arid vegetable crop, during 2011–12 seed crop production trials on mateera, snap melon, kachri and cluster bean were undertaken adopting HBCPSMA. About 386 kg TFL seed of potential arid vegetable crop varieties was produce during the period under report and distributed to the farmers, NGO's, KVK's and state and private agencies as a initial spread of the institute varieties and further seed multiplication (Fig. 65-67).

Fig. 65: Fruits of mateera variety Thar Manak for breeder seed production

Fig. 66: Fruits of kachri variety AHK-119 for breeder seed production

Fig. 67: Selection of fruits of kachri variety AHK-119 for varietal maintenance

Seed production trial in mateera

Improvement for yield potential

For improving quality seed yield potential in mateera va . Thar Manak, a series of treatment combinations were imposed adopting production site management approaches in summer and rainy season crop of 2011. The variety har Manak recorded higher fruit yield of about 18% under drip technology (2.0 m x 0.50 m) with limited irrigation water over channel system of crop cultivation during summer season. The rainy season crop was much affected at maturity by wild animals and the yield and quality of seeds was poor.

Seed production trial in kachri

Improvement for yield potential

For improving fruit and seed yield potentials of kachri AHK–119, a series of treatments based on production site management approaches were imposed to assess their suitability in the rainy season crop of 2011. The crop was raised adopting drip technology (2.0m x 0.50m) along with channel system of cultivation. However; no irrigation water was given due to normal monsoon rains during the period. The performance of kachri var. AHK–119 is given in table 32.

Seed production trial in snap melon

Improvement for yield potential: For improving quality fruit seed yield potential in snap melon, a series of treatment combinations were imposed adopting production site management approaches during summer season crop of 2011. The variety AHS–82 recorded higher fruit yield of about 15% under drip technology (2.0 m x 0.50 m) with limited irrigation water over channel system of crop cultivation.

Table 31. Seed production of arid vegetable crop varieties at CIAH, Bikaner

Crop - Varieties	Quantity (kg)
Mateera (Thar Manak)	9.5
Snap melon (AHS–82)	67.0
Bottle gourd (Thar Samridhi)	7.7
Kachri (AHK–119)	70.0
Cluster bean (Thar Bhadavi)	224.0
Palak (AHLP-1)	8.5
Total	386.2

Table 32. Performance of kachri AHK–119 under absolute rainfed conditions during 2011

Characters	Mean values
Days to male flower (DAS)	30.5
Days to female flower (DAS)	34.5
Days to first harvest (DAS)	70.5
Fruit weight (g)	64.8
Fruit length (cm)	5.52
Fruit diameter (cm)	4.27
No. of marketable fruits/plant	20.6
Fruit yield/plant (kg)	1.45
Fruit yield (q/ha)	99.5
Number of seeds/fruit	309.5
Seed yield/plant (g)	62.58

3

शिक्षा, प्रशिक्षण एवं प्रौद्योगिकी हस्तान्तरण

EDUCATION, TRAINING AND TECHNOLOGICAL INTERVENTION

At Bikaner

Visit and research- extension-farmers-interface meetings

887 farmers (both men & women farmers) visited the Institute and 25 research-extension-farmers-interface meetings were held with them in different groups at the institute during the reported time. They were acquainted with latest improved arid horticultural technologies to popularizing the same amongst the farmers for adoption purpose. Besides these, more than 100 B.Sc (Agri.) 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. Moreover, about 100 professionals, lecturers, teachers, scientists/ trainees, and other dignitaries came from different SAUs, colleges/ schools, ICAR research centres, state line department, NGOs etc. 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.

Front line demonstrations/ adaptive trials

Six frontline demonstrations of each improved varieties vegetable crop *viz* - Thar Mank (Mateera), AHS-82 (snap melon), AHK- 119 (Kachri), Thar Bhadavi (Cluster bean) and one front line demonstration of Thar Shobha (Khejri) were conducted on farmers fields (in Napasar, Chak no. 3NGM-Husangsar, Khara, Kesar desar Jatan villages) of Bikaner districts of Rajasthan. In addition, 21 method demonstrations about improved agro-techniques of arid fruits and vegetable production were given before visiting farmers/ extension functionaries or during farmer's field visits/ interaction.

Farmer's trainings

During the reported period, 06 farmer's training programme were conducted / organised

Visit to farmer's fields and farmers interest groups organization

During the reported time, the several farmer's fields of Churu, Nagaur, Sikar, Jodhpur, Jaisalmer, Barmer, Sri Ganganagar, Bikaner, district of Rajasthan were visited and 16 farmers interest groups (had interest in growing arid fruits and vegetables) were organized. They were acquainted with latest improved technologies arid fruits and vegetables crop production. These latest improved technologies arid fruit and vegetable crops production were popularized amongst the farmers and they were motivated to adopt the same on their fields.

Participation in farmer's fair and arranging technological exhibitions

The Institute, participated and organized exhibitions of arid horticultural technological in Krishi Vigyan Mela at IARI, Pusa, New Delhi during 01- 03 March, 2012.

At Godhra

One month training programme for Bachelor of Rural Studies (BRS) students

One final year BRS students of Mangal Bharati Lokshikshan and Krishi Mahavidhyalay, Gola Gamdi, Vadodara had undergone one-month course on horticulture at Central Horticultural Experiment Station, Vejalpur from 24.08.2011 to 22.09.2011.

Four final year BRS students of Samajseva Maha Vidyalaya, Gandhi Vidyapith, Vedchhi, Tapi and 1 BRS student of Shri. I. K. Chavda Gram Vidyapith, Kahnvadi, Anand district, had undergone one-month course on horticulture at Central Horticultural Experiment Station, Vejalpur from 01.12.2011 to 31.12.2011.

RAWE TRAINING

Organized one day exposure visit to CHES by the nine B.Sc. (Agri.) students of B.A.College of Agriculture, AAU, Anand on 15.07.2011 and 76 B.Sc. (Hons.) (Agri.) students of B.A.College of Agriculture, AAU, Anand on 23.01.2012 and 25 B.Sc. (Horticulture) students of ASPEE College of Horticulture, S.D. Agricultural University, Sardar Krushi Nagar, Dantiwada on 12.03.2012 under RAWE programme.

Krushi Mahotsav cum Exhibition

The Station participated in the *Krushi Mahotsav* and Exhibition organized by the Department of Agriculture, Gujarat at Gogamba, on 6th May, 2011. It put up a stall to explain the activities of station to the visitors and distributed publications.

The Station also participated in the *Krushi Mahotsav* and Exhibition organized by the Department of Agriculture, Gujarat at Godhra, during 20-22, May, 2011. It put up a stall and explained the activities of station to the visitors and distributed publications.

Farmer's interactions

During the year 2011-12, a total of 722 visitors including 433 farmers, 17 farm women, 202 students and 70 extension personnel visited the CHES farm to know the advance technology of Horticulture developed at the Station.

Fig. 68: Farmers visit and training at CIAH, Bikaner

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महिला सशक्तिकरण
Women Empowerment

During the reported period, > 200 farm women visited to 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 post harvest technologies, modern tools and techniques of value addition of arid fruits and vegetables, improved technologies of fruits and vegetable production in hot arid ecosystem, etc. by organizing group discussion, interface meetings, individual contacts.

They were taught about the techniques which may be helpful in reducing the drudgery in crop production and post harvest management. Self Motivated – Self Help Women Group (SM-SHWG) and No Earning Women toward Self Earning Woman (NEW to SEW) programmes planed and initiated for empowerment of farm women and other job seeking women.

Fig. 69: Farm women visiting the institute farm

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सम्मान व पुरस्कार

Awards and Recognitions

AWARDS:

1. Lata, K and Singh, Sanjay. (2011). Cost effective on farm storage: Zero energy cool chamber for the farmers of Gujarat. Paper presented oral presentation in National conference, organised by Lt ASM foundation at Dehradoon on "Horti Business – Linking Farmers with market, held during 28-31, May, 2011, pp 7. Awarded as best oral presentation.
2. Singh, A. K., Singh, Sanjay, Joshi, H. K., Sisodia P. S. and Rethinam, P. (2011) Possibility of blending of bael (*Aegle marmelos*) juice with noni- a useful heathy soft drink. Paper presented as poster presentation in National Symposium on Noni -Apanacea of Wellness, 1-2october, Chennai, organised by WNRF, Chennai, pp370. Awarded as best poster presentation.

1. Rai, A. K., Khajuria, S., Kanak Lata and Joshi, H.K.2011. Consumer acceptance for vegetable peagon pea (*Cajanuscajan* L); in Western India. Paper presented in National Symp. On Resource utilization through integrated farming system an biodiversity conservation in drylands. Dec.20-22, 2011 at CAZRI, Bhuj. 2nd best poster award bagged Ab. page.117.
2. Dr. B. D. Sharma, PS received Second Prize for the paper presented on Prospects and problems of date palm cultivation under arid conditions at PAU, Ludhiana during 15-17th March 2012 in NFFCHC-2012
3. Dr. Hare Krishna, Awarded 2nd prize in Hindi Essay writing during Hindi Week (14-21 Sep., 2011).
4. Dr. B. R. Choudhayry was awarded first prize in Hindi Essay writing during Hindi week celebrated by CIAH, Bikaner from 14-21 September, 201
5. Dr. B. R. Choudhary, Received first prize for Paper presentation in National Seminar on 'New Frontiers and Future Challenges in Horticultural Crops' held at PAU, Ludhiana during 15-17 March, 2012.

RECOGNITIONS :

Dr. S. K. Sharma

1. Co-chaired three sessions viz., Production System Management for High Quality, Brand Development, Labeling, Market Regulation and Credit Score System for Effective Marketing and Open Session during the "National Conference on Horti-Business-Linking Farmers with Market" at Dehra Dun w.e.f. 28-31 May, 2011 at Dehradun, Uttarakhand.
2. Acted as convener in the technical session III "Good Noni Crop Protection Practices – Noni Search 2011" in Noni Symposium

– "Noni – A Panacea for Wellness" during 01-02 October, 2011 at Chennai.

3. Co-chaired two sessions i.e. Agronomy and Seed Production in 30th Group Meeting of AICRP on Vegetable crops held at GBPUAT Pantnagar w.e.f. 13-16 January, 2012
4. Co-chaired Session III in National Dialogue on Climate Resilient Horticulture at IIHR, Bangalore w.e.f. 28-29th January, 2012.
5. Nominated as Member, Working Group on Agriculture, Govt. of Rajasthan, Jaipur.
6. Member, Task Force, ICAR, to evaluate and finalized DUS guidelines for vegetable crops.

Dr. Sanjay Singh

1. Acted as convener of the poster session in the National Symposium on Noni – A panacea of Wellness, 1-2 October, 2011, Chennai, organised by WNRF, Chennai..
2. Acted as Reviewer for the technical session VIII. i.e. Training and Pruning growth and development, fruit processing and rapportear in the Group Workers Meeting at Bawal, in the Session – i.e. Genetic resource management on 28-29 December, 2011
3. Acted as DDG nominee for the DPC meeting to consider promotion of ARS scientist of DMAPR, Anand for the discipline of organic chemistry and computer application on 12.1.12.
4. Acted as member in the Scientific Advisory Committee (SAC), meeting at KVK, Gola Gamdi, Vadodara on 16.6.11.
5. Acted as member in the Scientific Advisory Committee (SAC), meeting, at KVK, Panchmahal on 3-5-2011.

Dr. S. S. Hiwale

1. Nominated as Chairman in VI session on "Production technologies "in XV Vasantrao Naik memorial National seminar on Technologies for sustainable horticulture in Rain fed areas" held at Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, from 20-21 January, 2012.
2. Nominated by Director CIAH, Bikaner as Transparency officer and "Nodal officer, RTI for the regional station.
3. Nominated as Convener in session on 'Improvement of Arid zone fruits" & rapporteur in AICRP on Arid Zone Fruits workshop in session on "Plant propagation, Planting system and plant densities and weed management held at CCSHAU, Bawal during on 28-29th December, 2011.

Dr. R. Bhargava

1. Acted as member of Board of Studies (Biotechnology) in IASE University, Sardarshahar.
2. Nominated as a presenter for session-Propagation, planting density and weed management during Biennial Research Group Workers Meet held at RRS, Bawal during 28th -30th Dec, 2011.

Dr. B. D. Sharma

1. Vide letter No. 1(11)/2011-IA-V dated 19th December 2011, Director General, Indian Council of Agricultural Research, New Delhi nominated as Member Secretary, Quinquennial Review Team of Central Institute for Arid Horticulture and All India Coordinated Research Project on Arid Zone Fruits

2. Vide letter No. 117/94 IA-III dated 10th February 2012, Director General, Indian Council of Agricultural Research, New Delhi nominated as Member, Management Committee of Directorate of Rapeseed Mustard Research, Bharatpur for three years w.e.f 10-02-2012.
3. Vide letter No. 28(1)/2012-IA-I dated 24th March 2011, Deputy Director General (Education), Indian Council of Agricultural Research, New Delhi nominated me as Member of Flying Squad for the examination of AIEEA for UG to be held on 16th April 2011.
4. Vide letter No. 1(10)/2010-Exam (Pt) dated 07th February 2012, Deputy Director General (Animal Science), Indian Council of Agricultural Research, New Delhi nominated me as Arbitrator.
5. Director, CIAH, Bikaner nominated to act as Examination Coordinator of the ARS/ NET Examination held at Bikaner on 20-02-2012.
6. ICAR, New Delhi has nominated to act Member, Management Committee of Central Institute for Arid Horticulture, Bikaner for the three year w.e.f July 2011.
7. Acted as Presenter for Nutrient management and Water Management Sessions and Rapporteurs in Nutrient management in Arid Fruit Crops Session, ATR and Plenary Sessions in XVI Biennial Workshop of AICRP on AZF, held at RRS, Bawal, Haryana during 28-30th December 2011.

Dr. Hare Krishna

1. Nodal Officer for Special characteristics identification sub Task Force for *Ber* by PPV&FRA, New Delhi.
2. Served as the Chairperson of the Technical session-II (Propagation and Nursery Management) and evaluated the posters during the poster sessions of Technical sessions III (Cultural Practices); IV (Organic Farming) & VI (Postharvest Management and Value Addition of International Symposium on Minor Fruits and Medicinal Plants for Health and Ecological Security (ISMF & MP) held at Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India (19-22 December, 2011).

Dr. R. S. Singh

1. Nominated by PPV& FRA, Min. of Agri., New Delhi as Nodal officer of Sub-Taskforce on Date palm for DUS characters and meeting conducted on 16 Dec., 2011 at CIAH, Bikaner.

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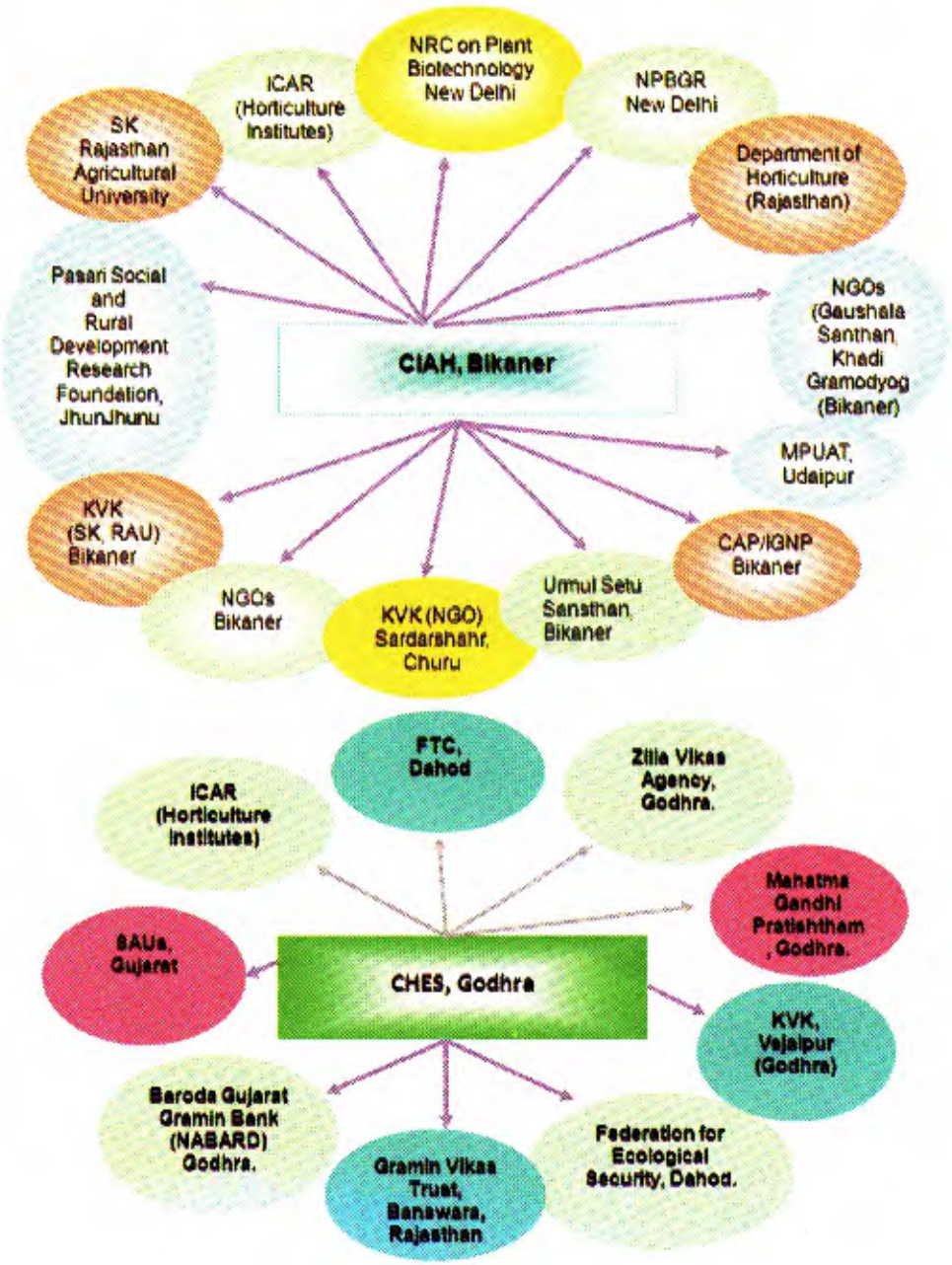
सम्पर्क एवं सहयोग

Linkages and collaborations



7

बाह्य वित्त–पोषित परियोजनाएं

Externally Funded Projects

CIAH, Bikaner

2. 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*

A large number of germplasm accessions (330) belonging to different geographical regions of India were collected from different sources and are being maintained at the field gene bank of CIAH farm. This large collection makes difficult to utilize germplasm resource for breeding and crop improvement. Using heuristic approach in Power Core software, 52 germplasm accessions of *Z. mauritiana* were identified as core collection from 330 accessions with 100 per cent coverage and it had coincidence rate of 98.11 per cent. No significant difference was observed on Shannon-Weaver and Nei diversity index for qualitative traits, mean and range for quantitative traits and cluster analysis between core and whole collection. On the basis of analysis, the core collection developed here represents entire diversity of each class in the whole collection with minimum redundancy. The core collection developed for *Z. mauritiana* will be useful in conservation and utilization of its germplasm for improvement.

Higher moisture stress tolerant genotype of *Ziziphus nummularia*

On the basis of physiological and biochemical parameters *Z. nummularia* genotype from Jaisalmer (CIAHN-J) was found higher tolerance to moisture stress compared to *Z. nummularia* from Bikaner and Godhra. *Z. mauritiana* and *Z. rotundifolia*. 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 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/ m^2/sec, proline level was increased by 35 fold and catalase increased by two fold during stress compared to control.

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
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An extensive survey was made to diversity rich districts of Gujarat (Anand, Dahod, Khera, Vadodara, Narmada, Panchmahals, Sabarkantha, Bharuch) and M.P.(Jhabua, Dhar, Ratlam, Indore, Ujjain, Shadol, Dewas and Badwani) were surveyed to identify, earmarked and collect the genotypes in the form of shoots, leaves, flowers and fruit for further evaluation. So far a total of 38 genotypes were collected which had fairly wide spectrum of variability with respect to growth, flowering, fruiting behaviour and quality attributes.

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

During the period under report, a total of 7 (new) elite genotypes were identified and earmarked and they will be collected during July-August, 2012. These genotypes were also collected in the form of shoots, leaves, flowers, seeds, etc. for morphological study.

In-situ establishment of different collection their maintenance and evaluation

Vegetative growth characters in terms of plant height, stem girth and plant spreads of forty one genotypes established in the field were recorded. All the genotypes are growing well under rainfed conditions of semi-arid conditions. Growth and fruiting behavior and quality attributes were recorded.

Characterization of different evaluated genotypes

Results of study on the vegetative growth and quality characters revealed that the different genotypes exhibited significant differences for growth parameter under rainfed conditions of hot semi-arid ecosystem

Vegetative growth

Results of study on the vegetative growth revealed that the *Morinda* genotypes exhibited significant differences for vegetative growth parameters. The plant height ranged from 130.50 in CHESN-17 to 225.00 cm in CHESN-23 while stem girth varied from 11.05 cm in CHESN-1 to 21.20 cm in CHESN-23. Plant spread ranged from 120.15 cm to 245.00 cm in E-W direction whereas plant spread in N-S direction ranged from 117.20 cm to 230.45 cm among the evaluated genotypes.

Leaf

The leaf length varied from 12.40 cm in CHESN-12 to 27.50 cm in CHESN-7 while leaf breadth varied from 7.82 cm in CHESN-15 to 17.40 cm in CHESN-10. The number of vain pairs recorded the maximum (11.33) in CHESN- 15 and the minimum (7.30) in CHESN-6. Petiole length varied from1.20 cm to 2.35 cm and it was recorded the highest in CHESN-31 and the lowest in CHESN-12 among the genotypes studied for leaf morphology. Wide differences in shape of the leaf were also observed among the genotypes.

Fruit Quality

Fruit yield/ plant, fruit weight, fruit length, fruit breadth, pyrenes/ fruit and number of seeds/ fruit, seed weight, TSS and pH of fruit juice ranged from 0.50-1.75 kg, 17.00-50.10 g, 2.40-5.00 cm, 2.34 -3.89 cm, 10.95-26.00, 25.00-58.50, 0.07 - 0.10g, 7.00-11.50^0 Brix and 4.00-5.00, among the different genotypes evaluated for yield and quality attributes under rainfed conditions of hot semi arid ecosystem.

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

Seeds of all the established genotypes were collected and sown in nursery. Elite genotypes (new) will be collected in the form of air layrings in July, 2012. More than 90% success hav been achieved by air layering in the month of July. Study on seed germination is also in progress. All the genotypes are growing well under rainfed condition of hot semi-arid ecosystem. Thirty genotypes of *Morinda citrifolia* has already been planted in the field at the station. Various propagation techniques are being standardized in *Morinda tomentosa*.

Identification of pests and diseases and their management

Plant of *Morinda tomentosa* does not suffer from any major pests and diseases, some leaf eating caterpillar and minor leaf spots due to fungi and post harvest rotting of pyrenes causing discoloration and emission of putrid smell due to fungi like *Rhizophus sp.* and *Aspergillus sp.* were found affecting the fruit.

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

Lead Centre

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Co-operating Centres

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Objectives

1. To validate the draft descriptors for watermelon and muskmelon.
2. To assemble and validate the varietal collections available with the Agricultural Universities, ICAR Institutes and other institution.
3. To maintain the reference/example varieties through maintenance breeding.
4. To identify specific morphological characters, if required.
5. To develop the database for the descriptor of targeted crops to add on to INDUS (India Database for DUS).

Watermelon

A total of 9 released varieties and 7 genotypes of watermelon were evaluated and characterized for different morphological characters. The ground colour of seed testa in RW 187-2 was found to be uniform white. Maximum seed length was observed in Charleston Grey (1.25 cm) and minimum in Arka Manik (0.68 cm). The 100 seed weight varied from 3.77 g in Arka Manik to 10.44 g in Thar Manak. Length of cotyledon varied from 2.46 cm in Durgapura Lal to 4.71 cm in Thar Manak. Leaf shape was found to be pentalobate in all references varieties of watermelon except Durgapura Lal where the leaf shape was non-lobed. Monoecious sex form was found in all the genotypes except AHW-65 which was andromonoecious in sex

form. Two types of ovary shape (oval, long) were observed with varying degree of pubescence (weak, medium, strong) (Fig. 70). Flesh colour was found to be red in all the tested genotypes except RW 187-2 where it was yellow. The firmness of flesh was categorized as soft, medium and firm. Fruit weight varied from 2.32 kg in Charleston Grey to 4.00 kg in Asahi Yamato. TSS was recorded from 8.32% in AHW-19 to 12.21% in RW 187-2 (Fig. 70). The seed of all the collected varieties/genotypes was maintained through selfing for utilization in next year.

Fig. 70:Variation in seed, leaf and ovary traits

Fig. 71: Variation in fruit traits

Muskmelon

Eleven varieties and nine genotypes were characterized. Seed colour was found to be white (Arka Jeet, Arka Rajhans, Kashi Madhu, Pusa Madhuras), creamy yellow (GMM-3, RM-43, Durgapura Madhu) and yellow (Pusa Sharbati). The 100 seed weight varied from 1.75 g in Arka Jeet to 4.02 g in RM-50. The intensity of green colour of cotyledon was found to be light (MHY-3, RM-50), medium (Durgapura Madhu, Kashi Madhu, Pusa Sharbati) and dark (Arka Jeet). Length of cotyledon ranged from 2.49 cm in Arka Jeet to 4.47 cm in RM-50. The intensity of leaf blade colour varied from light (RM-43), medium (Arka Jeet, Durgapura Madhu) and dark (Kashi Madhu, Pusa Sharbati, Pusa Madhuras). Two types of sex forms *viz.*, andromonoecious in all released varieties and monoecious in AHMM-8 was observed. Flesh thickness was ranged from 1.54 cm in Arka Rajhans to 3.20 cm in Pusa Sharbati. Flesh colour was found to be salmon (Pusa Sharbati, Pusa Madhuras), white (Arka Jeet), green (Durgapura Madhu), salmon orange (Kashi Madhu) and greenish white (Arka Rajhans, GMM-3) . Strength of attachment of peduncle at maturity was observed to be zero slip (Arka Jeet, Durgapura Madhu), half slip (Arka Rajhans, Kashi Madhu) and full slip (GMM-3). Fruit weight varied from 0.35 kg in Arka Jeet to 1.22 kg in MHY-5. TSS of fruits ranged from 11.60% in RM-50 to 12.95% in GMM-3. All the varieties/genotypes were selfed and seed was harvested for further utilization.

8

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Singh, P.K., Choudhary, B.R. and Singh, B. (2011). Biodiversity of underutilized vegetables in the tarai region of Kushinagar, Uttar Pradesh. *In.* National symposium on vegetable biodiversity held at JNKVV, Jabalpur (MP) from 4-5 April, 2011. pp. 113-114.

Singh, P.K., Choudhary, B.R., Bhardwaj, D.R., Chaubey, T. and Singh, B. (2011). Underutilized vegetables bounty from the nature for health and wealth in the *Tarai* region of Kushinagar, Uttar Pradesh. *In.* National Conference on Horticulture Business Linking Farmers with Market held at Dehradun, Uttrakhand from 28-31 May, 2011. pp 143-145.

Singh, R. S. (2011). "Cactus pear: A multipurpose plant for hot arid region" *In.* Book of Abstracts of International symposium on Minor Fruits and Medicinal Plants for Health and Ecological Security (ISMF&MP), BCKVV, Nadia, West Bengal, during 19-22 December, 2011, pp 24.

Singh, R. S., Bhargava, R., Pal, Garima and Sharma, S. K. (2011). "Post-harvest Management of Date palm Fruits" *In.* Abstract National Symposium on Resources Utilization Through Integrated Farming System and Biodiversity conservation in drylands, held at CAZRI, Regional Research Station, Kukma- Bhuj during 20-22 December, 2011, pp 99.

Singh, R. S., Bhargava, R., Sharma, B. D. and Sharma, S. K. (2012). "Prospects and problems of Date palm cultivation under arid conditions" *In.* Abstract of National Seminar on New Frontiers and Future Challenges in Horticultural Crops organized by Department of Horticulture, PAU, Ludhiana, during 15-17 March, 2012, pp 205-206.

Singh, R. S., Krishna, Hare and Sharma, S.K. (2011). "Underutilized fruits for nutrition and livelihood security in hot arid region". *In.* Book of Abstracts of International symposium on Minor Fruits and Medicinal Plants for Health and Ecological Security (ISMF&MP) BCKVV, Nadia, W.B. during 19-22 December, 2011, pp 23.

Singh, R. S., Pal, Garima and Bhargava, R. (2012). "Delicious drink from Date palm fruits"

In. Abstract National Seminar on New Frontiers and Future Challenges in Horticultural Crops organized by Department of Horticulture, PAU, Ludhiana, during 15-17 March, 2012, pp 203-204.

Singh, Sanjay and Singh, A. K. and Lata, Kanak. (2011). High quality fruit production of jamun through varietal improvement and canopy management under semi arid ecosystem of western India. Paper presented as oral presentation in National conference, organised by Lt ASM foundation at Dehradoon on Horti Business – Linking Farmers with market, held during 28-31, May, 2011, pp 28.

Singh, Sanjay, Singh, A. K. and Sharma, S. K. (2012). Resource management on minor fruits in semi-arid ecosystem of western India. International Symposium on Minor Fruits and Medicinal Plants for Health and Ecological Security, 19-22 December, 2012, BCKV, West Bengal.

Singh, Sanjay, Singh, A. K., and Sharma, S. K. (2011). Potential of noni in semi-arid ecosystem of western India, National Symposium on Noni - Apanacea of Wellness, 1-2 October, Chennai, organised by WNRF, Chennai, pp 101-109.

Sivalingam, P.N., Singh, D., Changal, H. K., Chauhan, S., Bhargava, R., Sharma, S.K., Padaria, J., Bhatta, K.V. and Mohapatra, T. (2012). Identification of *Ziziphus* genotype suitable for bioprospecting of gene for moisture stress tolerance by physiological and biochemical parameters. *In.* Abstract, "International Conference on Plant Biotechnology for Food Security: New Frontiers, Feb. 21-24, 2012, pp 192-93.

RADIO/ TV TALK

Dr. Sanjay Singh, Head

1. Delivered radio talk on the topic "Management of mango" on 08/08/11.
2. Radio talk on "Cultivation of Mosambi and Nimbu" was delivered at AIR, Godhra on 30/11/11.

Dr. A. K. Singh, Sr. Sci.

1. Delivered a radio talk on the topic *Bagayati pak man bilani kheti* at AIR, Godhra on 22/07/2010.
2. Delivered a radio talk on the topic *Bilani vaigyanic kheti ane ayurvedic mahatva* at AIR Godhra on 20/04/2011.
3. Delivered a radio talk on the topic *Goma Yashi bilani kheti* at AIR, Godhra on 06/09/2011.

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अनुसंधान रूपरेखा एवं परियोजनायें
Research Programmes and Projects

Code	Tile	Investigators
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 (karonda, phalsa, lasora, wood apple, ker, cactus pear, fig, pilu 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)	Cucurbitaceous vegetable crops: Bottle gourd, tomato, brinjal, beans, kakdi, round gourd, snap melon, kachri and khejri.	Dr. D. K. Samadia Dr. Hanif Khan
(h)	Wood apple, mango, sapota and custard apple	Dr. S. S. Hiwale

(i)	Jamun, tamarind, mahua and chiraunji.	Dr. Sanjay Singh Dr. A. K. Singh Dr. R. Bhargava Dr. V. V. Appa Rao
CIAH: 2	**Improvement of arid and semi arid fruit and vegetable crops including biotechnological interventions.**	**Dr. S. K. Sharma (Project Leader)**
(a)	Ber	Dr. Hare Krishna
(b)	Vegetable cropps	Dr. D. K. Samadia Dr. Hanif Khan
(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
(d)	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
(e)	Breeding for yield, quality, biotic and drought resistance in cucurbitaceous crops	Dr. S. Raja Sh. H. K. Joshi
	(karonda, phalsa, lasora, wood apple, ker, cactus pear, fig, pilu and mulberry)	Dr. R. S. Singh Dr. Dhurendra Singh
(f)	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.	
(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 hroticultural crops under abiotic stress	Dr. R. Bhargava Dr. R. S. Singh Dr. B. D. Sharma
(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
(e)	Post harvest management and value addition in arid horticultural crops.	Dr. R. Bhargava Dr. R. S. Singh Dr. S. R. Meena
(f)	Dynamics of horticultural growth and development in hot arid regions of western Rajasthan : A status study	Dr. S. R. Meena
(g)	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
(h)	Standardization of integrated nutrient management in arid horticultural crops.	Dr. B. D. Sharma Dr. R. Bhargava Dr R. S. Singh Dr. S. K. Maheshwari
(i)	Standardization of production technology of aonla.	Dr. A. K. Singh Dr. Sanjay Singh Dr. S. S. Hiwale
(j)	Standardization of production technology of mango and satgudi orange.	Dr. Sanjay Singh Dr. A. K. Singh Dr. V. V. Appa Rao Shri H. K. Joshi Dr. S. S. Hiwale

(k)	Crop regulation in moringa and intercropping studies under semi-arid conditions.	Dr. S. Raja Dr. V. V. Apparao
(l)	Organic farming studies in vegetables under semi-arid condition.	Dr. V. V. Apparao Sh. H. K. Joshi Dr. S. Raja
(m)	Augmentation of vegetable cultivation by tribal farmers of Panchmahals district of Gujarat: An extention action research.	Dr. V. Lenin Dr. S. Raja
(n)	Value addition in semi-arid fruit crops.	Dr. S. Raja Dr. V. V. Apparao
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 vegetables in arid region of Rajasthan.	Dr. S. M. Haldhar Dr. B. R. Choudhary Dr. R. Bhargava
(c)	Integrated disease management in semi-arid horticultural crops.	Sh. H. K. Joshi Dr. Sanjay Singh
(d)	Biological control of diseases of semi-arid fruits and vegetables.	Sh. H. K. Joshi
(e)	Management of major fungal diseases of semi-arid fruits and vegetables using foliar sprays with inorganic salts and organic compounds.	Sh. H. K. Joshir Dr. V. V. Apparao Dr. Sanjay Singh

CONCLUDED PROJECTS

CIAH: 1 (g)	Introduction, collection, characterization, conservation and evaluation of germplasm of arid fruit and vegetable crops under hot arid environment: Mango, guava and jamun	Dr. R. S. Singh Dr. R. Bhargava

CIAH: 3 (b)	Evaluation of ber based cropping system	Dr. Hare Krishna Dr. R. Bhargava Shri V. Karuppaiah (on study leave)
CIAH/ B 5	Development of greenhouse based propagation technology of horticultural crops under hot arid agro eco-system.	Dr. Dhurendra Singh Dr. S. R. Meena
CIAH/ B 15 (a)	Population dynamics of major insects pests on arid fruits and vegetables.	Shri V. Karuppaiah (on study leave) Dr. S. M. Haldhar Dr. D. K.. Samadia Dr. P. N. Sivalingam
CIAH/B15(c)	Molecular characterization of begomo virus affecting chilli in hot arid region.	Dr. P. N. Sivalingam Dr. Dhurendra Singh Dr. Hanif Khan Dr. S. M. Haldhar Dr. S. K. Maheshwari
CHES/ G 6	Integrated orchard management studies on ber, pomegranate and aonla	Dr. S. S. Hiwale Sh. H. K. Joshi Dr. V. V. Apparao
CHES/ G 7(a)	Integrated pest management in bitter gourd and pumpkin.	Shri H. K. Joshi Dr. S. Raja

Externally funded projects

EF 1	Bioperspecting of genes and allele mining for abiotic stress tolerance.	Dr. P. N. Sivalingam Dr. Dhurendra Singh
FF 2	Identification, collection, characterization, evaluation and conservation of Noni (*Morinda* spp. L.) of western India (Gujarat and M. P.).	Dr. A. K. Singh
FF 3	Validation of DUS testing guidelines for cucurbits i.e. watermelon and muskmelon.	Dr. B. R. Choudhary
FF 4	Validation of DUS descriptor for ber (*Ziziphus* sp.).	Dr. Hare Krishna
FF 5	Validation of DUS descriptor for date palm (*Phoenix dactylifera*).	Dr. R. S. Singh Dr. R. Bhargava

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संस्थान की अनुसंधान सलाहकार, प्रबंधन एवं शोध समितियां

RAC, IMC, IRC, QRT

QRT

Chairman
Dr. K. S. Khokhar
Hon'ble Vice Chancellor
CCSHAU, Hisar (Haryana)

Members

Dr. Y. N. Reddy
Former Head
ANGRAU, Hyderabad-500 072

Dr. B. M. C. Reddy
Former Director
CISH, Lucknow

Dr. R. H. Singh
Former Professor (Plant Pathology)
IARI, New Delhi

Dr. Y. R. Sarma
Former Director
IISR, Calicut (Kerela)

Member Secretary
Dr. B. D. Sharma
Principal Scientist
CIAH, Bikaner-334006 (Rajasthan)

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

Dr. S. Rajan
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

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 21-22 October, 2011 at CIAH, Bikaner

Institute Management Committee (IMC)

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

Members
Dr. S. Rajan
ADG (Hort.-I)
ICAR, New Delhi

Director (Hort.)
Govt. of Rajasthan, Jaipur

Director of Hort.
Gujarat State
Gujarat

Director of Research
S. K. RAU
Bikaner

Sh. Narendra Kumar Kiradu
Bikaner

Sh. K. Prabhakar Sadashi Chandane
President, All Indian Pomegranate Growers Association, Pune
FAO, CSWRI
Avikanagar (Rajasthan)

Dr. B. G. Bagle
Head
CHES, Godhra (up to 30.9.2010)

Dr. Sanjay Singh
Head
CHES, Godhra (w.e.f. 1.10.2010

Dr. Rakesh Bhargava
Pricipal Scienist
CIAH, Bikaner

Dr. D. K. Samadia
Sr. Scientist
CIAH, Bikaner

Dr. D. Singh
Sr. Scientist
CIAH, Bikaner

Member Secretary
Admn. Officer, CIAH, Bikaner.

The meeting of IMC was held on 09.11.2012

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संगोष्ठियां, प्रशिक्षण, व्याख्यान, बैठक आदि

Conferences, Training, Lectures, Meeting Etc.

Meeting

Dr. S. K. Sharma, Director

Attended Divisional Meeting of the Directors of Horticulture Division under Chairmanship of DDG (H) on 11th April, 2011

Attended the "Interaction Meeting of Project Directors/Project Coordinators" held at Bhopal (M.P.) during 15-17 June, 2011 under the Chairmanship of Hon'ble DG, ICAR, New Delhi.

Attended Meeting of "Working sub-groups of horticulture crops" held on 24th June, 2011 at New Delhi at New Delhi under the chairmanship of DDG (H), ICAR.

Attended Meeting of "Sub-Group No. 2 on Assessing Growth Rate of Horticulture Sector in XII Plan" held at Bangalore on 30th June, 2011 under the Chairmanship of DDG (H), ICAR, New Delhi.

Attended the Review Meeting of AICRPs, which was Chaired by Secretary, DARE and DG, ICAR, New Delhi on 25th July, 2011.

Attended the second meeting of Sub-Group No. 2 on Assessing Growth Rate of Horticulture Sector in XII Plan which was Chaired by DDG (Hort.), ICAR, New Delhi on 26th July, 2011

Attended RAC meeting held at IIVR, Varanasi (UP) during 09-11 August, 2011

Attended the meeting at Secretariat, Jaipur, under the chairmanship of Principal Secretary (Horticulture), Government of Rajasthan on 18th August, 2011

Attended the meeting held on "Sub-Group No. 2 on Assessing Growth Rate of Horticulture Sector in XII Plan" under the chairmanship of DDG (Hort.) at New Delhi on 29th August, 2011

Attended the meeting held on "Issue to form platforms for XII Plan" under the chairmanship of DDG (Hort.) at ICAR, New Delhi during 6-7 September, 2011

Attended the meeting on consultation workshop on Conservation Agriculture in the XII Plan at New Delhi on 22.09.2011

Attended the meeting of "Vice Chancellors of Agricultural Universities" at ICAR, New Delhi from 25-27th September, 2011

Participated in "National Dialogue Meeting for Application of the Nanotechnology in Agriculture" at Mumbai during 07-10 October, 2011

Attended meeting to finalize the Draft proposal for National Network Project on PGR management and use at New Delhi w.e.f. 18-19 Nov. 2011

Attended meeting on " National Dialogue on Climate Resilient Horticulture at IIHR Bangalore 28-29th January, 2012

Attended Director Vice-Chancellor Interface meeting and Directors Conference on 17-18th February, 2012 at New Delhi.

Participated in the programme of Hon'ble Director General, ICAR of Anantapur (Andhra Pradesh) w.e.f. 25-26 February, 2012.

Participated in the Nano-technology meeting at New Delhi on 12-03-2012 Chaired by Hon'ble DDG (Hort.).

Attended a meeting at New Delhi on 23.03.2012 under the Chairmanship of S. Rajan

ADG (Hort.I) regarding the Establishment of Centre of Excellence in Citrus at Abohar.

Attended first meeting of Task Force on Vegetable Crops at New Delhi on 27-03-2012.

The third review meeting of Network project on Tissue Culture of Palms was held at the Institute on 16.08.2011 which was chaired by Dr. H.P. Singh, DDG (Hort.), ICAR, and New Delhi. At the outset of the programme Dr. S.K. Sharma, Director, CIAH welcomed the participants. Dr. O.P. Pareek, Former Director of the Institute, Dr. S.K. Sharma, Director, Dr. Akela Vani, Principal Scientist, IIHR: Dr. Govind Singh, Professor and Head, Deptt. of Plant Biotechnology, SKRAU, Bikaner, Dr. R.S. Singh, Principal Scientist, CIAH, Bikaner, Dr. M.K. Rajesh, Dr. P.N. Shivlingam, Scientist, CIAH attended the meeting. Dr. Anitha Karun, Principal Scientist, CPCRI, Kasargod, Kerala, Dr. Dhurendra Singh, Senior Scientist CIAH, Bikaner, Dr. M. Jayanthi, Senior Scientist, DOPR Pedavegi, AP, presented the progress made under the Network Project with respect to coconut and arecanut, date palm and oil palm.

At the concluding remarks DDG (Horticulture) emphasized to scale-up the protocols of date palm, oil palm and coconut. DDG (Horticulture) was agreed to further strengthen this network programme in the XII plan with financial support from ICAR.

Institute Joint Staff Council (IJSC) Meeting was held on 16 September, 2011 and 07.12.11

Chaired IJSC meeting on 28.06.2011, 16.09.2011, 07.12.2011 and 21.02.2012

Chaired, I.R.C. Meeting held at CIAH, Bikaner o 21-22 October, 2011.

Meeting of validation of DUS testing in cucurbits in watermelon and muskmelon was held w.e.f. 02.11.2011 to 03.11.2011.

Chaired, Institute Management Committee (IMC) Meeting was held on 09.11.2011 at CIAH, Bikaner.

Meeting regarding KVK issues held at Bikaner on 14.11.2011.

Chaired, first meeting of ITMU was held on 16.11.2011 in which Dr. N.D. Yadav, Head, CAZRI, RRS, Bikaner acted as external member.

Dr. R. S. Singh

Attended PSC meeting to present the Final report of the Bael Project at NMPB office, New Delhi on 13.05.2011.

Attended Scientific Advisory Committee (SAC) Meeting of KVK as invitee on 03.05.2011 at KVK, Vejalpur, Godhra.

Attended meeting of NBPGR-NAGS Parternership on Efficient Management and Use of Plant Genetic Resources held at NBPGR, New Delhi on 29-30 July, 2011.

Attended Palm Workers Group meeting chaired by Hon'ble DDG (Hort), ICAR held at CIAH, Bikaner on 16.08.2011.

Attended ZEARC meeting at ARS, SKRAU, Bikaner on 23.8.2011.

Organized 4 days training programme for officials of AFRI on Vegetative Propagation of Khejri at CIAH, Bikaner during 1 - 4.10.2011.

Attended IRC meeting of the Institute from 21-22 October, 2011.

Participated in 16th Research Workers Group Meeting of AICRP on AZF held at CCS HAU, RRS, Bawal during 28 to30.12.2011.

Acted as Rapporteur in Plant Genetic Resource Management Session in XVI Biennial Workshop of AICRP on AZF, held at CCS HAU, RRS, Bawal, Haryana.

Attended Institute Management Committee meeting of CIAH, Bikaner as invitee on 09.11.2011.

Organized a meeting of platform "Conservation Horticulture" of Co-operating centres held at CIAH, Bikaner on 05.11.2011.

Attended Institute Technology Management Committee meeting as member at CIAH, Bikaner on 16 November, 2011.

Attended QRT meeting of CIAH, Bikaner held on 10.2.2012.

Attended Sensitization cum Training workshop for I/c PME Cell (Nodal Officer) on HYPM at IASRI, New Delhi on 03.03.2012.

Attended as member of Institute Management Committee meeting of Zonal Project Directorate (Zone VI) on Jodhpur on 19.3.2012.

Attended as member of IJSC meeting held at CIAH Bikaner on 21.02.12.

Organization of Hindi week programme from 14-21 September, 2011.

Dr. S. K. Maheshwari

Attended "National consultation- cum-Training on Diagnostics in Horticultural Crops" at CPRI, Shimla on 16th April, 2011

Dr. Sanjay Singh, Head, RRS, CHES

Participated in the meeting-cum-workshop of the Heads of the Division and Regional Stations/Centre from 14-15 June, 2011 held at CIAE, Bhopal, Madhya Pradesh.

Participated in the group workers meeting of AICRP on arid fruits at Bawal from 28-30 December, 2011.

Acted as member in the IJSC meeting at CIAH, Bikaner on 28-6-11, 9-11-11, 7-12-11 and 21-2-12.

Participated in the QRT meeting at CIAH, Bikaner on 10-2-12

Dr. Dhurendra Singh

worked as invigilator for conducting examination of JET and Pre- PG of SAUs of Rajasthan at College of Agriculture, SKRAU, Bikaner on 19.02.2012

worked as invigilator for conducting examination of ARS/NET of ICAR at Dungar College, Bikaner on 19.02.2012

Visited Tissue culture laboratory of AAU, Anand on 8.04.2011 alongwith Dr. P. N. Sivalingam.

Attended International workshop on cactus pear on 26.11.2011 at NBPGR, New Delhi

Attended NAIP Scientist meet on foreign training at NASC, New Delhi organized by NRC Plant Biotechnology, New Delhi on 28-30 Nov., 2011

Attended Biennial Meeting of the Group Workers of AICRP-AZF at RRS-Bawal Haryana on 28-30 Dec., 2011

Attended meeting on date palm organised by Horticulture Development Society, DoH, Jaipur on 12.08.2011

Attended Review meeting of Network project on Palm Tissue Culture organized at CIAH, Bikaner on 16.08.2011

P. N. Sivalingam

Attended Review meeting of Network project on Palm Tissue Culture organized at CIAH, Bikaner on 16.08.2011

Participated in International conference on Plant Biotechnology for food security: New Frontiers, 21-24 February, 2012, NAS complex, New Delhi

Dr. D. K. Samadia

Attended ZREAC Rabi - 2011 Meeting held at ARS, SKRAU, Bikaner on 23 - 24 August 2011

Dr. B. R. Choudhary

Participated in DUS review meeting organized by PPV&FRA, New Delhi during 11-12 November, 2011.

Attended meeting of ICAR platform project on protected cultivation held at IIVR, Varanasi on 22-11-2011

Conference

Dr. S. K. Sharma, Director

Attended National Symposium on Vegetable Biodiversity at JNKVV, Jabalpur during 04-05 April, 2011.

Participated in Directors' Conference and Foundation Day Celebration of ICAR during 15-16th July, 2011, at New Delhi.

Participated in Pre- Congress Workshop of AFRI, Jodhpur, on 19th July, 2011.

Participated in NAGS Workshop held at NBPGR, New Delhi during 29-30th July, 2011

Participated in a training programme on "Employer's Perspective on Labour Related Laws" held at NAARM Hyderabad during 03-07th August, 2011

Acted as Chief Guest in the Inaugural Function " New Technologies of Vegetable at CAZRI RRS, Bikaner on 02.11.2011.

Chaired the Hindi committee meetings held on 20.06.2011, 09.09.2011, 17.12.2011 and 21.02.2012. Quarterly Hindi workshops were also held on 30.06.2011, 21.09.2011, 19.12.2011 and 05.03.2012

Organized XVI Biennial Meeting of All India Coordinated Research Project on Arid Zone Fruits was held during 28 to 30 December, 2011 at Regional Research Station (CCSHAU), Bawal.

Dr. Sanjay Singh, Head

Participated in National conference, organized by Lt ASM foundation on "Horti-Business – Linking Farmers With Market" held during 28th -31st May, 2011 at Dehradun, Uttarakhand.

Participated in the 6th national symposium on noni- a panacea for wellness organized at Chennai on 1st to 2nd October-2011.

Participated in the State level Seminar on " Sustainable collection and profitable cultivation of aromatic and medicinal plants in Gujarat" organized by DMAPR, Boriavi, Anand on 18th January,2012.

Dr. A.K. Singh, Sr. Sci.

Participated in SPJS and National conference on Hoti Business-linking farmers with market, 28th -31st 2011, held at Dehradun.

Participated in National Symposium on Noni- A panacea for wellness, 1-2 October, 2011 at Chennai

Dr. V. Lenin, Sci.

Participated in the International Conference on 'Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences' held at New Delhi during 9-12 November, 2011, and delivered a oral presentation of the invited paper entitled 'Coordination Among Agencies Delivering Extension Services Under Agricultural Technology Management Agency'.

Dr.S.S.Hiwale, PS

Presented a paper "Sustainable Horticulture based cropping systems for increased productivity and carbon sequestration on marginal land under rain fed conditions" in XV Vasantrao Naik memorial National seminar on technologies for Sustainable horticulture in Rain fed areas" held at Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, from 20-21 January, 2012.

Dr. R. S. Singh

Attended, National Seminar on New Frontiers and Future Challenges in Horticultural Crops (NFFCHC-2012) held at PAU, Ludhiana, during 15-17 March, 2012.

Dr. S. K. Maheshwari

Attended Refresher Course on "Agricultural Research Management for Senior/ Principal Scientists" held at National Academy of Agricultural Research Management (NAARM), Hyderabad during November 3- 23, 2011.

Dr. S. M. Haldhar

Attended 3rd Congress on Insect Science '*Pest Management for Food Security aqnd Environment Health*' organized by department of entomology, PAU, Ludhiana- 141004 during 18-20, April, 2011.

Attended National Seminar on '*Emerging Pest Problems and their Bio-rational Management*' organized by Rajasthan College of Agriculture, Udaipur during 02-03, March, 2012.

Dr. P.N. Sivalingam

Participated in International Conference on Plant Biotechnology for Food Security: New Frontiers, 21-24 February, 2012, NAS complex, New Delhi

Dr. Hanif Khan

Participated in winter school training Course of 21 days on "Molecular approaches for allele mining and crop improvement" organized at the Division of Genetics, Indian Agricultural Research Institute, New Delhi from 5th January to 25th January 2012.

Participated in a 10 days short course training programme on "Bioinformatics in agriculture" held at Indian Agricultural Statistical Research Institute, New Delhi from 29th August to 07th September 2011.

Attended National Symposium on "Resource Utilization through Integrated Farming System and Biodiversity Conservation in Drylands" held during December 20-22, 2011 organized by CAZRI at Bhuj

Dr. B. R. Chodhary

Attended XXXth Annual Group Meeting of AICRP on Vegetable Crops at Department of Vegetable Science, COA, GBPUA&T, Pantnagar during 13-16 January, 2012.

Attended National Seminar on New Frontiers and Future Challenges in Horticultural Crops held at PAU, Ludhiana during 15-17 March, 2012

Dr. S. R. Meena

Participated in International Conference on "Innovative Approaches for Agricultural Knowledge Management : Global Extension Experience" New Delhi, during 09 – 12 November, 2011 and presented a research paper entitled "An expanding area under summer vegetables in hot arid ecosystem of western Rajasthan" .

Participated in a high level Farmer's Conference held at Rajasthan University of veterinary and Animal Science, Bikaner, Rajasthan, on 15.03.2.12

Lectures:

Dr. Sanjay Singh, Head

Lectures delivered in training programmes organised by the KVK, Panchmahal

1. Varietal description of jamun on 19.10-11.
2. Role of fruit culture in integrated farming system on 17-1-12.
3. Mango cultivation in dry land on 13-2-12.
4. Mulching technique in fruit orchard on 15-2-12.
5. Value addition on underutilized fruits on 22-9-11.
6. Delivered special lecture on the occasion of NFS Orientation-cum-gender sensitization meet for bankers at KVK, Panchmahal, organized by NABARD, Gujarat, Regional office, Ahmedabad in association with KVK, Panchmahal on 5-11-11.

Lectures delivered to the BRS (Bachelor of Rural Studies) students at CHES, Vejalpur.

1. Crop Production of karonda on1.9.11.
2. Crop Production of mahua on 7-9.11.
3. Canopy management on 15-9-11.
4. Crop Production in Jamun var. Goma Priyanka on 16-9-11.
5. Mulching in mango on 17-9-11.
6. Crop production in tamarind var. Goma Prateek on 19-9-11.
7. Crop Production of Karonda on 9-12-11.
8. Crop Production of Mahua on 15-12-11.
9. Canopy management on 21-12-11.
10. Crop production on jamun variety Goma Priyanka on 22-12-11.
11. Mulching in Mango on 23-12-11.
12. Crop production in tamarind var. Goma Prateek on 24-12-11.
13. Propagation techniques of under-utilized fruit crops on 26-12-11.
14. Crop Production of Karonda on 9-12-11.
15. Crop Production of Mahua on 15-12-11.
16. Canopy management on 21-12-11.
17. Crop production on jamun variety Goma Priyanka on 22-12-11.
18. Mulching in Mango on 23-12-11.
19. Propagation techniques of under-utilized fruit crops on 26-12-11.
20. Post harvest technology of seasonal fruits on 20-9-11.

Dr. A.K. Singh, Sr. Sci.

A lecture on bael was delivered and different bael varieties were exhibited during Krishi Mahotsava at Ghoghamba, Panchmahals on 6-5-2011. Ambali , Panchmahals on 11/05/2011 and Kothamba , Panchmahals on 19/05/2011.

Lecture delivered to BRS students/training at KVK

Lectures on different aspects of bael and aonla were delivered to BRS students (*Kendriya Nivas*) of Samajseva Mahavidyalaya Gandhi Vidyapeeth, Vedchhi, Tapi and Shri I. K. Chavda Gram Vidyapeeth, Kahnvadi, Anand during the training entitled "Semi-Arid Horticulture for Rural development from 01/12/11 to 31/12/11.

Lectures on different aspects of bael and aonla were delivered to BRS students (*Kendriya Nivas*) of Mangal Bharti, Golagamdi, Vadodara during the training entitled "Semi-Arid Horticulture for Rural development from 24/08/2011 to 22/09/2011.

A lecture on the topic Agro-techniques in aonla was delivered to the trainees on 24/11/2011during the training on Recent Trends in Aonla Production at KVK.

Dr. S. Raja, Sci.

Delivered lecture on Improvement and Production technology of different vegetable crops to BRS student for 5 days at CHES, Vejalpur

Dr. V. Lenin

Delivered a lecture on 'Benefit of internet in agriculture' to the farmers of Panchmahals district at KVK, Panchmahals, Vejalpur on 01.12.2011.

Sh. H.K. Joshi

Lectures was delivered to BRS students from Mangal Bharti, Golagamdi, Vadodara during 24.8.11 to 22.9.2011.

Lectures was delivered to BRS students from Samajseva Mahavidyalaya Gandhi Vidyapeeth, Vedchhi, Tapi and Shri I. K. Chavda Gram Vidyapeeth, Kahnvadi, Anand during 1.12.11 to 30.12.11.

Dr. Hare Krishna

Presented an oral paper on "*In vitro* clonal propagation of *lasora* (*Cordia myxa* Roxb.) using single node cuttings" in International Symposium on Minor Fruits andMedicinal plants for Health and Ecological Security (ISMF&MP) held during December 19-22, 2011 at BCKV, Kalyani, W.B.

Presented an oral paper on "Assessment of fruit based cropping model systems under hot arid region of Rajasthan" in XV Vasantrao Naik Memorial National Agriculture Seminar on Technologies for Sustainable Horticulture in Rainfed Areas held during January 20-21, 2012 at PDKV, Akola.

Dr. B. D. Sharma

Integrated Nutrient management in horticultural crops in Arid Region" in training programme for Farmers of Abhijeet Foundation, Phalodi organized at CIAH, Bikaner 14 July, 2011.

Drip Irrigation and fertigation in arid vegetable crops in arid region in training programme for farm women organized by CAZRI, RRS, Bikaner on 03.11.2011.

Nutrient management in arid horticultural crops in arid region in training programme at CAZRI, RRS, Bikaner on 15.11.2011.

Integrated Nutrient management in arid fruit and vegetable crops in farmers training programme organized at CIAH, Bikaner from 27-30.1.2012.

Fertigation in vegetable crops in training programme of farm women on 8.2.2012 at CAZRI, Bikaner.

Role of nutrient management in arid horticultural crops in arid region in Science Day programme on 28.2.2012 at CIAH, Bikaner.

Application on manures and fertilizers in vegetable crops on 31-01-2012. In: Farmers training prograame organized by ATMA, Sriganganagar held at KVK, Bikaner.

Historical perspective of CIAH, Bikaner on 1st April 2011 during Foundation Day function of CIAH, Bikaner.

Shusk chetron mein Jal sansadhan Prabandh on 14-02-2012. In: Resource

mamangement for increasing agriculture production held during 13-17th February 2012 at CAZRI, RRS, Bikaner.

Analysis of micronutrients in fruit crops-Criteria's and their applications. In: Training programme of State Level Officers of Rajasthan at ZRS, SKRAU, Bikaner on May 10th 2011.

Dr. Dhurendra Singh

Presented progress of date palm tissue culture in Review meeting of Network project on palm tissue culture organized at CIAH , Bikaner on 16.08.2011

Presented progress of date palm tissue culture in Biennial Meeting of the Group Workers of AICRP-AZF at RRS-Bawal Haryana on 28 Dec., 2011

Delivered a lecture on Hi-tech propagation- A water saving option, in National Training on water budgeting in horticultural crops in arid zone organized by ARS , SK RAU, Bikaner on 13.01.2012

Delivered a lecture on Exploring arid zone horticultural plants for medicinal and nutraceutical traits, on 31.01.2012 In NAIP National Training on "Naturally occurring nutraceuticals, crop protectants and other biomolecules for application in human and crop health" organized by Division of Agricultural Chemicals at IARI New Delhi from January 23 to February 2, 2012

Delivered a lecture on Biotechnology for improvement of horticultural crops in Farmers Training organized by RRS-CAZRI, Bikaner on 14.09.2011.

Delivered a lecture on Biotechnology in horticulture development in Farmers Training organized by RRS-CAZRI, Bikaner on 09.02.2012

Delivered a lecture on Hi-tech propagation of arid horticultural crops in Farmers Training organized by ARS-SKRAU, Bikaner on 14.02.2012

Delivered a lecture on Resource conservation through Biotechnology in Farmers Training organized by RRS-CAZRI, Bikaner on 16.02.2012.

Delivered a lecture on Hi-tech plant propagation in Farmer Workshop organized by Rajasthan Horticulture Development Society, Bikaner at Kisan Bhawan, Bikaner on 27.02.2012

Delivered a lecture on Biotechnology in horticulture development to students in National Science Day, organized by CIAH, Bikaner on 28.02.2012

Demonstrated live sample of tissue culture plants to school students in National Science Day, organized by CIAH, Bikaner on 28.02.2012

Delivered a lecture on Components of arid horticulture in Farmer Training organized by NRC on Equines, Bikaner on 24.02.2012

Delivered a lecture on improved technology of arid horticulture in Farmer Training organized by NRC on Equines, Bikaner on 22.03.2012

Dr. R. S. Singh

Improved Fruit Production Techniques in Arid Region" in training programme for Farmers of Abhijeet Foundation, Phalodi organized at CIAH, Bikaner 14 July, 2011.

Prospects and potential of fruits cultivation in arid region in training programme for farm women organized by CAZRI, RRS, Bikaner on 03.11.2011.

Bael and Aonla cultivation in a farmers training programme at CAZRI, RRS, Bikaner.

Cultivation of Non-traditional fruits in arid region in training programme at CAZRI, RRS, Bikaner on 15.11.2011.

Improved technology for Fruits cultivation in farmers training programme organized at CIAH, Bikaner from 27- 30.1.2012.

Cultivation of Less known fruits and vegetable in training programme of farm women on 8.2.2012 at CAZRI, Bikaner.

Importance of Horticulture Science and Improved Techniques of Fruit Cultivation in Science Day programme on 28.2.2012 at CIAH, Bikaner.

Dr. S. K. Maheshwari

Deliver a lecture on Shushk chhetriya phal evam sabjiyo ki pramukh bimariya evam unki

roktham in Kisan Prashikchhan Kaaryakram from 27-31 January, 2012 at CIAH, Bikaner.

Dr. B. R. Choudhary

'Fruit production in arid and semi-arid regions' in a training programme organized by CAZRI RSS, Bikaner during 2-5 November, 2011.

'Production of cucurbitaceous vegetables' in a training programme organized by CAZRI, RSS, Bikaner during 2-5 November, 2011.

'Importance and development of arid horticulture' in a training programme organized by CAZRI RSS, Bikaner during 14-18 November, 2011.

'Early cultivation of cucurbitaceous vegetables' in a training programme organized by KVK, Bikaner during 27-31 January, 2012.

'Early cultivation of cucurbitaceous vegetables' in a training programme organized by CIAH, Bikaner during 30-01-2012 to 01-02-2012.

'Protected cultivation of vegetables' in a training programme organized by CIAH, Bikaner during 30-01-2012 to 01-02-2012.

Dr. S. R. Meena

Delivered a lecture on "prospects of export and commercialization of arid fruits and vegetable" in farmer' s training programme organized by CAZRI, RRS, Bikaner from 13 – 17 February, 2012.

Delivered lecture on "prospects of export and commercialization of arid fruits and vegetable" in farmer' s training programme organized by CAZRI, RRS, Bikaner from 06 – 10 February, 2012.

Delivered a lecture on "utilization of arid horticultural traditional technologies" in a 05 days farmer's training programme organized by Central Institute for Arid Horticulture, Bikaner, from 27.01.2012 to 31.01.2012.

Delivered a lecture on "local vegetables grown in arid regions and their value addition" in a 05 days farmer's training programme organized by Central Institute for Arid Horticulture, Bikaner, from 27.01.2012 to 31.01.2012.

Delivered a lecture on "general management practices of arid vegetable production during *kharif* season." in off-campus farmer's training programme held in Napasar village of Bikaner, district, on 21.03.2012.

Delivered a lecture on " important factors keep in mind while producing arid vegetable during rainy season." in off- campus farmer's training programme held in Husangsar village (Chak No. 03 NGM) of Bikaner, distriact, on 23.07.2011

Training Imparted

One day training given to 58 students belonging to NAU, Navsari under RAWE programme. (HK Joshi Sanjay Singh,V.Lenin)

Lectures delivered regarding activities of the station to the nine B.Sc. (Agri) students of B.A.College of Agriculture, AAU, Anand on 15.07.2011, 76 B.Sc. (Hons.) (Agri) students of B.A.College of Agriculture, AAU, Anand on 23.01.2012 and 25 B.Sc. (Horticulture) students of ASPEE College of Horticulture, S.D. Agricultural University, Sardar Krushi Nagar, Dantiwada on 12.03.2012 under RAWE programme.(Sanjay Singh & V. Lenin)

Training attended

Dr. S. M. Haldhar

Attended (10 days) training programme on "*Forecast Modelling in Crops*" from 3rd august, 2011 to 12th august, 2011 at Division of Forecasting, IASRI, New Delhi.

Attended (10 days) training programme 'Naturally occurring nutraceuticals, crop protectants and other biomolecules for application in human and crop health' from January 23 to February 2, 2012 at Division of Agricultural Chemicals, Indian Agricultural Research Institute, New Delhi.

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अतिथियों का भ्रमण

Distinguished Visitors

- Visit of Dr. H.P. Singh, Hon'ble DDG (Hort.) on 15-16 August, 2011
- Dr. C. Dev Kumar, ADG (EPD), ICAR visited CIAH on 05-11-2011.
- Dr. S.L. Mehta, Former Vice Chancellor, MPUAT, Udaipur: Dr. S.A. Patil Former Vice Chancellor, UAS, Dharwad and presently Chariman, Karnataka Krishi Mission, Bangalore: Dr. K.V. Peter, Former Vice Chancellor, Kerala Agricultural University, Vellanikkava and presently Director, Noni Research Foundation, Chennai: Dr. H.S. Nainawati, Former ADG: Dr. R.P. Jangir, Director of Research, SK RAU, Bikaner and Dr. Govind Singh, Professor and head, Deptt. of Biotechnology SKRAU, Bikaner visited Institute on 06-11-2011
- Dr. Dinesh Kumar Goyal, IAS, Principal Secretary (Hort.) Govt. of Rajasthan, Jaipur along with his team visited CIAH on 19.09.2011.
- Dr. M. Anand Raj, Director, Indian Institute of Spices Research, Calicut and Dr. E.V. Sastri, Associate Professor, SKN College of Agriculture, Jobner visited the Institute on 23.12.2011.
- Dr. Manjit Singh, Director, Directorate of Mushroom Research, Solan along with Dr. N.V. Patil, Director, National Research Centre on Camel, Bikaner visited the institute on 22.02.2012.
- Chairman of Research Advisory Committee (RAC) of the Institute, Dr S. P. Ghosh, Ex- DDG (Hort.), ICAR, New Delhi and other respected members like Dr. S. Rajan, ADG (H-1) ICAR, New Delhi; Dr. K. K. Jindal, Ex- ADG(H), ICAR, New Delhi; Dr. J. P. Gupta, former Head, CAZRI, Jodhpur; Dr. Ponnuswamy, Dean, College of Horticulture and Research Institute, Periyakulam (T. N.) visited the Institute on12 February, 2011.
- Dr. N. K. Tyagi, Member, Agricultural Scientist Recruitment Board, New Delhi, visited CHES, Godhra on 7th April, 2011.
- Dr. Akella Vani, Principal Scientist, IIHR and Dr. Govind Singh, Professor and Head, Deptt. of Plant Biotechnology, SKRAU, Bikaner, visited the Institute on 16.08.2011.
- Dr. A. K. Dahama, Vice Chancellor, SKRAU, Bikaner and Dr O. P .Pareek, Former Director of the Institute visited the Institute on 16.08. 2011
- Dr. N. D. Yadav, Head, CAZRI, RRS, Bikaner, visited the Institute on 16-11-2011
- Dr. B. B. Vashishtha, Former Director, NRC on Seed Spices, Tabiji, Ajmer, Dr. V. S. Supe, MPKV, Rahuri; sh. D. R. Chaudhary, PPVFRA visited the Insitute on 16-12-2011.

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राजभाषा

Rajbhasha

संस्थाान में वर्ष 2011–12 के दौरान राजभाषा के कार्यान्व यन के लिए निम्न लिखित प्रमुख कार्यक्रम आयोजित किए।

बीकानेर

राजभाषा कार्यन्वयन समिति

राजभाषा कार्यन्वयन समिति की तिमाही बैठकों का आयोजन क्रमशरू दिनांक 20.06.2011, 09.09.2011 17.12.2011 एवं 21 फरवरी 2012 को किया गया। जिसमें संस्थान में राजभाषा की प्रगति की समीक्षा की गई एवं कार्यान्वयन मे आ रही कठिनाईयों को दूर किया गया।

हिन्दीा कार्यशाला

संस्थाान में कार्यरत अधिकारियों एवं कर्मचारियों को हिन्दी में कार्य करने की प्रेरणा के लिए राजभाषा विभाग के निर्देशानुसार प्रति तिमाही हिंदी कार्यशालाओं का आयोजन क्रमश दिनांक 30 जून 2011, 21 सितम्बकर 2011, 19 दिसम्बरर 2011 एवं 05 मार्च 2012 को किया गया।

दिनांक 19 दिसम्बिर, 2011 'राजकाज की भाषा के रूप में हिन्दी के प्रयोग की संभावनाएं' विषय पर आयोजित इस कार्यशाला में स्थानीय डूंगर महाविद्यालय के पूर्व प्राचार्य एवं हिंदी विभाग के अध्यनक्ष डॉ. देवी प्रसाद गुप्त मुख्य वक्ता थे । इस अवसर पर बोलते हुए डॉ. गुप्त ने कहा कि विवश होकर, दबाव में, प्रलोभन द्वारा, प्रताड़ना के आतंक में, आदि के द्वारा हिंदी का प्रयोग इसकी महत्ता को कम करते है । दिनांक 5 मार्च, 2012 को आयोजित कार्यशाला में युवा साहित्याकार श्रीमती संगीता सेठी ने विभागीय अधिकारियों एवं कर्मचारियों को सरकारी कार्य हिंदी में करने की अभिप्रेरणा नामक विषय पर व्याख्यान देकर प्रतिभागियों को हिन्दीक में कार्य करने हेतु प्रेरित किया।

हिन्दी सप्ताह का आयोजन

केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर में दिनांक 14 सितम्बर से 21 सितम्बयर, 2011 तक हिन्दी सप्ताीह का आयोजन किया गया । हिन्दी सप्ताह के आयोजन का उद्घाटन समारोह एवं हिन्दी दिवस 14 सितम्बर, 2011 को मनाया गया । इस अवसर पर समारोह की अध्यआक्षता करते हुए संस्थांन के प्रभारी निदेशक डॉ. राकेश भार्गव ने कहा कि हिन्दीस दिवस प्रति दिन होना चाहिए। यह तभी संभव है जब हम दिन–प्रतिदिन के कार्य हिंदी में करना आरंभ कर दें । उन्होंने कहा कि अखण्ड भारत की कल्पना बिना राष्ट्र भाषा के संभव नहीं होगी । इस अवसर पर उन्हों ने भारत सरकार के कृ षि मंत्री माननीय श्री शरद पवार के संदेश का वाचन भी किया । संस्थारन के प्रधान वैज्ञानिक डॉ. आर. एस. सिंह ने इस अवसर पर संबोधित करते हुए कहा कि हिन्दी एक सरल, सुबोध और सुप्रचलित भाषा है जिसको उतनी ही सरलता से अपनाया जा सकता है । उन्होने इस अवसर पर भारतीय कृषि अनुसंधान परिषद के महानिदेशक का संदेश वाचन भी किया ।

संस्थान के प्रशासनिक अधिकारी श्री वी. डी. विभापुरकर ने इस अवसर पर भारत सरकार के गृह मंत्री माननीय श्री पी. चिदंबरम के संदेश का वाचन किया । इससे पूर्व उन्हों ने कार्यक्रम में पधारे अधिकारियों एवं कर्मचारियों का स्वागत किया । हिन्दी सप्तासह के दौरान होने वाली विभिन्नं प्रतियोगिताओं की जानकारी देते हुए संस्था न के राजभाषा प्रभारी श्री प्रेम प्रकाश पारीक ने हिन्दी दिवस के उपलक्ष में भारत सरकार के मंत्रिमण्ड ल सचिव का संदेश पढ़ा। हिन्दी सप्तारह का समापन दिनांक 21 सितम्बमर, 2011 को हुआ । समापन समारोह से पूर्व हिन्दी कार्यशाला का आयोजन भी हुआ जिसमें राष्ट्री य उष्ट्र अनुसंधान केन्द्र , के निदेशक डॉ. एन. वी. पाटिल आमंत्रित वक्ता थे । अपने सम्बोनधन में डॉ. पाटिल ने वैज्ञानिकों से अपने शोध पत्रों को हिन्दी में लिखने का अनुरोध किया। उन्हों ने कहा कि हिन्दी में लेखन को आत्म सम्मानन के रूप में देखना चाहिए न की आत्म हीनता के रूप में । हिन्दी में शोध पत्र लेखन में ध्यान रखने वाली प्रमुख बातों का वर्णन भी डॉ. पाटिल ने अपने व्याख्यान में किया ।

समापन समारोह में राष्ट्रीय उष्ट्र अनुसंधान केन्द्र, बीकानेर के निदेशक डॉ. एन. वी. पाटिल मुख्य अथिति थे तथा अध्येक्षता संस्थान के निदेशक डॉ. सतीश कुमार शर्मा ने की। इस अवसर पर वरिष्ठ वैज्ञानिक डॉ. हरे कृष्ण ने कविता पाठ किया ।

हिन्दी सप्ताह के दौरान आयोजित प्रतियोगिताओं में विजेता प्रतिभागियों को पुरस्कार वितरण किया गया । हिन्दी निबंध लेखन में श्रेणीवार प्रतियोगिता का आयोजन किया गया था जिसमें वैज्ञानिक श्रेणी से डॉ. बी. आर. चौधरी, प्रथम तथा डॉ. हरे कृष्णय द्वितीय स्थान पर रहे । प्रशासनिक वर्ग में श्री कुलदीप पान्डे, प्रथम तथा श्री स्वरूप चंद राठौर, द्वितीय स्थान पर रहे । इसी प्रतियोगिता के तकनीकी वर्ग में – श्री पी.आर.सिंह ने प्रथम एवं श्री भोजराज खत्री ने द्वितीय स्थान प्राप्त किया । हिन्दी शब्द ज्ञान प्रतियोगिता में प्रथम स्थाय श्री स्वथरूप चंद राठौर ने तथा द्वितीय स्थान डॉ. उदय वीर सिंह ने प्राप्त किया । कार्यक्रम का संचालन एवं आयोजन प्रधान वैज्ञानिक डॉ. आर. एस. सिंह ने किया।

राजभाषा पत्रिका प्रकाशन

हिन्दी की प्रगति हेतु की जा रही गतिविधियों के अंतर्गत संस्थाान द्वारा एक वार्षिक राजभाषा पत्रिका 'मरु बागवानी' का प्रकाशन किया जा रहा है। इसमें संस्थान से संबंधित कार्यों को राजभाषा के लेख प्रकाशित किये जाते हैं।

संस्थाान समाचार का प्रकाशन

संस्थान द्वारा एक छमाही समाचार बुलेटिन का प्रकाशन द्विभाषी रूप में किया जाता है। इसमें संस्थान द्वारा किए जा रहे अनुसंधान कार्यों व राजभाषा की गतिविधियों से संबंधित समाचारों का प्रकाशन किया जाता है।

किसान प्रशिक्षण

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

गोधरा

राजभाषा कार्यन्वायन समिति

केन्द्र की राजभाषा कार्यान्वयन समिति की दिनांक 26–03–2011, 5–08–2011, 24–09–2011 ,वं 26–12–2012 को सम्पन्न हुई बैठकों में केन्द्र पर हिन्दी के कार्यान्वयन के साथ–साथ प्रगति के आयामों पर व्यापक विचार विमर्श करके हिंदी की प्रगति को सुनिश्चित करने के लिए कदम उठाये।

हिन्दी दिवस

केन्द्र में दिनांक 14 सितम्बर, 2011 को हिन्दी दिवस का आयोजन किया गया। इस कार्यक्रम में कँद्र के सभी अधिकारियों ,वं कर्मचारियों ने भाग लिया। केंद्र के अध्यक्ष डॉ– संजय सिंह ने हिंदी में कार्य करने की प्रेरणा के साथ सभी से संकल्प पर हस्ताक्षर करवाए।

हिन्दी कार्यशाला

केन्द्र में दिनांक 12 अक्टूबर, 2011 को हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में कँद्र के सभी अधिकारियों व कर्मचारियों ने भाग लिया। प्रधान वैज्ञानिक डॉ– एस. एस.–हिवाले ने कार्यशाला में व्याख्यान दिया।

प्रतियोगिता के पुरस्कार प्राप्त करते हुए प्रतिभागी

गोधरा में हिन्दी सप्ताह कार्यक्रम का आयोजन

14

कार्मिक

Personnel

STAFF POSITION AS ON 31.03.2011

CIAH (INCLUDING CHES)

Sr. No.	Designation	Post		
		sanction	filled	vacant
1.	Director (RMP)	01	01	00
2.	Scientific	35	19	16
3.	Technical	43	41	02
4.	Administrative	23	19	04

Krishi Vigyan Kendra: -

Category	Sanctioned in position Strength	
Scientific/Technical	01	01
Administrative	02	02
Technical	11	11
Supporting	02	02
TOTAL	**16**	**16**

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	Senior Scientist
5.	Dr. Dhurendra Singh	Senior 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
11	Dr. Hanif Khan	Scientist
12	Sh. Karuppaiah V.	Scientist – On study leave
13	Dr. S. M. Haldhar	Scientist
14	Dr.Sant Ram	Scientist
III. ADMINISTRATIVE		
1.	Shri V. D. Bhivapurkar	Administrative Officer
2.	Shri Raj Kumar	Fin. & Acc. Officer
IV. TECHNICAL		
1.	Shri D.K.Saraswat	T-8 (Technical Oficer)
2	Shri S.K. Pandey	T-6 (Technical Officer)
3	Dr. U. V. Singh	T-6 (Technical Officer)
4	Shri P.P. Pareek	T-6 (Technical Officer)
5	Shri M. K. Jain	T-5 (Technical Officer)
6	Shri Sanjay Patil	T-5 (Technical Officer)
7	Shri R. D. Rathva	T-5 (Technical Officer)
8	Shri K. K. Vankar	T-5 (Technical Officer)
9	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.	Sh. V. Lenin	Scientist
7.	Sh. Raja Shankar	Scientist
II. ADMINISTRATIVE		
1.	Smt. R. K. Shah	Asstt. Admn. Officer
III. TECHNICAL		
1	Sh. Nihal Singh	T-(7-8)(Technical Officer)
2	Sh. G.U. Trivedi	T-6 (Technical Officer)
3	Sh. M.N. Makwana	T-6 (Technical Officer)
4	Sh. A.V. Dhobi	T-5 (Technical Officer)
5	Shri G. R. Baria	T-5 (Technical Officer)
6	Sh.R.B.Baria	T-5 (Technical Officer)
7	Shri B. H. Patel	T-5 (Technical Officer)
8	Shri R. B. Baria	T-5 (Technical Officer)

KVK, Panchmahal

S. No.	Name	Designation/Discipline
I.	**PROGRAMME COORDINATOR**	
1.	Dr. (Ms) Kanak Lata	PC
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.)
6	Smt. Poonam Kalash	T-6 (SMS – Home Sci.)

Relieving on promotion/transfer

1. Dr. I. S. Singh, Scientist relieved on 08.04.2011 (A.N.) from CIAH, Bikaner following his transfer to NRCL, Muzaffarpur.
2. Dr. S. K. Singh, Scientist relieved on 08.04.2011 (A.N.) from CIAH, Bikaner following his transfer to NRCL, Muzaffarpur.

New entrants

Sl. No.	Name	Designation	Date of joining
1.	Sh. Sant Ram,	Scientist	5.9.2011
2.	Sh. Rakesh Kumar Meel,	T-4, KVK	27.3.2012

3. Shri G. S. Khatri, SSS relieved on 03.06.2011 (A.N.) from CIAH, Bikaner following his transfer to CHES, Vejalpur, Godhra (Gujarat).
4. Sh.V.K.Pandey, AAO relieved on 29.2.2012 from CIAH, Bikaner following his promotion to the post of Administrative Officer, NRCC, Bikaner
5. Sh. R.B.Baria, T-5 relieved on 24.3.2012 from CIAH, Bikaner following his transfer to CHES, Vejalpur, Godhra (Gujarat)
6. Sh. Rakesh Kumar Swami, UDC relieved on 31.3.2012 from CIAH, Bikaner following his promotion to the post of Assistant, CHES, Godhra.

Promotion

Sl.No.	Name and Present Grade/ Designation	Promoted to Grade/Scale	Date of merit promotion	Present place of posting
1.	Sh.P.P.Pareek T-5 (Technical Officer)	T-6 (Technical Officer) Pay Band – 3 / Rs 15600-39100 with Grade Pay of Rs 5400.00	29.06.2011	CIAH, Bikaner
2.	Sh. M. N. Makwana T-5 (Technical Officer)	T-6 (Technical Officer) Pay Band – 3 / Rs 15600-39100 with Grade Pay of Rs 5400.00	29.06.2011	CHES, Godhra
3.	Dr. U. V. Singh T-5 (T.O.- Field Technician)	T-6 (T.O.-Field) Pay Band – 3 / Rs 15600-39100 with Grade Pay of Rs 5400.00	04.05.2011	CIAH, Bikaner
4.	Sh.P.R.Singh, T-3 (Field Technician)	T-4 (Field Technician) Pay Band – 2 / Rs 9300-34800 with Grade Pay of Rs 4200.00	7.12.2010	CIAH, Bikaner
5.	Sh. Satpal, T-3 (Driver)	T-4 (Driver) Pay Band – 2 / Rs 9300-34800 with Grade Pay of Rs 4200.00	29.6.2011	CIAH, Bikaner
6.	Sh. Ashok Kumar Mali, T-2 (Tractor Driver)	T-3 (Tractor Driver) Pay Band – 1 / Rs 5200-20200 with Grade Pay of Rs 2800.00	29.6.2011	CIAH, Bikaner
7.	Sh. T.S.Dhakiya, T-2 (Tractor Driver)	T-3 (Tractor Driver) Pay Band – 1 / Rs 5200-20200 with Grade Pay of Rs 2800.00	29.6.2011	CHES, Godhra

Administrative

Sl.No.	Name and Present Grade/ Designation	Promoted to Grade/Scale	Date of merit promotion	Present place of posting
1.	Sh.V.K.Pandey, AAO	Administrative Officer	NRCC, Bikaner	29.02.2012

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.	Smt. R. K. Shah,	Assistant	PB-2/9300-34800 GP 4200	01.09.2008 PB-2/9300-34800 GP 4600
1.	Sh. R.K. Solanki,	P.A.	PB-2/9300-34800 GP 4200	01.09.2008 PB-2/9300-34800 GP 4600
2.	Sh.P.V.Solanki,	UDC	PB-1 5200-20200 GP 2400	4.7.2009 PB-1 5200-20200 GP 2800
3.	Sh.H.S.Patel,	UDC	PB-1 5200-20200 GP 2400	13.3.2010 PB-1 5200-20200 GP 2800

ACP

Sl. No.	Name of Official with designation		Existing pay scale	Date of grant of 1st Financial Up-gradation and scale of pay
1.	Sh. P.V.Solanki,	LDC	Rs 3050-4590 (Pre-revised)	04.07.2001 Rs 4000-100-6000 (Pre-revised)

Supporting

Sl. No.	Name of Official with Designation		Existing pay band and grade pay	Date of grant of 1st Financial Upgradation & PayBand+GP	Date of grant of 2nd Financial Upgradation & PayBand+GP	Date of grant of 3rd Financial Upgradation & PayBand+GP
1.	Sh. N. L. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008 PB-1/5200-20200 GP 1900	01.09.2008 PB-1/5200-20200 GP 2000	19.12.2009 PB-1/5200-20200 GP 2400

2.	Sh. M. K. Asari	SSS	B-1/ 5200-20200 GP 1800	01.09. PB-1/5200-20200 GP 1900	01.09.2008 PB-1/5200-20200 GP 2000	9.12.2010 PB-1/5200-20200 GP 2400
3.	Sh. M.D. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09. PB-1/5200-20200, GP 1900	01.09.2008 PB-1/5200-20200, GP 2000	5.4.2010 PB-1/5200-20200, GP 2400
4.	Sh. K. R. Vaghela,	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008 PB-1/5200-20200, GP 1900	01.09.2008 PB-1/5200-20200, GP 2000	9.4.2011* PB-1/5200-20200, GP 2400

Sl. No.	Name of Official with Designation		Existing pay	Date of grant of 1st Financial upgradation and Pay Band+Grade Pay		Date of grand of 2nd Financial upgradation and Pay Band+Grade Pay	
1.	Sh. B. M. Baria	SSS	PB-1/ 5200-20200 GP 180	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
2.	Shri K. D. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
3.	Shri M. J. Parmar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
4.	Shri S. J. Patel	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
5.	Shri A. D. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
6.	Shri F. T. Patel	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
7.	Shri B. K. Jadav	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
8.	Shri K. S. Chauhan	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
9.	Shri V. G. Pate	ISSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
10.	Shri G. L. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
11.	Shri H.M. Tirgar	SSS	PB-1/ 5200-20200G GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
12.	Shri G.A. Chauhan	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
13.	Shri M.M. Vankar	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000

14.	Shri D. B. Yadav	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
15.	Shri Z. A. Chauhan	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
16.	Shri C. D. Rathva	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
17.	Shri D. S. Rawat	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
18.	Shri F. P. Chauhan	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
19.	Shri F. S. Parmar	SS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000
20.	Shri S. K. Harijan	SSS	PB-1/ 5200-20200 GP 1800	01.09.2008	PB-1/5200-20200, GP 1900	01.09.2008	PB-1/5200-20200, GP 2000

Sl. No.	Name of Official with designation		Existing pay band and grade pay	Date of grant of 1st Financial Up-gradation and Pay Band + Grade Pay
1.	Shri Chandubhai D. Rathva,	SSS	PB-1/5200-20200 GP 1800	01.09.2008 PB-1/5200-20200, GP 1900
2.	Shri G. S. Rathva	SSS	PB-1/5200-20200 GP 1800	01.09.2008 PB-1/5200-20200, GP 1900
3.	Shri M. K. Meena	SSS	PB-1/5200-20200 GP 1800	31.12.2009 PB-1/5200-20200, GP 1900

Joining on Transfer

Sr. No.	Name and Designation		Joining from .. to..	Date of joining
1.	Sh.D.K.Saraswat,	T-8 -	Joined at CIAH, Bikaner from CHES, Godhra.	15.11.2011
2.	Sh.R.D.Ratha,	T-5 -	Joined at CIAH, Bikaner from CHES, Godhra.	19.3.2012
3.	Sh.R.B.Baria,	T-5 -	Joined at CHES, Godhra from CIAH, Bikaner.	24.3.2012
4.	Sh. K.K.Vankar,	T-5	Joined at CIAH, Bikaner from CHES, Godhra	19.3.2012

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Budget

Expenditure 2011-12

	Plan		
Head	Bikaner	Godhra	Total
Pay & Allowances	0.00	0.00	0.00
Contingency	32.16	16.84	49.00
T.A.	4.49	2.5	6.99
Equipment	97.17	6.01	103.18
Works	78.02	0.00	78.02
H.R.D.	1.64	0.36	2.00
Library	5.27	0.50	5.77
Furniture	3.00	1.99	4.99
Total	221.75	28.20	249.95
	Non-Plan		
Pay & Allowances	254.71	260.97	515.68
Wages	0.00	112.56	112.56
T.A.	3.47	0.50	3.97
Contingency + Equipment	62.00	6.68	68.68
Works	4.86	0.00	4.86
OTA	0.022	0.00	0.22
Total	**325.26**	**380.71**	**705.97**

Revenue Receipt 2011-12

Head	Bikaner	Godhra	Total
Sale of Farm Produce	1.21	10.73	11.94
Tender Fee	2.07	0.01	2.08
Interest on STD	2.47	--	2.47
License Fee	0.32	0.13	0.45
Interet on Loan & Advances	1.04	0.74	1.78
Sale of condemned items	1.76	0.82	2.58
Electric charges	0.37	--	0.37
Water charges	0.02	--	0.02
Guest House	0.23	--	0.23
LSPC	--	--	--
Miscellaneous	0.43	0.04	0.47
Total	9.92	12.47	22.39

Revenue Receipt 2011-12 (Plan Schems)

Head	Seed Project	KVK Godhra	Total
Sale of Farm Produce	1.68	0.32	2.00
Miscellaneous	0.00	0.00	0.00
Total	**1.68**	**0.32**	**2.00**

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मौसमी आंकड़े

Meteorological Data

Meteoroligcal data at CIAH, Bikaner (2011-12)

S. No	Month	Temperature		Relative Humidity		Rainfall	Rainy Day	Wind	Evop.
		Max.	Min.	Max.	Min.	(mm)	--	Km/hr	mm/day
1	April, 2011	37.89 °C	22.24 °C	48 %	15 %	--	01	6.0	9.3
2	May, 2011	42.80 °C	28.70 °C	52 %	16 %	7	01	12.1	15.1
3	June, 2011	41.60 °C	28.76 °C	57 %	25 %	27	03	12.0	13.6
4	July, 2011	39.27 °C	25.84 °C	67 %	39 %	132	06	9.9	8.8
5	August,2011	36.80 °C	27.50 °C	80 %	56 %	174	04	7.4	6.5
6	Septemer, 2011	35.78 °C	24.75 °C	84 %	50 %	69	--	7.2	5.1
7	October, 2011	35.60 °C	20.30 °C	62 %	24 %	--	--	4.5	5.6
8	November, 2011	32.10 °C	16.21 °C	66 %	27 %	--	--	2.7	4.0
9	December, 2011	23.26 °C	07.18 °C	72 %	27 %	--	--	3.1	2.4
10	January, 2012	19.50 °C	05.30 °C	73 %	25 %	--	--	4.3	1.6
11	February, 2012	26.70 °C	14.20 °C	64 %	14 %	--	--	4.8	3.4
12	March, 2012	31.92 °C	14.94 °C	58 %	15 %	--	--	5.0	8.0

Meteoroligcal data at CHES, Godhra (2011-12)

S. No.	Month	Temperature		RH (%)	Rainfall (mm)	Rainy days
		Max. (°C)	Min. (°C)			
1.	April, 2011	39.82	22.44	48.93		
2.	May, 2011	41.43	24.81	46.92		
3.	June, 2011	41.91	25.86	43.83	82.2	3
4.	July, 2011	38.60	26.23	75.54	264.3	6
5.	August,2011	37.83	25.75	80.39	514.1	18
6.	Septemer, 2011	33.26	25.12	81.44	128.4	11
7.	October, 2011	37.83	21.39	74.52		
8.	November, 2011	34.84	20.85	58.60		
9.	December, 2011	31.22	16.70	60.44		
10.	January, 2012	27.31	9.66	59.61		
11.	February, 2012	30.10	12.47	56.70		
12.	March, 2012	35.46	14.73	53.54		

भाकृअनुप
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