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ANNUAL REPORT

2016-17

भाकृअनुप
ICAR

ICAR-Central Institute for Arid Horticulture

Bikaner-334 006 (Rajasthan)

CENTRAL INSTITUTE FOR ARID HORTICULTURE
के शु बा सं

वार्षिक प्रतिवेदन
ANNUAL REPORT
2016-17

भाकृअनुप-केन्द्रीय शुष्क बागवानी संस्थान
बीछवाल, बीकानेर–334 006, राजस्थान
ICAR-Central Institute for Arid Horticulture
Beechwal, Bikaner-334 006, Rajasthan
(An ISO: 9001: 2008 Certified Institute)

प्रकाशक / Published by

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उद्धरण / Correct Citation:

वर्षिक प्रतिवेदन 2016–17 / Annual Report 2016-17
भाकृअनुप–केन्द्रीय शुष्क बागवानी संस्थान /
ICAR-Central Institute for Arid Horticulture
बीछवाल, बीकानेर–334 006 / Beechwal, Bikaner 334 006, Rajasthan

लेजर सजा, संरचना, छायाचित्र, हिन्दी रूपान्तरण /
Laser setting, designing, photography, hindi translation

श्री बी. आर. खत्री / Sh. B. R. Khatri
श्री एम. के. जैन / Sh. M. K. Jain
श्री संजय पाटिल / Sh. Sanjay Patil
श्री पी. पी. पारीक / Sh. P. P. Pareek

Layout design & Printed at

M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi 110028.

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Beechwal, Bikaner-334 006

Prof. (Dr.) P.L. Saroj
Director

PREFACE

I am delighted to present the Annual Report 2016-2017 of the ICAR-Central Institute for Arid Horticulture, Bikaner. In view of the exigent demands to feed the ever-increasing population as well as to meet the requirement of horticulture-based industries, it is necessary to develop novel technological innovations which are able to engender high quality produce under challenging environment of arid & semi-arid regions. Ever since its inception, ICAR-Central Institute for Arid Horticulture, Bikaner is dedicated to serve the growers of arid & semi-arid regions by developing a gamut of contemporary technologies such as introduction of promising new crops/ varieties from iso-climatic regions, package & practices for commercial cultivation of horticultural crops under prevalent resource-scarce conditions, production of quality planting materials and postharvest management & value addition of the horticultural produce to contain the economic losses.

The present report gives a glance of 4 mega research projects and 12 externally funded projects, new varieties/ novel methodologies developed, scientific advisory/ services provided, transfer of the technologies and scientific information, human resource development, linkages fostered with various stakeholders of NARS and other research organizations. I would like to place on record my admiration for the efforts of all the members of the Institute Research Committee (IRC) who have discussed all the research activities exhaustibly and come forward with meticulously formulated plan of action within the stipulated time frame. I also thank technical personnel, administrative, finance and other staff of the Institute for all the time and efforts, they have put into ensuring the implementation and execution of policies and programmes of the Institute.

I am abundantly blessed to have erudite guidance and perpetual support of Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR in accomplishing the mandate and carrying forward the vision of the Institute. I also express my gratitude to the Hon'ble Deputy Director General (Horticultural Science) and to ADG (Hort.-I) and ADG (Hort.-II) for their critical remarks and worthy suggestions, which often help sail past the administrative constraints, smoothly.

This Annual Report is the manifestation of sincere commitment and unremitting endeavours of our Scientists and other staff of the institute. I wish to express my sincere appreciation to Dr. R. Bhargava, Dr. R. S. Singh, Dr. Hare Krishna, Dr. D. K. Sarolia and Dr. S. R. Meena for their abiding and unswerving support in this venture for bringing out the Annual Report (2016-17). The technical support in terms of computerization and art & photography by Sh. Bhoj Raj Khatri/Sh. Sanjay Patil is deeply acknowledged.

Dated: June 2017, Bikaner

(P. L. Saroj)

Contents

Executive Summary

Plant Genetic Resources and Crop Improvement

Fruits

A rich germplasm of mandate crops are being maintained at the field gene bank of the institute. Under the reported period, 01 genotype each of date palm and grapefruit, 11 of acid lime, 08 of mandarin, 11 of sweet oranges, 16 of different species of *Citrus* rootstocks and 05 of guava were added to the germplasm gene bank. Besides, genotypes of different fruit crops being maintained in field gene bank were evaluated for morphological, yield and yield attributing characteristics.

During the period under report, a survey of different districts of Haryana (Hisar, Bhiwani, Mahendragarh and Rewari) was made for marking of promising *ber* genotypes. A wide variation was observed among the collected genotypes for the studied traits. Likewise, diversity rich areas of Gujarat viz., Panchmahal, Vadodara, Bharuch, Gandhinagar, Bhavnagar and Mahisagar districts were surveyed and diverse genotypes of guava (25) were identified on the basis of desirable horticultural traits. For lime, Panchmahals, Bharuch, Bhavnagar and Mahisagar districts were surveyed and 27 diverse genotypes were identified on the basis of desirable horticultural traits. Similarly, a benchmark survey was made to identify elite genotypes of custard apple (22) from Gujarat and Chittorgarh, Rajasthan during 2016-17.

Exotic fruit species like Marula nut, Argan, Carob and Chinese jujube were maintained and evaluated for growth, flowering and fruiting. During 2016-17, a total of 05 varieties of ber (Thar Malti), bael (Thar Neelkanth), jamun (Thar Kranti), mulberry (Thar Harit) and phalsa (Thar Pragati) were identified at institute level.

Vegetables

For safe conserving of arid vegetable genetic resources at ICAR-CIAH, monitoring of 500 germplasm including dessertic melons (125), non-dessertic melons (161) and gourds (60) under –20^{0}C deep freeze storage facilities was done. During 2016, enhanced seed germplasm of mateera AHW-19, kakri AHC-13 and palak AHLP-1 was deposited for LTS to NBPGR, New Delhi. About 815.00 kg seed of institute varieties / genotypes was produced and distributed to farmers, NGO's, KVK's and national, state and private agencies for spreading and further seed chain in arid zone vegetable.

During 2016, gynoecious ivy gourd AHIG-1, sponge gourd AHSG/2015/F5/01 and long fruited bottle gourd line AHLS/2015/ F6/01 was tested for uniformity and marketable quality yield under high temperature conditions of hot arid agro-climate. Likewise, Khejri Selection–2 was studied for plant growth, pod quality, harvesting period, yield and bio-mass production.

For understanding genetic quality and seed yield potential, studies on snap melon (AHS-82), kachri (AHK-119), mateera (AHW-19), kakri (AHC-13), palak (AHLP-1), sword bean (Thar Mahi) and moringa (AHMO-1-4s) was done during 2016–17 with varietal maintenance breeding and breeder seed production crops adopting HBCPSMA under revolving funds of ICAR seed project.

Among thirty genotypes of watermelon evaluated during summer 2016, red fleshed genotypes AHW/BR-5 and AHW/BR-25 performed better and selected for further evaluation. Amongst the progenies of 6 exotic lines of watermelon, EC-829545 was found the most promising. Similarly, amongst the evaluated lines of muskmelon, AHMM/BR-47 was selected as promising line which has 11-12% TSS. Amongst the muskmelon crosses,

IC-0599709 x Punjab Sunehri resulted the best combination with respect to horticultural traits.

Amongst the twelve F_1's of ridge gourd, AHRG-62 x AHRG-29 was found the best followed by AHRG-29 x AHRG-41 for days to produce 50% flowering, days to first fruit harvest, fruit length and fruit weight.

Two new genotypes of drumstick, twenty five genotypes of ivy gourd and twenty genotypes of spine gourd were collected and planted in field for further evaluation after the survey made in Gujarat. The evaluation of genotypes exhibited a wide range of variability with respect to different horticultural traits.

During 2016-17, two varieties of vegetable crops *viz*., Thar Kavi and Thar Harsha were identified in pumpkin and drumstick, respectively, at institute level.

Crop Management and Agrotechniques

Observations on growth, yield, physiological and fruit quality parameters were recorded on growth and development of *ber*, *bael*, *khejri* and drumstick grown in association with *aonla* in the different cropping models. The average yield of *aonla* varied considerably in different cropping model systems with the highest being recorded in *aonla-khejri* (51.4 kg per plant), *aonla-ber* (49.3) followed by *aonla*-Kinnow (37.2 kg/plant) and *aonla*-mulberry (35.9), while the lowest was recorded in *aonla-Moringa* (34.6 kg/plant). Photosynthetically active radiation was recorded to be the maximum with *Moringa* followed by *karonda* and *bael* during extreme summer season. However, the least was noted in *ber* and *khejri* for most of the period under study. *Aonla* and *karonda* leaves were observed to maintain the comparatively higher relative water content throughout the period under study followed by *khejri* and *bael,* while the lowest was noticed with *ber*.

Economic analysis of mango based cropping system, under rainfed condition of semi-arid ecosystem, 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.

During 2016-17, observations were recorded on growth, yield and bio-mass production in khejri var. Thar Shobha with varying (12) planting models under rainfed situation. Based on three years of mean data, Thar Shobha recorded pod yield of 6.58 kg/plant under KM-1, KM-9 & KM-11. Similarly, marketable fruit yield of kachri var. AHK-119 (56.58 q/ha) and tender pod yield of cluster bean var. Thar Bhadavi (54.34 q/ha) was recorded as inter-crop with khejri and adopting recommended techniques of HBCPSMA concept from 2014 to 2017 time period.

Soil samples from 47 varying sand-dune landscape crop-field situations (3, 6 & 9 years) under investigation were studied to understand the scope of improvement in fertility build-up with khejri based crop production site management approach and the results exhibited that HBCPSMA concept is effective in improving organic carbon and nutrient status in sandy soils of hot arid region.

The seedlings of native crop-plant species such as ker, jharber, rohida, lasora, kumat and khejri were studied as inter-crop/boundary plantations under production site management approach. Based on field performance over the years, two jharber genotypes (R17P1 and R37P1) were identified as most potential for fruit, fodder and bio-mass production under absolute rainfed conditions of hot arid agro-climate.

Integrated Nutrient and Water Management

Monitoring of microbial population at two depths (0.00 - 0.15 and 0.15 - 0.30 m) in bael and Kinnow as affected by integrated nutrient management revealed that the bacterial population in different treatments ranged from 7 to 35 $x10^5$ cfu g^{-1} soil, fungal from 1.5 to 3.5 $x10^5$ cfu g^{-1} soil and actinomycetes from 14-28 x 10^5 cfu g^{-1} soil in different INM treatments. Total microbial population was minimum in the absolute control and significantly highest in the treatment where recommended dose of N, P and K was associated

with FYM and consortium of biofertilizers at both the depth. The fruit weight, fruit yield, TSS, acidity and juice recovery were measured in Kinnow under different INM treatment and it was noted that the maximum fruit weight (230 g) was recorded in RDF of N, P, K + FYM + PSB + Azotobactor + VAM, which was significantly at par with RDF of N, P, K +FYM + Azotobactor treatment.

Application of different combinations of NPK doses significantly increased yield of *kachri*. Application 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O respectively, gave the highest *kachri* yield (116.4 q/ ha).

Effect of graded dose of N application increased the yield of the cluster bean with or without inoculation of *Rhizobium*. Application of 60 kg N/ ha along with *Rhizobium* seed inoculation gave the highest vegetable cluster bean as well as grain yield.

Results revealed that potato tuber yield varied from variety to variety under sprinkler and drip irrigation systems**.** Kufri Chipsona (535 q/ ha) gave the maximum mean tuber yield under sprinkler, while Kufri Frysona gave the maximum yield (435 q/ ha) under drip irrigation.

Crop Physiology and Biotechnology

The RAPD profiles of 11 accessions of woodapple available at CHES, Godhra were developed to identify germplasm and assess the phylogenetic relationship.

The secondary hardening of the tissue cultured date plants is being carried out in green house and temperature is gradually being raised to wean the plants for subsequent transfer to field.

Crop Protection

Fifteen watermelon varieties/genotypes were evaluated for resistance against mosaic disease under field conditions during summer season of 2016. Per cent disease index (PDI) of mosaic disease was from 4.67 to 31.33% in different genotypes/ varieties of this crop. Variety 'Asahi Yamato' was found tolerant against mosaic disease with PDI (4.67). Likewise, fifteen muskmelon genotypes were evaluated for resistance against *Fusarium* wilt during summer season of 2016 and genotypes like AHMM/BR-42, AHMM/BR-41 and AHMM/BR-51 were found resistant.

The seasonal incidence of fruit borers, *Aubeus himalayanus, Meridarchis scyrodes, Dudua aprobola*, *Curculio album*, *Arenipses sabella* and *Batrachedra amydraula* recorded in the arid and semi-arid horticultural crops.

Twenty five varieties/ genotypes of ber were selected for final evaluation trials against fruit fly resistance during 2016-17 at ICAR-CIAH Farm. The varieties/genotypes, Katha, Illaichi and Tikadi were resistant; BS-75-1, Safeda, Dandan, Gola, Goma Kirti, Jogia, Narma, Reshmi, Mundia, Seb, ZG-3, Akharota and Umran were moderately resistant; Banarasi Karaka, Banarasi Pawandi, Chhuhara, Kaithli, Thar Bhubhraj and Thar Sevika were susceptible, whereas Sanur-3, Sanur-4 and Sanur-5 were the most susceptible varieties/ genotypes of ber. A significant difference in fruit fly population was observed under different modules. The IPM module-III was registered significantly lower fruit fly population (10.90 %) followed by module-II (21.38 %) and the highest fruit fly population was observed under control module (57.95 %).

Post Harvest Technology

Storage studies revealed that the Goma Priyanka jamun fruits when treated with calcium chloride 1.5 % and kept in Zero Energy Cool Chamber recorded 4 days shelf life with comparatively better fruit quality, while untreated control had 2 days shelf life. However, Zero Energy Cool Chamber alone recorded 3 days shelf life.

Various value added products such as aonla mouth freshner, dry dates, soft dates, kachri based curry powder, pickles of wood apple and bael etc. were prepared and assessed for their acceptability.

Agricultural Extension

The information on traditional vegetables grown, their use and marketing system, change in cropping patterns and socio-economic characteristics of farmers, ITKs were investigated. The major constraints faced by farmers in

adopting the technologies were also collected. The information on rural wisdom of inhabitants of arid region of district Bikaner was assessed and information on value added products developed by them was collected. On and Off campus training were organized and demonstration on arid vegetable were laid on farmers field.

Externally funded projects

At ICAR-CIAH, Bikaner and its Regional Station CHES, Vejalpur (Godhra), a total of twelve externally funded projects were in operation.

Under DUS project on musk melon & water melon, ber, bael and aonla, reference varieties are being maintained under field conditions and morphological characteristics of these reference varieties were also recorded so as to confirm the distinctness, uniformity and stability in the described characters. Under the DUS centres on date palm and the jamun, the draft guidelines were submitted to the Authority for finalization of DUS guidelines in respective crops. Under DUS Center on chironji and tamarind, data are being recorded for preparation of DUS descriptor. Under, CRP-AB, the work on morphological characterization of bael (30), aonla (15) and lasoda (15) was carried out during the reported period. Under ICAR Scheme 'Production and Demonstration of Tissue Culture Raised Plants under Three Locations and Collection and Maintenance of Elite Germplasm of Date Palm', tissue culture raised plants supplied by coordinating centers are being evaluated under the field conditions. The physico-chemical properties of the soil have been found improved in terms of organic carbon, available nutrients, etc. as a result of application of organic nutrient sources under the 'Network Project on Organic Farming in Horticultural Crops'. Findings of 'Network Project on Micronutrient Management in Horticultural Crops for Enhancing Yield and Quality', suggested application of micronutrients for improved yield and quality of produce.

1. INTRODUCTION

Arid and semi-arid regions were considered to be non-conventional areas for agricultural production due to wide magnitude of abiotic stresses; however together with dry sub-humid, arid and semi-arid lands accounts for about 228 mha (i.e. 69%) of country's total geographical area. Extreme temperatures regimes, high evapo-transpiration rate and intense solar radiation juxtaposed with low and erratic rainfall makes these regions the most vulnerable regions in India. Besides environmental stresses, edaphic stresses such as salinity, low soil moisture retention, deep underground water table etc. also contribute to the misery of dwellers of these regions. However, incidentally these areas are one of the most heavily populated areas, where livelihood of inhabitants are directly impacted by environmental stresses. The conditions are inevitably aggravated by climate variability coupled with other physical and socio-economic factors, which may lead to huge economic losses, famine and migration of inhabitants. Food security under such fragile situations can only be achieved by promoting crop diversity. Therefore, crop diversification by growing traditional/ indigenous crops with other intercrops or introducing new crops in farming system can minimize the risk of crop failure due to adverse weather, diseases and insect-pests attack. Further, conserving moisture, enhancing nutrient use efficiency and maximizing the utilization of available natural resources are key to successful cropping under arid and semi-arid regions.

To address these issues underlined above, 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 ICAR-IIHR, Bengaluru) was merged with it as its Regional Station on 1st October, 2000. Subsequently, two divisions i.e. Division of Crop Production and Division of Crop Improvement were created in the Institute w.e.f. 1st August, 2013.

MANDATE

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of horticultural crops of arid and semi-arid regions.
- Repository of genetic resources and scientific information on horticultural crops of arid and semi arid region.
- Transfer of technology, capacity building and impact assessment of technologies
- Coordinate research and validation of technologies on fruit crops of arid and semi-arid regions.

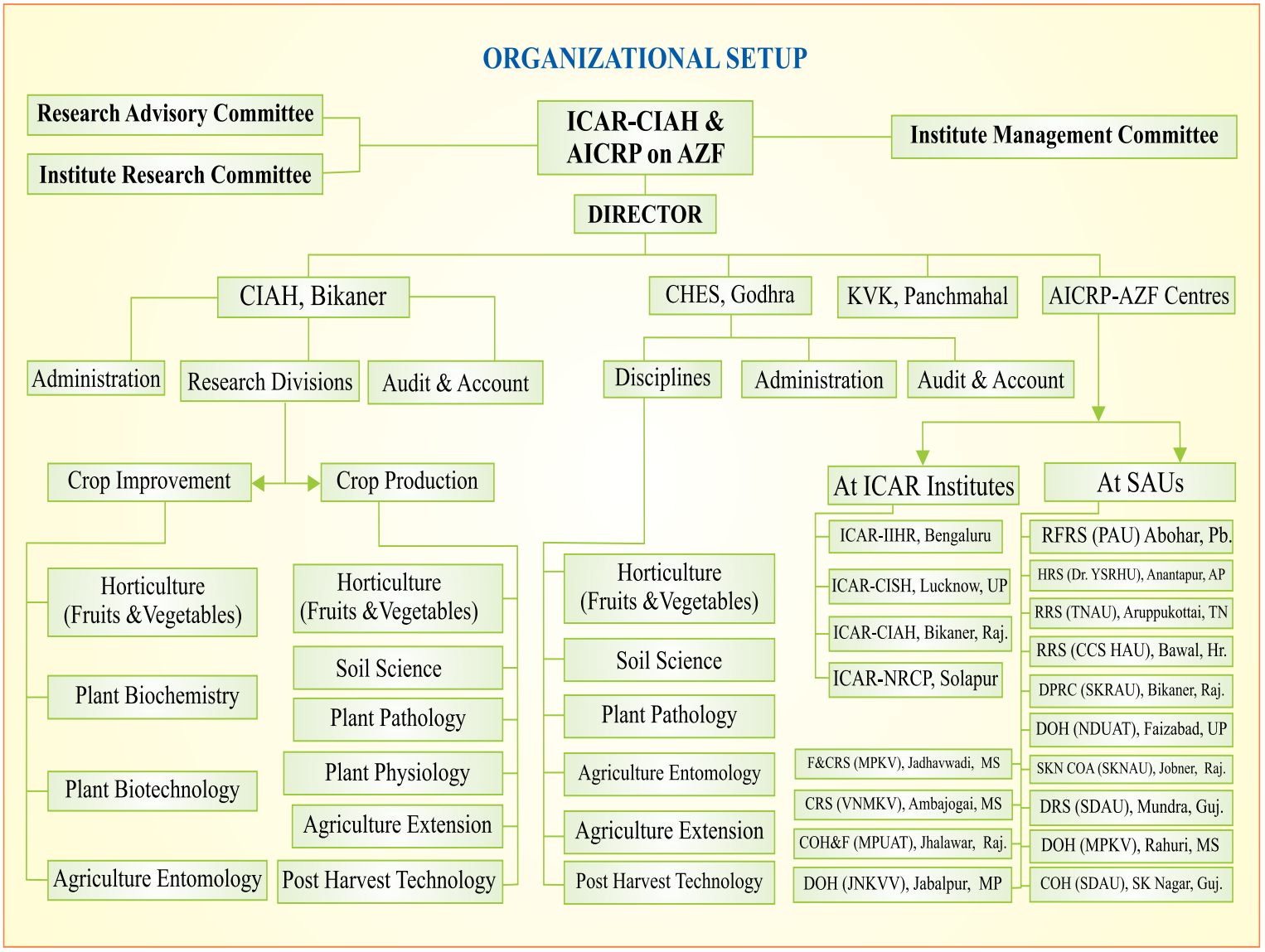
MISSION/OBJECTIVES

- 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, 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 postharvest technology package for extended use of the horticultural produce of arid region.
- To develop integrated pest and disease management technologies for horticultural crops under arid environment.
- 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 2016-17 and the significant results obtained in different projects are presented hereunder.

ORGANIZATIONAL SETUP



2. RESEARCH ACHIEVEMENTS

GENETIC RESOURCES

Introduction, collection, characterization, conservation and evaluation of germplasm of arid and semi-arid fruit and vegetable crops

FRUITS

At Bikaner

Ber (*Ziziphus mauritiana*)

Introduction, collection, conservation and evaluation of *Ziziphus* spp. under hot arid environment

During the period under report, a survey of different districts of Haryana (Hisar, Bhiwani, Mahendragarh and Rewari) was made for marking of promising *ber* genotypes. Fruits of collected genotypes were also subjected to physico-chemical analysis for comparison of quality characteristics. A wide variation was observed among the collected genotypes for the studied traits (Fig. 1). Most of the genotypes were round in shape; however, oval and ovates were also found. Fruit cavities were either present exclusively on stem end or at both stem & stylar ends. Fruit weight varied from 1.3-16.2 g, while stone weight varied from 0.42-1.15 g. The lowest TSS content (11.2 ^{0}Brix) was noted in HR Coll. 4, while the highest (22.8 ^{0}Brix) was recorded in HR Coll. 13. Similarly, the highest contents of ascorbic acid was noted in HR Coll. 15 (220.37) followed by HR Coll. 14 (201.5) and HR Coll. 7 (201.5).

Fig. 1. Morphological diversity in ber genotypes collected from Haryana.

Ber variety 'Thar Malti'

Ber variety 'Thar Malti' at the Institute level was identified, which was previously known as 'CIAH Ber S-15'. It is precocious bearer and high yielding. It is

semi-erect and less thorny. These two characteristics are desirable traits as they facilitate easy harvesting of fruits. It is a late maturing variety; however unlike commercial variety Umran, it has soft texture pulp that is, organoleptically, a desirable trait. Further, even unripe fruits have soft pulp texture.

Date palm (*Phoenix dactylifera*)

Collection and conservation

Sixty four date palm varieties/genotypes including exotics were conserved in the field gene bank. The offshoots of cv. Medjool were procured from State of Palestine in April, 2016 and planted in July 2016 for evaluation. The work on development of germplasm repository of male palm was initiated and 02 elite germplam were collected and planted in the field for evaluation. One late maturing, rain tolerent, red colour berry germplasm was identified and an offshoot was planted in the germplasm repository. Three offshoots of Sri Ganganagar Local was collected and kept in nursery for rooting.

Evaluation

The maximum plant height and spread was observed in cv. Muscat followed by Halawy and Dayari. The fruiting was observed in 26 genotypes out of 64 germplasm. Exotic cultivars Siwi and Amhat introduced from Egypt started flowering/ fruiting after 6 years of planting. However, fruiting was low in cv. Amhat and Siwi due to young stage of plants. Both varieties are of yellow berry colour. The spathe emergence/ flowering in plants introduced from ICARDA, Jordan in April, 2015 started after two year of planting during March, 2017. The spathe emergence and flowering was observed in 38 germplasm during 2017. Flowering in male palms were early than female plants.

The maximum length of bunch was observed in cv. Sewi (108cm) followed by Zahidi and Bikaner Local (100cm). The variation in number of bunches from 2-10 per plant and fruits yield varied from 3.0 to 60.0 kg/plant was recorded among the germplasm. Similarly, number of strands/bunch ranged from 7-40 and number of berries/strand varied from 8 to 26. The maximum number of bunches/ plant were observed in cv. Sewi (10) followed by Khadrawy and Nagal (8). The maximum number of berries (26 per strand) was recorded in cv. Zahidi followed by Khalas (20) and Khuneizi (17), while the minimum was in Kotho variety (8). The bigger size and fruit weight (18.8g) was observed in cv. Medjool followed by Dayari, Hayani (10.23g to 12.92g) and minimum fruit weight (4.01g) was in Umshok. Variation in morphological characters of stones such as weight, size, groove were studied. The weight of stone varied from 0.65- 1.60 g. The early *doka* stage was observed in cv. Nagal Muscat, Tayer, Siwi, Halawy and harvested from mid June to end of June. Cultivar Nagal was harvested earliest *i.e.* 16th June. The maturity of fruits (*doka* stage) recorded in maximum cultivars in the second week of July. However, cvs. Medjool, Dayari and Sewi were harvested late in first week of August, 2016. Maximum fruit yield at *doka* stage was observed in cv. Sewi (60.0 kg/tree) and Halawy, Zahidi. Khalas (52.0 kg) followed by Khadrawy, Chip chap and Medjool (46.0kg). However, the minimum fruit yield (3.0kg/ plant) was observed in cv. Kotho because of young plants.

The berries in late maturing cultivars Medjool, Dayari and Sewi were damaged due to 3-4 days rains at the end of July month at the time of harvesting and fruits were spoiled due to high humidity. The pind (tamer) stage was not observed in any genotypes.

Varietal evaluation

Varietal performance of cvs. Halawy, Khalas, Zahidi, Medjool and Khadrawy were observed for growth, flowering /fruiting, yield and quality of fruits. The maximum plant height was observed in cv. Halawy (5.60m) and spread (5.10 x 4.90m) followed by height of plant (3.20 to 3.80m) in cvs. Medjool. Khadrawy and Zahidi. The growth performance was vigorous in Halawy and Khalas as compared to Zahidi, Khadrawy and Medjool. Plant growth in Khadrawy was drooping type. Flowering/ fruiting was observed in all varieties. As intercrop, mustard was grown during rabi season for proper utilization of interspaces of trees.The maximum fruit yield/tree was observed in cv. Khalas (52.0kg/ tree) and Halawy (50.5kg.) followed by Medjool (46kg), Zahidi (42.0kg), and Khadrawy (35kg). The fruit quality with respect to fruit weight, size and TSS (36.0 to 48.5 ^{0}Brix) varied among varieties.

Evaluation of tissue cultured plants

Tissue cultured plants of cv. Barhee and KCS-143 were evaluated for growth, flowering/fruiting and vegetative growth. Plant height of Barhee (2.70m) was better than KCS-143 plant (1.60m). The spathe emergence/ fruiting was observed in cv. Barhee and KCS plant. The berry weight was 9.8g in Barhee and 8.5g in KCS plant. The colour of berry was light yellow and sweet in taste. First time fruiting with one bunch was observed in KCS-143 plant after 6th year of planting. *Doka* stage was noted in the last week of July month *i.e.* 22 and 30th July. However, fruits were damaged by wild animals due to low plant's height.

Performance of seedlings

The flowering/fruiting was observed in 3 seedling plant during 8th year planting and fruit quality in seedling type were astringent in taste at *doka* stage. Variation in fruit size, colour and taste was also observed.

Effect of spray of Ethrel

A preliminary study on Ethrel (1000ppm) spray on bunches in 3 trees in cv. Medjool was done with the aim for early maturity and ripening of late maturing variety under arid conditions. The spray was done in last week of June. In late maturing variety, colour change in berry was on 01.7.2016 and doka stage was observed on 24th July by spray treatment. Doka fruits were harvested during 28-30th July 2016 for dry date preparation. The preliminary results indicated that spray of 1000ppm Ethrel enhanced early maturity and ripening in cv. Medjool by this means the doka fruits can be utilized for value addition.

Aonla (*Emblica officianlis*)

At Bikaner

Frost resistant aonla genotype

The rootstocks of aonla were budded with the buds of frost tolerant germplasms. After attaining the suitable height, the new plant will be planted in the main field to see the frost resistance in aonla accessions.

At Godhra

Growth Characters

Twelve varieties of aonla (Chakaiya, Banarasi, Francis, Krishna, Kanchan, NA-10, Anand-1, Anand-2, NA-7, Goma Aishwarya, BSR-1 and BSR-2) were studies for their qualitative and quantitative characters of fruits during the year 2016-17. Apart from these varieties, five genotypes established under field condition were evaluated for vegetative growth characters.

Among the varieties, tree growth was observed upright spreading in Banarasi, Krishna, Chakaiya, tall upright in Anand-1 and Aanad-2; tall spreading in NA-7, drooping in Francis and tall semi-spreading in Kanchan and BSR-1 under rainfed conditions of western India. The foliage in Banarasi, Chakaiya, Krishna, Kanchan, Anand-1, BSR-2 and Anand-2 had sparse, whereas in Francis, NA-7, BSR-1 and NA-10 had dense foliage. The tree trunk colour of different varieties were grey in Banarasi, Krishna, Francis, Chakaiya, Anand-1 and Anand-2 and whitish grey in Kanchan, NA-7 and NA-10 . The inflorescence colour was deep pink in Banarasi and Krishna; yellowish green in Francis; pinkish green in Chakaiya and Kanchan; green to light pink in NA-7, NA-10 and Anand-1 while, light green to pinkish colour of inflorescence was observed in Anand-2 and BSR-1.

Fruit characters

The fruit shape was observed triangular in Banarasi and Krishna, flattened round in Francis, NA-7, Goma Aishwarya, Chakaiya, Kanchan and NA-10 and flattened oval in Anand -1 and Anand-2. Fruit colour of Banarasi and Kanchan was whitish green; light green in Krishna, Francis and Chakaiya; yellowish green in NA-7, NA-10 and Anand-2 and greenish yellow in Anand-2. Fruit stalk was observed short and thick in Banarasi, Krishna, NA-7 and NA-10 and short and thin was observed in Francis, Chakaiya, Kanchan, Aanand-1 and Anand-2. Fruit stem end cavity was noticed shallow and deep, it was observed shallow in Banarasi, Francis, Chakaiya, Kanchan, Anand-1 and Anand-2, whereas it was

deep in Krishna, NA-7 and NA-10. Stylar end was leveled in Banarasi, Francis, Chakaiya, Kanchan, and NA-10; prominent in Krishna and less prominent in NA-7, Anand-1 and Anand-2. Number of segments in all the varieties had six but in few varieties like Krishna and Kanchan 6-8 segments may also be seen. Most of the varieties showed whitish green colour flesh excluding Krishna which had yellowish green colour under rainfed semi-arid environment of western India. The highest fruit set was recorded in the NA-7 (51.10%) followed by Goma Aishwarya (50%), Krishna (47.50%), NA-10 (42.70%), NA-10 (39.88%) and Kanchan (35.13%) and it was lowest in Banarasi (21.24%) followed by Chakaiya (26.13%). The time of fruit set was noticed during the 1st fortnight of March in Krishna, Francis, Chakaiya, Kanchan and 2nd fortnight of February in Banarasi, NA-7 and NA-10, whereas it was recorded 2nd fortnight of March in Anand-1 and Anand-2. The time of fruit maturity was observed during last week of October in Banarasi, Francis, NA-10 and the same was observed during last week of November in Krishna, Chakaiya, Kanchan, Anand-1 and Anand-2. Days of maturity of different varieties ranged between 206 -217 days.

Quality characters

The characters in terms weight ranged between 26.91-35.80 g, being the maximum in Banarasi (35.80 g) followed by NA-7 (34.17 g) and it was measured the minimum in BSR-1(15.15g) followed by Kanchan (25.15 g). The fruit length ranged between 3.15-3.50cm, whereas it was observed the maximum in Banarasi (3.50 cm) followed by Krishna (3.47 cm) and NA-7 (3.42 cm), and the same was observed the minimum in Francis (3.05 cm) followed by Anand-1(3.15 cm) and Anand -2 (3.12 cm). Among the varieties, fruit breadth varied between 3.41-4.32 cm and the maximum breadth was observed in Banarasi (4.32 cm) followed by NA-7 and Chakaiya (4.00 cm), whereas it was minimum in Francis (3.41 cm). The percentage of fruit set (53.80 %) and fruit retention (28.40%) were recorded the maximum in NA-7 followed by Krishna for 47.00 % fruit set and 22.53% fruit retention, and the minimum fruit set and fruit retention were recorded 33.15% and 17.50 in Banarasi.

The juice content was recorded the highest in NA-7 (58.30 %) followed by Goma Aishwarya (53.15%), Anand-1 (52.10%), however Chakaiya had the lowest juice content (41.20%). The astringency level was highest in Krishna, Chakaiya, and NA-10, and it was least in NA-7, whereas the rest of the varieties had medium astringency. The acidity ranged between 2.01-2.23 % being the maximum in Banarasi (2.23%) followed by Krishna (2.16 %), whereas it was observed 2.01% in Kanchan followed by Anand-1. The pulp content ranged between 21.42-31.90 g and it was recorded the maximum in Banarasi (32.90 g) followed by NA-7 (31.67g) and Krishna (31.21g), whereas the minimum pulp content was in Anand-1 (21.42 g). The estimated vitamin C content among all the varieties ranged between 342.70- 459.27 mg /100gm. It was observed the highest in NA-7 (459.27 mg/100gm) followed by Kanchan (427.27 mg/100g) and the same was found to be the lowest in Banarasi (342.70mg/100gm). The total soluble solids were recorded the maximum in Goma Aishwarya (10.50^{0}brix) NA-7 (10.25% Brix) followed by Anand-1 (10.00^0 Brix) and Anand-2 (9.75^0 Brix), while Banarasi and Anand-2 had the minimum value (8.50^0 Brix). The value of specific gravity ranged between 1.05-1.44 being the highest in Banarasi (1.44) followed by Anand-1 (1.36) while it was least in Francis (1.05) followed by NA-7 (1.18). Stone shape was observed triangular in Banarasi and Krishna; round in Chakaiya, Kanchan, Anand-1 and Anand-2; oval in Francis and NA-10; oval round in NA-7. Banarasi followed by Krishna and NA-7 enunciated large stone and seed size, whereas it was small in Chakaiya, Kanchan, BSR-1, Anand-1 and Anand-2, while the rest of the varieties had medium stone size. The weight of the stone was exhibited the highest in Francis (2.5g) followed by Krishna and Anand-1 (2.5 g), and it was least in NA-7 (1.97 g) under rainfed hot semi-arid environment.

Pomegranate (*Punica granatum*)

The germplasm block was laid out during 1995-96 and the repository contained 154 germplasm. The germplasm were screened in this repository on the basis of yield and physical parameters of fruits. Out of 154 germplasm, ten were found to be promising type. The maximum plant height and canopy spread (N-S to E-W) was recorded in germplasm Jodhpur collection followed by Kazaki Anar (Table 1). While,

Table. 1. Evaluation of vegetative growth parameters of pomegranate germplasm.

Variety	Plant height (cm)	North- South (cm)	East-West (cm)	Fruit Weight (g)
19/16	230	213.3	215.3	138.5
P-23	206.6	183.5	185.7	74.4
Crendo Illicho	204.9	175.8	177.3	66.8
P-13	213	201.7	203.5	99.6
P-21	214	205.3	207.9	84
Kazaki Anar	236.67	213.30	216.33	136
Jodhpur Collection	236.70	214.3	217.3	143
Ruby	207.9	199.9	201.6	96.7
Mridula	215.3	205.7	207.7	108.3
G-137	236.67	213.30	223.33	89.2

the maximum fruit weight, fruit length and width were recorded in Jodhpur Collection followed by 19/16, respectively. The yield attributing parameters of fruit like fruit weight were recorded highest in germplasm in Jodhpur Collection but number of fruits per plant and yield per plant was recorded in germplasm 19/16 was 3.5 kg per plant followed by Jodhpur Collection 3.48 kg per plant. Among the germplasm Jodhpur Collection was screened for anardana purpose.

The Sixty nine germplasm lines were multiplied and replanted between line of old germplasm for conservation, maintenance, evaluation and utilization purposes. The observation were recorded like plant height, canopy spread, number of branches and trunk girth. The maximum plant height (97.3 cm) and canopy spread (73.3 cm EW & 66.7 cm NS) was recorded in Jodhpur Red. The numbers of branches were recorded in three germplasm Khog, Saih Sirin as well as P-26 (7.0) and trunk girth (16.7 mm) were recorded in Jodhpur Red. The minimum plant height (32 cm) in Banaras Collection, canopy spread East × West (9.5 cm) in S8×14, North × South (6 cm) in S8×14, number of branches (1.0) in Karavi and trunk girth (4 mm) were recorded in Surkh Anar (Table 3).

Table. 2. Yield and physico-chemical characteristics of pomegranate genotype.

Variety	Fruit Length (cm)	Fruit Width (cm)	Seed Index (g)	Test weight (g)	Peel weight (g)	Total weight (g)	No. of fruits	Yield/ Plant (Kg)
19/16	6.81	6.61	21	210.5	59	78.2	45	3.51
P-23	5.95	5.72	13	130	24.8	56.2	15	0.84
Crendo Illicho	5.78	5.66	20.8	207.2	33.3	37.3	20	0.74
P-13	6.75	6.61	20	200	34.8	52.4	12	0.62
P-21	6.47	6.36	12	119	40	44	16	0.70
Kazaki Anar	6.71	6.47	22	221	42	96	23	2.20
J. Collection	7.61	7.55	18.7	186.5	66.3	91.8	38	3.48
Rubby	6.59	6.46	20	199	33	56.7	11	0.62
Mridula	6.22	5.95	17	170	46.67	68.33	13	0.88
G-137	5.77	5.57	21	205	47.33	81.33	32	2.603

Table 3. Morphometric parameters of different germplasm.

S. No.	Germplasm	Height (cm)	Canopy (cm)		Trunk girth (cm)	No. of Branches
			E-W	N-S		
1	Jalore Seedless	35.5	27.5	23.0	10.6	5.5
2	Jodhpur Red	97.3	73.3	66.7	16.5	6.7
3	Kajaki Anar	51.7	44.0	51.7	10.9	3.0
4	Ganesh	48.5	49.5	46.5	12.4	4.3
5	Dorsata Malus	49.0	35.0	37.5	10.8	2.7
6	Saranpur	69.5	73.0	48.0	11.1	5.3
7	G-137	37.5	54.0	36.5	10.3	4.0
8	Kabul	60.0	36.5	43.0	8.5	2.7
9	Basein Seedling	61.3	34.3	32.7	10.5	6.7
10	Banaras Collection	32.3	39.0	31.7	9.0	4.0
11	Basein Seedless	40.7	33.3	31.3	8.7	4.3
12	Alha	43.7	31.3	34.3	9.4	4.0
13	Kandhari	73.0	50.0	46.3	12.2	5.3
14	Bedana Suri	59.0	57.0	49.7	11.9	6.7
15	GK-VK-1	65.0	45.5	45.0	11.6	4.3
16	Speen Sakarin	65.3	38.0	36.7	9.0	5.3
17	12|1	86.0	50.0	46.0	11.9	6.0
18	Muskat	78.0	62.3	53.3	14.2	4.7
19	Dholka	52.0	43.7	44.0	12.8	4.0
20	19/10	59.7	60.0	47.0	11.0	5.0
21	Jalore Red	57.0	49.3	52.0	13.1	4.3
22	Uthkal	57.7	41.0	57.0	11.5	5.0
23	Kalisirin	47.3	29.3	30.7	8.9	5.3
24	AHPG-C1	64.3	21.7	20.0	9.7	4.7
25	Khog	67.7	42.3	52.0	10.4	7.0
26	Coimb.White	71.0	45.3	49.3	13.8	6.3
27	Saih Sirin	68.0	40.3	39.7	11.0	7.0
28	MR 599	58.7	32.7	38.0	9.6	6.0
29	AHPG-C3	55.0	49.0	47.3	12.5	5.0
30	Yercaud	71.0	35.0	40.0	13.5	5.3
31	Jodhpur Collection	72.0	45.0	42.0	14.6	6.0
32	Bedana Thin Skin	52.0	25.7	23.0	7.4	3.7
33	AHPG-C4	65.7	17.0	22.7	8.9	5.3
34	S8x10	63.7	22.3	23.3	9.6	6.7
35	P-23	43.0	19.5	18.0	8.3	3.0
36	P-21	41.5	31.5	31.0	13.4	6.0
37	A K Anar	76.3	26.7	22.3	9.2	6.3

Contd...

Table 3 (Concluded)

S. No.	Germplasm	Height (cm)	Canopy (cm)		Trunk girth (cm)	No. of Branches
			E-W	N-S		
38	P-26	39.0	38.0	26.0	10.4	7.0
39	Crenedo De Elecho	35.5	21.0	17.5	9.5	4.0
40	Kabul Kohinoor	57.0	35.3	37.3	11.1	5.0
41	EC-62812	37.3	25.3	29.7	9.2	5.3
42	Ruby Winter Bloom	52.0	30.5	28.5	11.2	5.5
43	Mridula	45.0	33.0	32.3	9.5	4.3
44	Tujests EC 104347	70.0	21.0	21.7	9.0	4.0
45	Sirin	37.7	20.7	18.7	7.6	5.3
46	S8x12	57.3	18.7	19.0	8.5	6.0
47	Boseka Link	88.0	19.7	17.7	9.6	3.7
48	Yercaud Local	57.7	20.3	16.3	8.4	4.0
49	Tabest	52.7	14.3	20.0	8.8	3.3
50	Gule Shah Red	42.3	18.3	21.3	7.9	3.7
51	Speen Danedar	62.0	15.0	19.0	9.7	4.0
52	S8x13	58.0	16.3	16.7	8.8	3.0
53	Patna-5	62.7	18.0	19.3	9.5	5.3
54	Sur Sukkar	65.7	13.7	15.7	8.2	3.3
55	Malta	61.3	20.0	18.0	8.8	4.7
56	Gulsa Red	57.3	25.0	23.7	9.7	5.7
57	Gule Shah	62.0	17.7	19.0	9.2	4.0
58	S8x14	65.5	9.5	6.0	6.7	3.0
59	Surat Anar	48.0	16.7	21.7	10.2	4.7
60	Gule Shah Rose Pink	60.0	22.7	25.0	11.2	5.3
61	Kurvi	42.5	5.5	7.5	7.4	1.0
62	Bedana Seedless	72.0	18.5	22.5	7.8	2.5
63	Jyoti One Line	64.3	20.0	22.3	9.9	5.0
64	P-13	35.0	18.5	20.0	7.8	5.0
65	Agah	62.7	16.0	14.7	7.8	4.0
66	Ec-12613	62.7	28.0	30.0	9.9	6.0
67	S8x16	65.3	17.3	17.3	8.6	5.3
68	Achikdana	63.3	11.7	11.0	8.2	4.0
69	Surkh Anar	49.0	18.7	19.7	4.0	5.0

At Godhra

In totality 43 genotypes of pomegranate were planted and established under field condition. Plants are healthy and surviving well.

Air layers of pomegranate cultivars Mridula, Bhagwa, Super Bhagwa, Ruby, S-1, Deshi and Sindhuri were collected and planted in the field.

Bael (*Aegle marmelos*)

At Bikaner

Bael germplasm (18) were conserved and evaluated for growth, flowering, fruiting and effect of frost/low temperature. The vegetative growth of plants varied from 2.20m to 4.80m under hot arid conditions. The maximum germplasm are of seedling types. Fruiting was noted in nine germplasm during 2016, but flowers and immature fruit drop were observed during summer. During the year-2017, effect of frost/low temperature was not observed. Variation in number of fruits per plant (03 to 48) was noted during February. Development of varietal block of bael NB-5, NB-9, CISH Bael-1, CISHB-2, Pant Sujata, CIAH Bael Sel-2, GomaYashi and Thar Divya are in progress. Budded bael cv. Goma Yashi was planted for evaluation under hot arid conditions.

Ethrel @1000ppm was sprayed during the month of March 2017 on foliage/ fruits to see the effect on fruit cracking and early maturity, ripening. Initial results showed that fruit cracking was low on sprayed fruit and also enhanced early maturity / ripening of fruits

At Godhra

Bael varieties were studied for their phenolics, flavonoids and antoxidant activity. The total phenolics (mg/g FW) ranged between18.90 - 48.58 being the highest in Pant Sujata and the same was minimum in Pant Urvashi, whereas total flavonoids (mg/g FW) and antioxidant activity (CUPRAC (micro mol TE/g) ranged between 14.86-38.83 and 98.75-160.81, respectively among the varieties. The maximum flavonoids and total phenols was recorded the maximum in Pant Sujata followed by Thar Divya (24.53 and 33.19) and the same was recorded the minimum in Pant Urvashi. O-dihydric phenol (mg/g FW) was found the highest in Pant Sujata (0.81) and it was least in NB-9 (0.28) among the varieties namely Thar Divya, NB-9, NB-7, NB-16, NB-17, Pant Sujata, Pant Aparna, Pant Urvashi, Pant Shivani, Thar Neelkanth, CISHB-1 and CISHB-2.

Salient features of released variety Thar Neelkanth

It belongs to mid maturity group (April) and its striking features are earliness, compact growth, medium height, spiny, better yield with quality fruits having pleasant flavour with attractive colour of pulp. It started flowering and fruiting from 3rd year of budding. Average yield per plant 75.67 kg (8th year), average fruit weight 1.45 kg, fruit size 15.10 cm x 15.00 cm, fruit girth 47.30 cm, shell thickness 0.18cm, total number of seed 73, seed weight 0.21g, total seed weight 15.46g, fibre weight 110.17 g, shell weight 265.00g, locules in cross section 13-16, pulp 71.30%, TSS pulp 40.10^{0}B, TSS mucilage 51.50^{0}B, acidity (0.30%) and vitamin C 19.90 mg / 100 g pulp were recorded. The fruit of this genotype is having good flavour and aroma. It is highly suitable in drought prone dry land conditions and also suitable for sherbet, powder and squash making

Germplasm Evaluation

Apart from the 14 varieties, 159 germplasm established through *in-situ* patch budding were evaluated for growth, flowering and fruiting characters, out of which flowering and fruiting was noticed in 48 genotypes during the year 2015-16,

and variability was noticed in their morphological characteristics among the different bael genotypes. Variation in growth habit was observed as upright, spreading, semi spreading and drooping type and foliage with compact, dense and sparse among all the forty eight characterized genotypes. Tree shapes of different genotypes were dome, irregular, semi circular, broad vase and elliptical types among all the genotypes. There were variability in the leaf characters *i.e.,* leaflet shape (ovate, ovate to cordate, broadly lanceolate to ovate, broadly ovate, elliptical and elliptical to lanceolate), leaf margin (superficially, prominent; crenate, crenulate), leaf apex (acute, acuminate, slightly aristate and subacute), leaf base (broadly cuneate, round, narrowly cuneate and truncate) and leaf surface (dull rough and shiny smooth) in rainfed semi-arid ecosystem of western India. The bark colour was yellowish grey, greyish yellow, blackish grey, dark grey and light whereas splitting pattern was irregular intersecting striations having small rectangular blocks. There was wide range of variability found in floral biology *i.e.*, floral bud emergence peak period of flowering and quantitative characters of floral organs of different genotypes of *bael*.

The TSS content in pulp varied between 31.50 °B-41.50 °B, TSS of mucilage 14.50°-50.50 ° B, titratable acidity 0.29%- 0.55% ,vitamin C 12.02 to 24.30 mg/100 g, total sugar 16.50 21.70 per cent, non reducing 14.10 to 17.60 and reducing sugar 3.17 to 3.67, respectively among the evaluated genotypes. The total phenols considered to be one of the most desirable characters in *bael* ranged from 1990 mg - 3031 mg per 100g. Based on the observation on various aspects particularly fruiting pattern and quality attributes, genotypes viz., CHESB-11, CHESB-16, CHESB-21, CHESB-27, CHESB-29 and CHESB-31 were found to be superior for various qualitative and morphological characters among the genotypes evaluated under rainfed semi-arid ecosystem.

Important features of identified genotype of bael "CHESB-11"

Average yield per plant 52.10 kg in 6th year, fruit weight 1.54 kg, fruit size 21.50 cm x 13.20 cm, fruit girth 45.21 cm, shell thickness 0.18cm, total number of seeds 85, seed weight 0.15g, total seed weight 12.58g, fibre weight 30.60g, shell weight 200.10g, locules in cross section 14-17, TSS pulp 38.13^{0}B, TSS mucilage 49.80^{0}B, acidity (0.29%) and vitamin C 22.83 mg / 100 g pulp were recorded. It is late maturing variety (1stweek of May). The fruits of this genotype are having good flavour and aroma. It is highly suitable for sherbet; pickle, *murabba* and powder making. Fruits of this variety having uniform ridges on the fruit surface, which is more prominent at stylar end (Fig. 2).

Intervarietal characterization of bael varieties

A total of twelve varieties of bael (*Aegle marmelos* Correa) were established through *in-situ* patch budding were studied for leaf morphological variation. Results of study revealed that all varieties of bael showed considerable morphological variation with respect to shape, margin, base and apex of leaf and bark colour and splitiing. These varieties can be identified up to some extent by observing the morphology of leaf and bark.

Fig. 2. Fruiting of bael "CHES-B11"

Mulberry (*Morus* sp.)

Morphological characterization of mulberry

The effective utilization of germplasm depends on systematic characterization and identification of genotypes with specific traits. Further, selection of suitable genotypes from gene pool requires a thorough knowledge of morphological characteristics of different genotypes for utilizing them in breeding. Therefore, ten mulberry genotypes *viz*., Thar Lohit, Thar Harit, CIAH-3, SL-1, SL-2, Gurgaon Local, Delhi Local, Ajmer, MI-315 and MI-380, available at the Institute, were characterized for morphological traits like shoot, bud and leaf characteristics. Nature of shoot was either slightly curved or straight. Similarly, nature of bud attachment was either slanting outward or adhering to branch (Fig. 3). The predominating bud

shape was acute triangle. However, some genotypes had round bud shape. Leaf colour was noted to be green or light green depending upon the genotype. Likewise, leaf surface was either rough or smooth. No variation was noted for the characters like presence of petiole groove and accessory bud (Table 4). A distinct variation was recorded regarding leaf arrangement (phyllotaxy), which was noted to be either alternate or spiral (Fig. 4). The regular arrangement of leaves on a stem is an important aspect of plant form, known as phyllotaxy. The orders of spiral phyllotaxy were ½, 1/3, or 3/8.

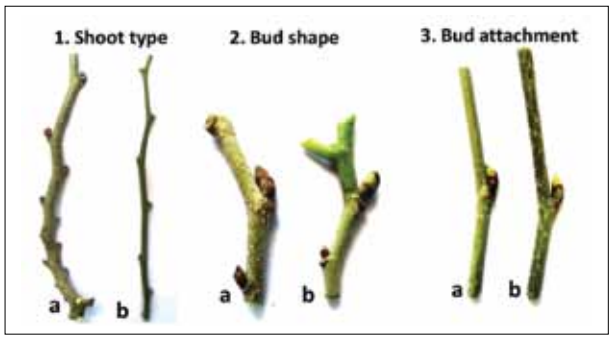


Fig. 3. Variation in shoot and bud characteristics of mulberry. 1. Shoot type (a) slightly curved (b) straight; 2. Mature bud shape (a) acute triangle (b) round; 3. Bud attachment (a) adhering to branch (b) slanting outward.

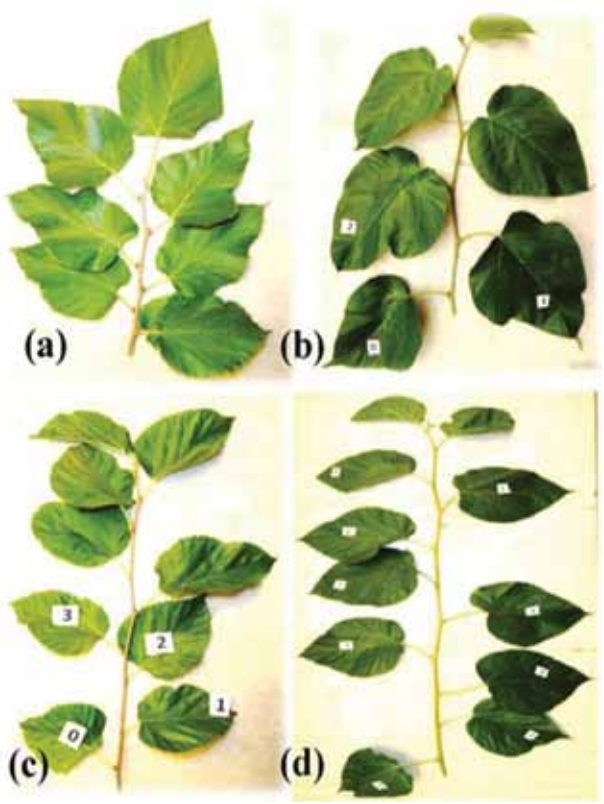


Fig. 4. Divergence in phyllotaxy as seen in mulberry genotypes; (a) & (b) Distichous or ½ Phyllotaxy (c) Tristichous or 1/3 Phyllotaxy (d) Octastichous or 3/8 Phyllotaxy

Table 4. Characteristics of mulberry genotypes.

Character-istics	Genotypes									
	Thar Lohit	Thar Harit	CIAH-3	Delhi Local	Gurgaon Local	Ajmer	SL-1	SL-2	MI-315	MI-380
Shoot type	Slightly curved	Slightly curved	Slightly curved	Straight	Slightly curved	Slightly curved	Straight	Slightly curved	Slightly curved	Straight
Bud attachment	Slanting outward	Adhering to branch	Slanting outward	Slanting outward	Slanting outward	Slanting outward	Slanting outward	Slanting outward	Slanting outward	Adhering to branch
Mature bud shape	Round	Round	Round	Acute triangle	Round	Acute triangle	Acute triangle	Acute triangle	Acute triangle	Round
Presence of stipule	Present	Present	Present	Absent	Present	Present	Present	Present	Present	Present
Bud color	Reddish brown	Dark Brown	Dark brown	Dark brown	Brown	Brown	Brown	Brown	Dark brown	Dark brown
Accessory bud	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Branch color	Gray	Gray	Gray	Gray	Gray-yellow	Gray-yellow	Gray-yellow	Gray-yellow	Gray	Gray
Leaf colour	Green	Green	Green	Green	Green	Green	Light green	Light green	Green	Green
Leaf surface	Rough	Smooth	smooth	Rough	Rough	Rough	Rough	Rough	Rough	Smooth
Leaf margin	Smaller more pointed	Large serration	Large round	Large round	Large round	Large round	Large round	Large round	Large round	Large round
Petiole groove	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present

Mulberry variety 'Thar Harit'

Mulberry (*Morus alba*) variety 'Thar Harit' at the Institute level was identified, which was previously known as CIAH Mulberry-2. It is precocious, prolific bearer and plant canopy short stature and spreading type. It starts bearing in 3rd year. Fruit colour is appealing green-white and is nutraceutical-rich, thirst quencher and suitable for table and processing purposes.

Evaluation of germplasm of mulberry

Four accessions received from CSGRC, Hosur planted under field conditions on 27.07.13. All accessions came into fruiting during March, 2016 and also during 2017. Some fruit characters are presented here under;

MI-363: White colour fruits, 3-4 cm long; MI-572: Red fruited, 5-8 cm long fruits; MI-775: Small 1-2 cm long, white colour fruits.

Guava (*Psidium guajava*)

Diversity rich areas of Gujarat viz., Panchmahal, Vadodara, Bharuch, Gandhinagar, Bhavnagar and Mahisagar districts were surveyed and diverse genotypes identified on the basis of desirable horticultural traits. All the identified genotypes were of seedling origin and age of trees varied in between 7 to 20 years. Also air-layers of five identified genotypes from Panchmahals district were collected and established in the field gene bank.

Fruit characters: Various fruit characters of different accessions presented in table-5, which showed wide variability in terms of fruit shape, peel colour, pulp colour, shape at stalk end, calyx cavity, longitudinal ridges on fruit surface and relief of fruit surface. Among the various accessions observed, CHESG-2, CHESG-3, CHESG-4, CHESG-5, CHESG-10, CHESG-15, CHESG-16, CHESG-18 and CHESG-22 had round fruit shape, CHESG-9, CHESG-13, CHESG-14 and CHESG-23 had conical fruit shape, , CHESG-1, CHESG-25 had subglobose fruit shape, CHESG-7, CHESG-8, CHESG-9, CHESG-13, CHESG-14, CHESG-19 and CHESG-23 had conical fruit shape, CHESG-6, CHESG-11 had pyriform fruit shape while others had obovate fruit shape. The outer fruit peel colour on ripening varied among the different accessions. Yellowish-green peel colour was observed in CHESG-1, CHESG-3 CHESG-6, CHESG-8, CHESG-9, CHESG-10 and CHESG-17; CHESG-3, CHESG-5, CHESG-12, CHESG-16, CHESG-19 and CHESG-21 had dark yellow to yellow peel; CHESG-2, CHESG-11, and CHESG-22 had green peel; CHESG-4 and CHESG-18 had orange greenish peel colour; greenish yellow peel colour was noted in CHESG-13, CHESG-17 and CHESG-24; CHESG-14, CHESG-25 had pale yellow colour, while CHESG-15 and CHESG-23 had grey yellow and whitish yellow peel colour respectively. The pulp colour varied (Fig. 5, 6) as white in CHESG-1, CHESG-3, CHESG-6, CHESG-7, CHESG-8, CHESG-10 and CHESG-22; red in CHESG-2; creamish white in CHESG-4, CHESG-5, CHESG-17, CHESG-19; creamish in CHESG-23; creamish light pink in CHESG-25; pink in CHESG-9; light pink in CHESG-12, CHESG-14; pale pink in CHESG-15, CHESG-20, CHESG-21, CHESG-24 and yellow white in CHESG-18.

Fruit physical quality attributes: Different fruit physical quality attributes viz., fruit weight, size and their physical composition differed significantly among different guava accessions. The fruit weight varied from 53.50 g in CHESG-12 to 318.50 g in CHESG-8. The maximum fruit weight was recorded in CHESG-8 (318.50 g) followed by CHESG-7 (292.50 g), CHESG-19 (262.25 g) and CHESG-21 (253.66 g). The minimum fruit weight was observed in CHESG-12 (53.50 g) followed by CHESG-22 (88.20 g) and CHESG-9 (98.50 g). The fruit length varied from 4.09 cm in CHESG-22 to 9.95 cm in CHESG-21. The maximum fruit length was recorded in CHESG-21 (9.95 cm), followed by CHESG-8 (9.53 cm), CHESG-19 (9.33 cm), CHESG-7 (9.30 cm), CHESG-6 (9.16 cm) and CHESG-20 (8.40 cm), while the minimum fruit length was recorded in CHESG-22 (4.09 cm) followed by CHESG-16 (5.20 cm). The fruit width varied from 4.30 cm CHESG-12 followed by 4.50 cm in CHESG-22 to 8.25 cm in CHESG-8 followed by 7.90 cm in CHESG-7; 7.67 cm in CHESG-19 and 7.43 cm in CHESG-18. However, highest fruit length: width ratio was recorded in CHESG-11 (1.45) followed by

CHESG-21 (1.40), CHESG-17 (1.38), CHESG-20 (1.37) and CHESG-12 (1.3). The length of seed core varied from 2.5 to 5.45 cm. The maximum seed core length was recorded in CHESG-5 (5.45 cm) followed by CHESG-8 (5.25 cm) and 5.20 cm in CHESG-10 and CHESG-14, whereas, the minimum seed core length was observed in CHESG-12 (2.50 cm) followed by CHESG-22 (2.70 cm) and CHESG-17 (2.80 cm). The number of seed/fruit varied 55.30 to 609 and being the maximum in CHESG-25 (609.0) followed by CHESG-20 (600.0) and CHESG-20 (510.0). The minimum number of seed/fruit was recorded in CHESG-12 (55.30) followed by CHESG-9 (98). The maximum seed weight/fruit was recorded in CHESG-20 (9.12 g) followed by CHESG-13 (8.16 g), while it was found minimum in CHESG-12 (0.94 g) followed by CHESG-19 (1.62 g) and CHESG-23 (1.85 g). Seed hardness determines the table quality of guava fruits, which varied from soft as in CHESG-18, CHESG-19, CHESG-22 and CHESG-23; medium-soft in CHESG-1, CHESG-3, CHESG-4, CHESG-5, CHESG-6, CHESG-8, CHESG-10, CHESG-11, CHESG-14, CHESG-15, CHESG-16, CHESG-17 and CHESG-21 and medium-hard in CHESG-2, CHESG-7, CHESG-9, CHESG-15 and CHESG-16 and hard in CHESG-12, CHESG-13, CHESG-20, CHESG-24 and CHESG-25.

Fruit chemical quality attributes: Fruit chemical quality attributes also varied significantly among various guava accessions. The TSS of fruit juice ranged from 10.80 to 16.33 ^{0}B, being the highest in CHESG-24 (16.33 ^{0}B) followed by CHESG-21 (16.0 ^{0}B), CHESG-7 (15.50 ^{0}B) and CHESG-9 (15.30 ^{0}B), while the minimum TSS was recorded in CHESG-19 (10.80 ^{0}B). The titrable acidity in fruit juice ranged from 0.28 to 0.70%, being the highest in CHESG-24 (0.70%) followed by CHESG-21 (0.60%) and CHESG-20 (0.56%) and the minimum acidity content was noted in CHESG-5 (0.28%). The TSS:acid ratio among different accessions varied from 39.82 in CHESG-5 followed by 39.35 in CHESG-8 to 20.37 in CHESG-19 followed by 23.32 in CHESG-24. The maximum ascorbic acid content was recorded in CHESG-7 (280.50 mg/100 g), followed by CHESG-4 (275.72 mg/100 g), while lowest ascorbic acid was recorded in CHESG-22 (136.50 mg/100 g). CHESG-7 had the maximum reducing (7.61%) and total sugars (9.78%) followed by CHESG-6 (7.35 & 9.61%), while the minimum reducing and total sugars was recorded in CHESG19 (4.11%) and CHESG-12 (5.70%), respectively. The highest non-reducing content was obtained in CHESG-22 followed by CHESG-10 and it was the minimum in CHESG-17 (1.09%).

Table 5. Fruit physical characters of guava accessions.

Accessions	Place of collection	Shape	Peel colour	Pulp colour	Shape at stalk end	Calyx cavity	Longitudinal ridges	Relief of fruit surface
CHESG-1	Bodidra	Subglobose	Yellowish green	White	Rounded	Small	Absent	Smooth
CHESG-2	Rampur	Round	Green	Red	Rounded	Medium	Present	Rough
CHESG-3	Paroli	Round	Yellow	White	Broadly rounded	Small	Absent	Smooth
CHESG-4	Paroli	Round	Orange grrenish	Creamish white	Broadly rounded	Small	Absent	Smooth
CHESG-5	Paroli	Round	Yellow	Creamish white	Rounded	Broad	Absent	Smooth
CHESG-6	Rampur	Pyriform	Yellowish green	White	Pointed	Small	Present	Rough
CHESG-7	Rampur	Subglobose	Dark yellow	White	Rounded	Small	Absent	Rough

Contd...

Table 5 (Concluded)

Accessions	Place of collection	Shape	Peel colour	Pulp colour	Shape at stalk end	Calyx cavity	Longitudinal ridges	Relief of fruit surface
CHESG-8	Godhra	Pyriform	Yellow green	White	Rounded	Small	Present	Rough
CHESG-9	Godhra	Conical	Yellow green	Pink	Pointed	Small	Absent	Smooth
CHESG-10	Godhra	Round	Yellowish green	White	Rounded	Broad	Present	Rough
CHESG-11	Zingiri	Pyriform	Green	White	Necked	Small	Absent	Smooth
CHESG-12	Paroli	Obovate	Yellow	Light pink	Rounded	Small	Absent	Smooth
CHESG-13	Kasanpur	Conical	Greenish yellow	White	Pointed	Small	Absent	Smooth
CHESG-14	Waghodiya	Conical	Pale yellow	Light pink	Pointed	Small	Present	Smooth
CHESG-15	Sihor	Round	Grey yellow	Pale pink	Broadly rounded	Small	Absent	Smooth
CHESG-16	Sihor	Round	Yellow	Pink	Rounded	Broad	Absent	Smooth
CHESG-17	Chandrala	Obovate	Greenish yellow	Creamish white	Necked	Small	Absent	Smooth
CHESG-18	Kuazar	Round	Orange grrenish	Yellow white	Rounded	Broad	Present	Smooth
CHESG-19	Veerpura	Obovate	Yellow	Creamish white	Rounded	Small	Present	Rough
CHESG-20	Veerpura	Subglobose	Yellowish green	Pale pink	Rounded	Small	Absent	Rough
CHESG-21	Mota surkha	Conical	Yellow	Pale pink	Rounded	Small	Absent	Rough
CHESG-22	Pipliya	Round	Green	White	Broadly rounded	Small	Absent	Smooth
CHESG-23	Sihor	Conical	Whish yellow	Creamish	Pointed	Small	Absent	Smooth
CHESG-24	Rampur	Round	Greenish yellow	Pale pink	Truncate	Small	Present	Bumpy
CHESG-25	Rampur	Subglobose	Pale yellow	Creamish light pink	Rounded	Broad	Absent	Rough

CHESG-21 CHESG-15 CHESG-16 CHESG-24

Fig. 5: Comparative colour in pink fleshed guava accessions.

CHESG-4 CHESG-6 CHESG-23 CHESG-19

Fig. 6: Comparative colour in white fleshed guava accessions.

Establishment of field gene bank of guava

Different guava cultivars viz., Allahabad Safeda, L-49, Shweta, Lalit and Dhawal from CISH, Lucknow, MPUATS-1, MPUATS-2, KG guava from Udaipur, Thai guava from Bharuch and VNR Vihi-1 from Gandhinagar were collected and established under field condition. Air layers of five guava selections from Panchmahal district were also collected and established in the field gene bank of guava. In all, 15 genotypes of guava were established in field gene bank of guava.

Lime (*Citrus aurantifolia*)

At Godhra

Diversity rich areas of Gujarat viz., Panchmahals, Bharuch, Bhavnagar and Mahisagar districts were surveyed and 27 diverse genotypes were identified on the basis of desirable horticultural traits. All the identified genotypes were of seedling origin and age of trees varied in between 10 to 15 years. Perusal of the data on the variability in leaf characters of acid lime accessions revealed a wide range of variability in leaf blade length, width, L:W ratio, shape, margin, apex and leaf petiole wing characters (Table 6). The leaf blade length was recorded maximum in CHESL-1 (9.13 cm) followed by CHESL-15 (9.03 cm) and CHESL-12 (8.77 cm) and it was minimum in CHESL-27 (5.50 cm). The width of leaf blade varied from 2.70 to 4.89 cm being maximum in CHESL-1 (4.89 cm) followed by CHESL-15 (4.89 cm), while it was recorded minimum in CHESL-27 (2.70 cm). However, L:W ratio was found maximum in CHESL-21 (2.31) followed by CHESL-23 (2.28) and CHESL-27 (2.07), whereas, it was observed minimum in CHESL-6 (1.64). Among the studied genotypes, the leaf shape was observed ovate, obovate, elliptic and orbicular, whereas leaf margin was observed as crenate, sinuate, dentate and entire. Variation in leaf apices were also observed amongst different lime accessions (Table 6). The petiole wing length varied from 0.83 to 2.0 cm among lime accessions. The maximum petiole wing length was recorded in CHESL-13 (2.0 cm) followed by CHESL-12 (1.76 cm), while the minimum petiole wing length was recorded in CHESL-26 (0.83). The petiole wing width was observed narrow in CHESL-1, CHESL-8, CHESL-10, CHESL-15, CHESL-16, CHESL-17 CHESL-21, CHESL-23, CHESL-24 and CHESL-26; broad in CHESL-2, CHESL-7 and medium in rest of the accessions. Petiole wing shape also varied as obdeltate (CHESL-1, CHESL-3, CHESL-5, CHESL-9, CHESL-12, CHESL-15, CHESL-19, CHESL-22, CHESL-25), obovate (CHESL-2, CHESL-6, CHESL-8, CHESL-11, CHESL-13, CHESL-14, CHESL-16, CHESL-18, CHESL-23, CHESL-27), linear (CHESL-4, CHESL-10, CHESL-17, CHESL-21, CHESL-24) and obcordate (CHESL-7, CHESL-20, CHESL-26).

Variability recorded for physico-chemical characters in 27 accessions of acid lime revealed significant differences among the accessions (Table 7). The maximum fruit length was observed in CHESL-13 (5.73 cm), followed by CHESL-2 (5.44 cm), CHESL-27 (5.23 cm) and CHESL-12 (5.17 cm), while, CHESL-16 recorded the minimum fruit length (3.30 cm). Among the collections, CHESL-12 (5.17) recorded the maximum fruit diameter. It was followed by CHESL-13 (5.0 cm) and CHESL-2 (4.99 cm) and the minimum was recorded in CHESL-16 (3.13 cm). Fruit length/diameter is the parameter that indicates fruit shape. Fruits with a high length/diameter ratio are longer than those with a lower value are spherical. Among the genotypes, CHESL-5 had the highest fruit length/diameter value (1.17), exhibiting the stretched appearance. CHESL-14 had the lowest fruit length/diameter

Table 6. Leaf characters of acid lime accessions.

Accessions	Place of collection	Leaf blade						Petiole wing	
		Length (cm)	Width (cm)	L:W	Shape	Margin	Apex	Width	Shape
CHESL-1	Godhra	9.13	4.90	1.87	Ovate	Crenate	Acute	Narrow	Obdeltate
CHESL-2	Godhra	8.76	4.41	1.98	Obovate	Sinuate	Acute	Broad	Obovate
CHESL-3	Bodidra1	7.60	3.80	2.00	Ovate	Dentate	Acute	Medium	Obdeltate
CHESL-4	Bodidra1	6.83	3.53	1.93	Obovate	Crenate	Acuminate	Medium	Linear
CHESL-5	Bodidra1	6.73	4.16	1.65	Elliptic	Crenate	Obtuse	Narrow	Obdeltate
CHESL-6	Bodidra2	7.26	4.40	1.64	Obovate	Sinuate	Rounded	Medium	Obovate
CHESL-7	Bodidra2	6.73	3.26	2.06	Obovate	Sinuate	Obtuse	Broad	Obcordate
CHESL-8	Bodidra2	7.46	3.93	1.89	Obovate	Sinuate	Obtuse	Narrow	Obovate
CHESL-9	Rampur	7.80	3.86	2.02	Elliptic	Sinuate	Obtuse	Medium	Obdeltate
CHESL-10	Dangriya	6.40	3.46	1.85	Elliptic	Crenate	Obtuse	Narrow	Linear
CHESL-11	Paroli	7.86	4.40	1.79	Obovate	Sinuate	Obtuse	Medium	Obovate
CHESL-12	Vejalpur	8.77	4.30	2.04	Elliptic	Crenate	Obtuse	Medium	Obdeltate
CHESL-13	Matriya	7.26	3.36	2.16	Ovate	Crenate	Obtuse	Medium	Obovate
CHESL-14	Vandeli	7.70	3.83	2.00	Elliptic	Crenate	Obtuse	Narrow	Obovate
CHESL-15	Vandeli	9.03	4.89	1.84	Ovate	Crenate	Rounded	Narrow	Obdeltate
CHESL-16	Bediya	6.93	3.97	1.75	Obovate	Dentate	Obtuse	Narrow	Obovate
CHESL-17	Bediya	6.36	3.63	1.75	Obovate	Sinuate	Rounded	Narrow	Linear
CHESL-18	Vejalpur	7.33	3.66	2.01	Ovate	Sinuate	Acuminate	Medium	Obovate
CHESL-19	Ghoghomba	6.76	3.83	1.77	Orbicular	Sinuate	Obtuse	Medium	Obdeltate
CHESL-20	Kotda	5.63	2.90	1.98	Ovate	Dentate	Acuminate	Medium	Obcordate
CHESL-21	Khajuri	6.46	2.80	2.31	Elliptic	Dentate	Acute	Narrow	Linear
CHESL-22	Nava Gaon	7.87	4.20	1.87	Obovate	Sinuate	Obtuse	Medium	Obdeltate
CHESL-23	Sahera	8.13	3.56	2.28	Ovate	Crenate	Obtuse	Narrow	Obovate
CHESL-24	Sahera	6.77	3.30	2.05	Ovate	Crenate	Acute	Narrow	Linear
CHESL-25	Khanpur	7.33	4.03	1.81	Elliptic	Sinuate	Acuminate	Medium	Obdeltate
CHESL-26	Khanpur	6.06	3.25	1.86	Ovate	Entire	Acuminate	Narrow	Obcordate
CHESL-27	Zingiri	5.50	2.70	2.07	Elliptic	Crenate	Obtuse	Medium	Obovate
SEm±	-	0.27	0.20	0.08	-	-	-	-	-
CD at 5%	-	0.76	0.57	0.22	-	-	-	-	-
CV%	-	6.37	9.28	7.10	-	-	-	-	-

Table 7. Physico-chemical characters of acid lime accessions.

Accessions	Fruit physical quality attributes								Fruit chemical quality attributes				
	Length (cm)	Diameter (cm)	Length/diameter	Weight (g)	Juice (%)	No. of segment fruit^{-1}	Peel thickness (mm)	No. of seed fruit^{-1}	TSS (^{0}B)	Acidity (%)	TSS/acidity	Juice pH	Ascorbic acid (mg/100 ml juice)
CHESL-1	4.73	4.40	1.07	42.10	51.70	10.66	2.00	11.00	9.03	8.53	1.06	2.02	43.75
CHESL-2	5.44	4.99	1.08	61.34	55.66	12.00	1.56	7.66	7.73	9.30	0.85	1.80	71.93
CHESL-3	4.06	3.86	1.05	38.88	50.32	11.00	1.20	12.00	9.40	8.80	1.06	2.10	37.17
CHESL-4	3.82	3.81	1.02	35.43	49.53	10.33	1.60	11.00	9.16	7.46	1.22	2.26	33.53
CHESL-5	4.23	3.61	1.17	37.31	50.23	10.66	1.33	11.00	10.59	10.36	1.02	2.20	42.29
CHESL-6	4.08	3.76	1.09	40.83	48.40	11.33	1.30	12.00	8.38	6.89	1.23	2.23	46.48
CHESL-7	4.31	4.33	0.99	44.90	51.66	12.00	1.16	10.00	8.16	7.78	1.05	2.13	50.70
CHESL-8	4.01	4.00	1.00	44.07	54.66	10.33	1.07	7.66	8.66	5.63	1.57	1.63	73.33
CHESL-9	4.07	3.63	1.12	41.30	48.66	11.33	1.17	10.66	10.49	10.01	1.04	2.26	46.99
CHESL-10	3.54	3.36	1.05	20.40	42.20	10.66	1.63	7.66	8.62	8.41	1.03	1.90	54.23
CHESL-11	4.79	4.38	1.09	50.42	50.28	12.33	1.10	11.00	8.63	8.50	1.01	2.13	73.88
CHESL-12	5.17	5.17	1.00	62.67	51.25	11.66	1.16	8.00	8.46	8.15	1.04	2.03	114.55
CHESL-13	5.73	5.00	1.14	65.66	54.20	9.66	1.27	9.33	9.33	7.21	1.29	1.22	124.03
CHESL-14	3.92	4.07	0.96	31.89	55.37	12.00	1.63	9.33	8.06	8.15	0.99	2.02	46.53
CHESL-15	4.53	4.30	1.05	39.74	44.50	11.00	1.20	9.66	9.21	8.47	1.09	2.10	53.07
CHESL-16	3.30	3.13	1.05	29.36	54.26	9.66	1.03	9.66	9.16	8.06	1.14	2.26	54.26
CHESL-17	3.96	3.56	1.11	38.73	53.82	11.33	1.23	10.66	10.00	6.25	1.60	1.84	73.53
CHESL-18	4.61	4.22	1.09	46.61	51.51	10.33	1.50	8.33	8.93	6.14	1.45	1.83	65.14
CHESL-19	4.75	4.47	1.06	56.42	52.54	11.66	1.17	7.66	8.20	7.75	1.06	2.00	77.56
CHESL-20	4.23	4.14	1.02	41.00	44.05	12.33	1.05	12.33	8.63	8.60	1.00	1.90	53.87
CHESL-21	4.65	4.25	1.09	45.82	50.07	11.66	1.50	8.00	8.73	8.56	1.02	1.98	73.33
CHESL-22	4.08	4.00	1.01	38.30	49.89	10.66	1.05	8.67	8.26	7.19	1.15	1.97	51.71
CHESL-23	3.64	3.56	1.02	25.99	50.52	11.66	1.26	11.66	8.53	7.30	1.17	1.85	101.87
CHESL-24	4.59	4.27	1.07	46.29	49.10	10.00	2.07	9.33	8.03	7.76	2.12	1.43	82.40
CHESL-25	5.03	4.45	1.12	50.35	50.08	11.66	2.23	5.33	8.56	9.08	0.95	2.13	34.30
CHESL-26	4.35	4.01	1.08	36.76	49.28	11.00	1.60	9.33	8.70	7.79	1.12	1.75	46.18
CHESL-27	5.23	4.71	1.11	51.83	53.20	11.66	1.37	6.00	9.09	6.24	1.45	2.50	43.01
SEm±	0.20	0.15	0.04	3.78	2.04	-	0.11	1.21	0.25	0.34	0.05	0.09	6.96
CD at 5%	0.57	0.44	NS	10.75	5.79	NS	0.31	3.42	0.72	0.97	0.14	0.28	19.75
CV%	7.88	6.49	-	15.22	6.98	-	13.48	22.15	4.98	7.44	7.48	8.67	19.50

value (0.96) followed by CHESL-7 (0.99), therefore both had round fruit shape. The accessions varied significantly with respect to fruit weight. The highest fruit weight was observed in CHESL-13 (65.66 g), which was closely followed by CHESL-12 (62.67 g) and CHESL-2 (61.34 g). CHESL-23 recorded lowest fruit weight (25.99 g), followed by CHESL-16 (29.36 g) and CHESL-14 (31.80 g). An important character in lime is high acidity content, thin peel, lesser number of seeds and high juice content. The juice content in the fruit showed considerable variation among the accessions, which was measured the highest in CHESL-2 (55.66 %), followed by CHESL-14 (55.37 %), CHESL-16 (54.26 %) and CHESL-13 (54.20 %) while the least juice content was observed in CHESL-10 (42.20 %). Among the genotypes, CHESL-11 (12.33) recorded the maximum number of segments per fruit and the same was least in CHESL-13 (9.66). Among the accessions, the minimum peel thickness was observed in CHESL-16 (1.03 mm) followed by CHESL-20 (1.05 mm), CHESL—8 (1.07 mm), CHESL-11 (1.11 mm) and CHESL-12 (1.16 mm). CHESL-25 (2.23 mm) recorded the thickest peel followed by CHESL-24 (2.07 mm) and CHESL-2 (2.0 mm). In these accessions, CHESL-21 (12.33) had the highest average number of seeds per fruit while CHESL-3 and CHESL-6 (12.0) ranked next. The low seeded genotypes included CHESL-25 (5.33) and CHESL-27 (6.0).

The data presented in Table 7 showed significant variation in chemical quality attributes of fruit juice. The TSS content of the fruit juice varied from 7.43 to 10.59 ^{0}B. The highest TSS was recorded in CHESL-5 (10.59 ^{0}B), followed by CHESL-9 (10.49 ^{0}B) and CHESL-9 (10.0 ^{0}B) and lowest was recorded in CHESL-2 (7.73 ^{0}B). CHESL-5 (10.36 %) recorded the highest acidity content followed by CHESL-9 (10.01 %) and CHESL-2 (9.30 %). Among all the genotypes, CHESL-8 (5.63 %) had the lowest acidity content followed by CHESL-18 (6.14 %). The magnitude of the TSS/acidity ratio indicates a characteristic fruit juice flavour. CHESL-17 (1.60) had the highest TSS/acidity value and therefore was less sour in taste.

Among various accessions, CHESL-2, CHESL-25, CHESL-14, CHESL-20, CHESL-11, CHESL-21, CHESL-9 and CHESL-12 with a TSS/acidity ratio of 0.85, 0.95, 0.99, 1.0, 1.01, 1.02, 1.03 and 1.04 had the most souring taste, respectively. The highest juice pH was observed in CHESL-27 (2.50) followed by CHESL-16 (2.26) and the least in CHESL-13 (1.22). The maximum ascorbic acid content was recorded in CHESL-13 (124.03 mg/100 ml), followed by CHESL-12 (114.55 mg/100 ml), while lowest ascorbic acid was recorded in CHESL-4 (33.53 mg/100 ml).

Based on the observations, CHESL-2, CHESL-12, CHESL-11 and CHESL-13 are found superior on the basis of desirable horticultural characters.

Establishment of field gene bank of lime

Three lime cultivars viz., Vikram, Pramalini and Sai Sarbati were collected from Parbhani and established under field condition. Air layers of twenty identified lime accessions from Panchmahals district were also collected and established in the field gene bank of lime. In all, 23 genotypes of lime were established in field gene bank of lime.

Indeginous and exotic underutilized fruits

Karonda (*Carissa carandas*)

At Bikaner

Out of four, fruiting was observed in two genotypes (red and greenish red colour). However, fruit yield was 2-3kg/bush. The maximum size of fruit was 2.36x1.77 cm and 4.63g weight.

Wood apple (*Feronia limonia*)

At Bikaner

Three wood apple genotypes were evaluated for growth, flowering and fruiting under arid conditions. The initial growth of plant was slow in all genotype. Flowering was not observed in five years old plants.

At Godhra

Thirty nine genotypes (CHESW1-39) in the form of fruits with leaves and shoots were collected from different parts of Gujarat during year 2016-17. All the existing genotypes were seedling origin and age of genotypes varied between from 18 to 63 year and the genotypes were collected on the basis of desirable character like precocity in bearing, less spine intensity, earliness and regular bearing, dwarf nature of tree and strong aroma of fruits. During morphological and physical analyses, genotypes varied in fruit shape (Round, Flat, Oval, Triangular), fruit colour (Dull White, Greyish, Greyish-White), pulp colour (Toffee Colour, Light Brown, Pale Gold), fruit stem end (Flat, Depressed), seed shape (Broad Ovate), seed colour (Amber) and plant growth habit (Erect, Semi-Spreading, Spreading). The leaf length and breadth varied between 5.92cm-27.35cm and 4.20-18.63cm, respectively. The leaf has five to seven leaflets but mostly was found 7 or 9 and the size of leaflets ranged 2.18-4.70cm in length and 1.21-2.85cm in breadth. The spine length was found from 1.20-3.47cm. The fruit weight, fruit length, fruit breadth, pulp weight , shell weight, shell thickness, seed No., seed weight in fresh and dry basis, were recorded between 145.52-431.23g, 63.21-98.38mm, 65.28-98.87mm, 68.12-245.42g, 63.92-147.35g, 3.10-4.61mm, 200-410, 21.75-27.86g in fresh and 4.68-13.21g in dry, respectively. Chemical analysis of fruits divulged that the TSS in pulp and peel ranged between 13.68-35.36 and 18.23-26.42, acidity in pulp and peel 3.56-6.58% and 2.12-2.92%, vitamin C 26.12-35.36mg/100g in pulp and 18.23-26.42 mg/100g in peel , pulp 45.03-61.55%, pulp shell ratio 0.79-1.83, pulp seed ratio 2.86-8.88 in fresh and 14.60-24.88 in dry, pH of fruit 2.86-3.29, reducing sugar 1.11-1.25%, total sugar 1.92-2.51%, respectively. The protein content was estimated and it varied in leave 38.12-46.20%, pulp 12.63-22.60% and in seed 16.24-26.12% among the genotypes. Mineral content showed variation among the analyzed genotype fruits. Nitrogen, phosphorus, potassium, calcium and magnesium ranged 3.32-5.12 %, 0.029-0.069%, 1.20-1.83%, 0.11-0.32% and 0.28-0.63%, respectively on dry weight basis.

Evaluation of wood apple germplasm

All the germplasm (11) were evaluated for their flowering and fruiting characters. The genotype CHESW-2 and CHESW-6 were found to be promising. The flowering starts in CHESW-2 on second week of March and CHESW-6 in the first week of April under rainfed conditions.

Custard apple (*Annona reticulata*)

At Godhra

A benchmark survey was made to identify and collect elite genotype of custard apple from Gujarat and Chittorgarh, Rajasthan during 2016-17. Twenty two genotypes (CHESCA-1-22) in the form of fruits with leaves were collected from various places of Gujarat during year 2016-17. All the existing genotypes were seedling origin and age of genotypes varied between from 4 to 15 years. Genotypes was collected on the basis of desirable characters like precocity in bearing, earliness, fruit size, fruit colour, fruit surface structure, regular bearing and dwarf status of tree and aroma of fruits. During morphological and physico-chemical analysis, genotypes varied as tree height (Tall, Dwarf, Medium), growth habits (Erect, Spreading), leaf shape (Ovate, Lanceolate, Elliptic), leaf base (Acute, Obtuse), leaf apex (Acute), leaf length (9.42-13.26cm), leaf breadth (4.20-8.56cm), petiole length (1.37-2.12cm), leaf colour (Green), petiole colour (Green), fruit shape (Cordate, Broadly Cordate, Round), fruit surface (Mammilated, Impressed), fruit exocarp colour (Green, Red), time of harvest maturity (Early, Mid, Late), persistent mummified fruit/tree (Absent, Present), fruit shape at peduncle (Depressed, Flattened), segmentation on surface (Overlapping, Reticulate), protuberances on fruit surface (Very small, Small, Medium, Large), fruit length (6.13-9.42cm), fruit breadth (6.38-9.12cm), fruit weight (192.15-401.16g), pulp weight (68.36-170.58g), rind weight (78.21-195.23g), fruit colour (Creamy white), fruit core length (1.32-3.80cm),

pulp texture (Soft, Gritty), total sugars (12.67-17.74%), reducing sugars (11.43-15.47%), vitamin C (19.18-37.07), no. of flakes with seed/fruit (20-63), no. of flakes without seed/fruit (3-21), firmness of flesh (Firm, Medium), T.S.S (14.58-29.56 ^{0}Brix), acidity (0.29-0.39%), TSS:acid (20.22-99.86), pulp aroma (Mild), eating quality (Good, Very Good), self life (3-6days), Mg (21.82-39.31 mg/100g fruit), K (257.47-295.92 mg/100g fruit), Na (4.37-15.38 mg/100g fruit), Ca (15.44-21.52 mg/100gfruit), total seed (23-63), no. of seed/100g fruit wt. (10-29), 100 seed wt. (5.00-7.52g), seed length (9.45-15.68mm), breadth (5.12-8.32mm), thickness (2.52-5.12mm), flakes length (19.54-28.85mm), flakes breadth (10.15-18.36mm), respectively.

Manila tamarind (*Pithecelobium dulce*)

At Bikaner

Three germplasm of *Pithecelobium* was evaluated for growth under field conditions and the plants were growing well. Flowering was not observed even after four years of planting in any type.

At Godhra

Survey was made and 25 genotypes were collected from Panchmahal district of Gujarat. Promising genotypes have been established in the field. Peak period of flowering was noted in January-February in all genotypes. The maximum fruit weight 29.30 g with 76.40 per cent pulp was recorded in CHESM-4, while, highest TSS was recorded in CHESM-12 (24.80 ^{0}Brix).

Cactus pear (*Opuntia ficus indica*)

At Bikaner

Cactus pear genotypes were conserved in the nursery. The clones 1308, 1269, 1270 and 1271 were maintained in field. The clone 1308 sprouted early than other clones. The performance of clone 1269 was found better in respect of cladode's production per plant than other clones. Clone -1269 is a fodder type.

Jamun (*Syzigium cuminii*)

At Godhra

Promising genotypes (26) of jamun were evaluated for growth, flowering, fruiting and fruit quality attributes. Peak period of panicle emergence was recorded in the month of February. Peak period of flowering and fruit set was recorded in the month of March in all genotypes. Peak period of ripening was recorded in the month of May-June in all the genotypes. During, 2016, Goma Priyanka recorded 61.90 kg fruit yield, 19.60 g fruit weight, 16.10 g pulp weight, 82.14 % pulp and 15.10 ^{0} Brix TSS. Thar Kranti variety was identified which ripened in the last week of May. During 2016, it recorded 68.00 kg fruit yield per plant, 20.90 g fruit weight, 17.70 g pulp weight, 84.68 % pulp and 18.40 ^{o} Brix TSS.

Further, 40 genotypes including Konkan Bahadoli, CISHJ-37, Gokak 1, Gokak 2, Gokak 3, Seedless and Seeded jamun have been evaluated for growth, flowering, fruiting and fruit quality attributes. Two promising genotypes GJ-67 and GJ-68 were collected from Por village of Vadodara district and those have been established in the field. Total 68 jamun genotypes have been established in the field.

Description of newly identified variety: Thar Kranti

Vegetative growth

It is having semi-spreading type growth pattern. Mean data of 2015 and 2016 showed 5.30 m tree height, 64.00 cm root stock girth, 5.2 m North-South plant spread, 4.80m East-West plant spread and 98.12 cm^2 leaf area. Leaves are opposite, simple, mostly firm and glossy, elliptic, pinnately veined with lateral veins close together. New vegetative shoots in the jamun are emerged in 2 distinct flushes from February to May and from August to October.

Flowering

Budded plants start flowering during 3rd year of planting. Flowering takes place in February-March. Flowers are hermaphrodite. The inflorescence is terminal or lateral and develops mostly on one year old shoots and older branches. Flowers are regular, bisexual with five free sepals. Peak period of anthesis was recorded between 8.00 AM- 1.00 PM. Peak period of dehiscence was recorded between 9.00 AM –2.00 PM. Self and cross pollination result in fruit set.

Fruit yield and quality attributes of Thar Kranti

It ripens during 4th week of May. Mean data of 2015 and 2016 showed 65.00 kg per plant fruit

yield, 20.10 g fruit weight, 85.57 per cent pulp, 17.10°Brix TSS, 0.40% titratable acidity, 12.50% total sugars, 6.20% reducing sugars and 48.45 mg/100 g vitamin C under rainfed conditions of hot semi-arid ecosystem.

Tamarind (*Tamarindus indica*)

At Godhra

Promising genotypes (24) of tamarind were evaluated for growth, flowering, fruiting and fruit quality attributes. Maximum panicle length was recorded in Goma Prateek (14.10 cm), followed by CHEST-10.

The maximum number of fruits per panicle was recorded in Pratisthan (4.20), closely followed by Goma Prateek (3.90) and T-263 (3.40). Peak period of ripening time in majority of genotypes was March. Maximum fruit yield per plant (35.00 kg) was recorded in T-10, while minimum was recorded in PKM-1 (5.00kg/plant). Goma Prateek recorded maximum pod weight (27.10 g), pulp per cent (53.00%) and TSS (71.80 ^{0}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 collected from Arappukotai, Tamil Nadu have been established in the field, they are growing well.

Chironji (*Buchanania lanzan*)

At Godhra

Thirty promising genotypes of chironji were evaluated for growth, flowering, fruiting and fruit quality attributes. The peak period of flowering and fruit set in chironji was recorded in the month of February and March, respectively. Maximum panicle length and fruit set per panicle was recorded in Thar Priya, closely followed by CHESC-2. After evaluation, CHESC-2 was found promising.

Mahua (*Madhuca longifolia*)

At Godhra

Promising genotypes (30) of Mahua were evaluated for growth, flowering, fruiting and fruit quality attributes. The highest total soluble solids, total sugars and vitamin C content was recorded in flowers of Thar Madhu. Maximum fruit weight (28.50 g) and seed weight (12.10 g) was found in Thar Madhu, while MH-14 recorded 27.20 g fruit weight and 11.30 g seed weight.

Karonda (*Carissa carandus*)

At Godhra

Total 40 genotypes were evaluated in karonda. Konkan Bold recorded maximum fruit weight (14.40 g) and TSS (11.40 ^{0}Brix) but fruit yield was 8.20 kg per plant only. Minimum acidity (0.42%) was recorded in Konkan Bold during ripening. Maximum fruit yield (12.00 kg/ plant) was recorded in Thar Kamal, closely followed by CHESK-3.

Khirni (*Manilkara hexandra*)

At Godhra

Thirty genotypes were evaluated for flowering, fruiting and fruit quality attributes. Peak period of ripening was recorded from last week of April to May in all the genotypes. Maximum fruit weight (5.00 g) and TSS (24.40 ^{0}Brix) was recorded in Thar Rituraj, closely followed by CHESK-1, CHESK-6, CHESK-11, CHESK-12 and CHESK-16.

Brief characters of Thar Rituraj

It was collected from Parwadi village of Panchamahal district, Gujarat. It has spreading growth habit, thick trunk, dense foliage and drooping branches The peak period of flowering was recorded in the month of December. It ripens in third week of May and recorded 5.00g fruit weight, 24.40 ^{0}Brix TSS.

Phalsa (*Grewia subinaequalis*)

At Godhra

Total 25 genotypes are established in the field. Peak period of flowering was noted in second week of February. After evaluation Thar Pragati was identified.

Description of newly identified variety: Thar Pragati

Vegetative growth

It is having spreading type growth pattern. Mean data of 2015 and 2016 showed 2.20 m plant height, 2.10 m North-South plant spread and 2.00m East-

West plant spread. Leaf simple, round to cordate, thick papery, rough, dark green, reticulate veination, base round, acute apex, alternate arranged.

Flowering

Plants propagated through cuttings start flowering during 2nd year of planting. Flowering takes place in February. Flowers are borne in the axils of leaves. In each axil, there are 3-7 peduncles and each peduncle has 3-6 flowers of yellow colour. Flowers have 4-5 sepals, 4-5 petals, 70-80 stamens and well developed gynoecium. Flowers are mostly cross pollinated and honey bees play major role in pollination.

Fruit yield and quality attributes of Thar Pragati

It ripens during the month of April. Mean data of 2015 and 2016 showed 3.60 kg per plant fruit yield, 2.10 g fruit weight, 90.45 per cent pulp, 20.10 ^{0}Brix TSS, 3.12% titratable acidity, 12.42 % total sugar, 8.10 % reducing sugar and 19.12 mg/100 g ascorbic acid under rainfed conditions of hot semi-arid ecosystem.

Exotic species

Exotic fruit tree species (Chinese jujube, Argan, Marula nut) were maintained in the field for performance evaluation under hot arid conditions. Flowering-fruiting was observed in argan plant. There was no fruiting in marula nut trees and it was found to be susceptible to frost/ low temperature.

Citrus

Studies on compatibility and adaptability of *Citrus* rootstocks under hot arid environment of Rajasthan

Collection of various rootstocks (18) Rough lemon, Rangpur lime, Trifoliate orange, Sohmyadang, NRC-03, CRC-12, CRH- 47, Pomy Roy, X- 639, Sonviyang, Volkameriana, IPS- 238, Alemow, Swingle, Cleopatra, Pectinefera, wood apple and bael; Sweet orange cv. (11) Newhall Navel, Washington, Jaffa, Blood Red, Hamlin, Mosambi, Sathgudi, Lanelate, Valencia Olind, Ruby Red and Pineapple; Acid lime varieties (06) NRCC- 07, 08, Vikram, Pramalini, Sai Sarbati and Balaji; Grape fruit (1)- Flame; Mandarin Cultivars (08) Kinnow, Nagpur Seedless, Freemont, Fairchild, Muscot, Michal, Daisy and Pera Tangelo from ICAR-CCRI, Nagpur. Centre of Excellence on Fruit crops Mangiyana, Govt. of Haryana, MPUAT, Udaipur and PAU Station Abohar.

Five acid lime genotypes were collected from Jaipur Area of Rajasthan. 55 *Citrus* Species, Varieties and Rootstocks are collected and are being maintained at ICAR-CIAH.

A new orchard of *Citrus* is established with diverse commercial cultivars of mandarin on different rootstock species in one hectare at CIAH research farm during April, 2016 to March 2017.

A. Freemont grafted on Rough lemon, Karna Khatta, Pectinefera & Troyer

B. Michal on Rough lemon, Rangpur Lime, Troyer, Pectinefera & Karna Khatta

C. Daisy on Karna Khatta, Rangpur lime, sour orange, Troyer, Pectinefera & Rough lemon

D. Kinnow grafted on Pectinefera, Troyer and Rough lemon

Initial observations of above mandarins have been recorded *e.g.* survival per cent, plant height, canopy (E-W, N-S), No. of branches, No. of new flushes, stem diameter (at union and 5 cm above and below the union), leaf area, leaf thickness, suckering habit, growth habit etc.

Eight rootstocks namely, CRH-47, CRC-12, NRC-03, Volkameriana, Rangpur lime, Trifoliate orange, Sohmydang, wood apple seeds are sown in nursery and initial observation have been recorded e.g. test weight, seed length, seed width, seed thickness, germination per cent, germination days to sowing, survival per cent, off type plants and polyembryony per cent etc.

VEGETABLES

Germplasm Conservation

Monitoring for maintenance and conservation of vegetable germplasm

Regular monitoring of vegetable germplasm (500 lines) including dessertic melons, non-dessertic melons and gourds was done for their safe conservation in gene bank (–20 ^{0}C deep freeze) facilities at the institute.

As per germplasm maintenance work plan, the registered line of mateera AHW-19 and kakri AHC-13 was taken during spring-summer season of 2016. Based on germination and field crop studies, both the crop seeds can be stored successfully for 7-8 and 10-12 years under ambient and freeze / deep freeze (–20 ^{0}C) conditions, respectively for cyclic enhancement. Sufficient quantity of seed was produced and deposited for LTS at NBPGR, New Delhi. Similarly, seed enhancement for sword bean var. Thar Mahi and palak genotype AHLP-1 was also done to fulfill indents.

Trait specific genetic material in the form of potential lines / value added genotypes / varieties (>20) in particular to native cucurbits, chilli, sword bean, cluster bean, palak and Moringa were supplied to institutions under national net-work (Rajasthan, Gujarat, MP, TN and UP) for use in breeding as abiotic stresses tolerant genes or commercial seed production (Table 8).

Kakri (*Cucumis melo* var. *utilissimus*)

Maintenance breeding and evaluation: Kakri, a non-dessertic form of *Cucumis melo* and producing prolific andromonoecious flower, non-bitter fruit used like cucumber for vegetable salad at immature / tender stages was developed from native germplasm of arid region in 1998. During spring–summer season of 2016, kakri variety AHC–13 was studied under varietal maintenance, seed enhancement and conservation using 10 years stored seed material (–20^0 C deep freeze). The crop was evaluated for 45 traits on germination, growth, flowering, fruit set, yield and seed components under varying sowing period (January, February and March) and production techniques (polythene sheet as surface / channel covering and open field cultivation).

Mateera (*Citrullus lanatus*)

Maintenance breeding and evaluation: The concerted research on drought hardy *Citrullus* species of Indian Thar Desert from 1994–2010 at ICAR-CIAH, Bikaner for germplasm conservation and use in breeding programme resulting to development

Table 8. List of vegetable crop-plant germplasm of ICAR-CIAH and seed supplied during 2016-17.

S/No	Crop	Name of variety, line or value added genotype
1	Kachri	AHK-119 & AHK-200
2	Snap melon	AHS-10 & AHS-82
3	Kakri	AHC-2 & AHC-13
4	Bottle gourd	Thar Samridhi & AHLS/2015/01
5	Ridge gourd	AHRG-1
6	Round melon	AHRM-1
7	Mateera	AHW-19 & Thar Manak
8	Moringa	AHMO-1-4s
9	Sword bean	Thar Mahi
10	Chilli	CIAH-Mathania Type-1
11	Palak	AHLP-1
12	Cluster bean	Thar Bhadavi

Fig. 7. Mateera AHW–19: drought and abiotic stresses tolerant variety of watermelon of Indian *Thar* desert, and immature / tender stages fruits used for vegetable and mature for dessert use

of promising lines and varieties (mateera AHW-19, AHW-65 and Thar Manak) recommended for cultivation under high temperature and abiotic stressed conditions. During spring–summer season of 2016, mateera var. AHW–19 (Fig. 7) was studied under varietal maintenance, seed enhancement and conservation using 10 years stored seed material (–20^0 C deep freeze). The crop was evaluated for 45 traits on germination, growth, flowering, fruit set, quality, yield, seed and uniformity components adopting varying sowing period (January, February and March) production techniques (polythene sheet as surface / channel covering and open field cultivation).

Ridge gourd (*Luffa acutangula*)

Studies on generated ridge gourd: Based on fourth generation results of unique line AHRG–15–4–1 (Fig. 8) (segregating material from *Luffa acutangula* x *Luffa hermaphrodita*), selected progenies were further studied with large population during rainy season of 2016. The developed line exhibited pre-dominantly gynoecious sex form of flowering in maximum plants resulting to vary high fruit set and it is assumed parthinocarpic fruit development because there was no male flower up to 60 days of plant growth. However, later on two plants in the line recorded pre-dominantly gynoecious (more female flowers) and male flowers in clusters. Moreover, all the plants died at 85 days age-old and it was suddenly (within 24 hours) and without attending fruit maturity.

Fig. 8. Bearing pattern in pre-dominant gynoecious ridge gourd line AHRG–15–4–1 and producing parthinocarpic fruits under hot arid agro-climate.

Watermelon (*Citrullus lanatus*)

Evaluation of exotic lines and selection

Evaluated performance of single plant progenies of 6 exotic lines of watermelon. EC-829545 gave maximum TSS (14-15%) having round fruits (3-3.8 kg) with 22-28 cm diameter. It produced round fruits of 22-28 cm diameter with 1.16 cm rind thickness and red flesh. Early to harvest and took 75-80 days to harvest. Fruit light green rinded with stripes. EC-829541, EC-829542 also performed best under hot arid conditions and selected for further validation. Based on overall performance, exercised single plant selection, selfed the selected plants and harvested the seed separately for further validation.

EC-829542 EC-829545

Germplasm evaluation, selection and maintenance

Evaluated 30 genotypes of watermelon during summer 2016 and recorded wide variability. Among red fleshed genotypes, AHW/BR-5 and AHW/BR-25 performed better and selected for further evaluation. AHW/BR-5 being andromonoecious in nature evaluated under net house conditions without hand pollination and observed fruit setting and seed formation without pollinators. Identified a small fruited genotype (AHW/BR-22) which

produced 30-35 cm long fruits weighing 2-3 kg, 18-25 cm in diameter and 12-14% TSS. Ovary 2.5-3 cm long, fruits ice box type, bear 3-4 fruit/ plant having dark green rind devoid of stripes. YF 5-2-4 produced non-lobed leaves with 10-11% TSS and bear 3-5 fruits plant with saffron coloured flesh. AHW/BR-13 produced 28-32 cm long fruits with white flesh and high seeded (80 g seed/ fruit) which are red in colour. Maintained the seed of all promising lines through selfing and conserved for further utilization.

Variability in watermelon

AHW/BR-22: promising line of watermelon

Generation advancement and selection

During summer season of 2016 raised 10 segregating populations of watermelon comprising F_4, F_5 and F_6. Among the populations selected desirable segregants, self pollinated and harvested the seed.

Muskmelon (*Cucumis melo*)

Germplasm evaluation, selection and maintenance

During summer season of 2016, evaluated a total of 20 germplasm of muskmelon which showed considerable variation in yield and quality traits. Among the evaluated lines, selected AHMM/BR-47 as promising line which produced first harvesting in 75-80 days after sowing and bear 3-4 fruits/ plant having 11-12% TSS. The average fruit weight of this line varied from 0.6-0.8 kg having netted and thick rind (0.3 cm) with small seed cavity (5-6 cm) and 2.8-3.1 cm thick flesh of salmon orange colour. Single plant selection was exercised for purification of all lines. Maintained the seed of all lines and reference varieties through inbreeding.

AHMM/BR-47

Suppression of male flowers by ethrel in muskmelon

Studied the effect of Ethrel 40% (2-Chloroethylphosphonic acid, 40% in water) on the suppression of male flowers in a monoecious line of muskmelon (AHMM/BR-8; IC-0599709). Ethrel was mixed in distill water and sprayed during evening hours. The results revealed that two consecutive foliar spray of 125 ppm ethrel at 2-4 true leaf stage and 20 days after first spray suppressed the male flowers.

Evaluation of cross combinations

Evaluated 5 crosses made by utilizing Kashi Madhu, Pusa Madhuras, Punjab Sunehri, Arka Rajhans and MHY-3 as male parent and IC-0599709 (a monoecious line) as female lines. Among the evaluated crosses, IC-0599709 x Punjab Sunehri resulted best combination with respect to TSS (11.60%), days to first fruit harvest (73 days) and fruits/ plant (3.80). Fruits were round weighing 750 g with 3.08 cm flesh thickness, 0.30 cm rind thickness and 4.86 cm seed cavity. All evaluated F_1s showed monoecious sex form (Table 9).

Table 9. Performance of muskmelon hybrids.

F_1's	Fruits/ plant	TSS (%)	Fruit weight (g)	Fruit diameter (cm)	Flesh thickness (cm)	Rind thickness (cm)	Size of seed cavity (cm)	Flesh colour
IC-0599709 x Kashi Madhu	3.20	10.80	0.67	9.48	2.60	0.24	5.80	Salmon orange
IC-0599709 x Pusa Madhuras	2.80	11.32	0.84	9.26	2.82	0.22	5.86	Salmon orange
IC-0599709 x Punjab Sunehri	3.80	11.60	0.75	10.88	3.08	0.30	4.86	Salmon orange
IC-0599709 x Arka Rajhans	3.20	10.20	0.77	10.40	2.04	0.22	6.44	Creamy
IC-0599709 x MHY-3	2.80	11.14	0.90	11.46	2.58	0.24	6.46	Greenish white

Generation advancement and selection

Evaluated seven segregating populations comprising F_2 and F_3 of AHS-82 x AHK-119, AHLM-2 x Arya, AHLM-2 x AHS-82, AHLM-2 x IC-0599709, IC-0599709 x AHLM-2, IC-0599709 x Pusa Madhuras and IC-0599709 x Hara Madhu during summer 2016. AHS-82 x AHLM-2 F_3 produced 15-20 fruits/ plant which were non-bitter at tender stage and devoid of curve. The fruit weight varied from 70-120 g with 15-20 cm length and 2-2.5 cm diameter. Based on overall performance selected AHS-82 x AHK-119 F_2 and AHS-82 x AHLM-2 F_3 and advanced through selfing to derive new desirable segregants.

AHS-82 x AHK-119 F_2

AHS-82 x AHLM-2 F_3

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

Performance evaluation

Evaluated the earlier purified genotype of longmelon (AHLM-2; IC-0619213) during rainy season of 2016. The fruit weight, fruit diameter and fruit length at marketable stage varied from 57.9-73.5 g, 1.7-2.0 cm and 26.1-28.5 cm, respectively. It produced 15-21 marketable fruits per plant which are tender, light green and free from bitterness. Early in harvesting and took 45-50 days in first harvesting. Multiplied and conserved the seed of AHLM-2 for further evaluation.

Seed extraction studies in longmelon

Seed extraction of longmelon is a specialized job because of its mucilage nature. Conducted an experiment to extract seed of longmelon using different concentrations of HCl. Harvested fully ripened matured fruits and crushed the pulp. Kept the pulp in plastic containers and added HCl @ 1-6 ml/ litre of pulp with constant stirring till the removal of mucilage adhering of seed. The results showed that addition of HCl @ 5 ml/ litre of pulp with constant stirring completely removed the mucilage adhering in 30 minutes. After that the seeds were washed 4-5 times thoroughly with water to make them free of acid and dried. This method resulted in easy and quick extraction of seed of longmelon without affecting germination.

Ridge gourd

Evaluation of exotic lines

Evaluated performance of single plant progenies of four exotic lines of ridge gourd during summer season of 2016. Among the lines EC-829555 produced cylindrical, dark green fruits of 20-25 cm long fruits weighing 80-100 g and 2.5-2.8 cm in diameter. Based on overall performance selected superior plants, self pollinated and harvested the seed separately for further evaluation.

Flowering and seed studies in ridge gourd

Studied the flowering and seed parameters in Thar Karni variety of ridge gourd during summer season of 2016. The male and female flowers start to appear on 5th and 9th node onward, respectively. Anthesis takes place at 5.0 PM. Male flowers borne in clusters of 12-18 whereas female flowers solitary in leaf axil. A single plant produced 740 male flowers and 30 female flowers with female to male sex ratio of 1: 24. Fruits become ready to harvest for seed in 40-45 days after anthesis. Single fruit produced 90-130 seeds weighing 8-12 g. Produced 02 kg seed of Thar Karni and sold among the farmers.

Evaluation of F_1's

Evaluated 12 F_1's of ridge gourd during summer season of 2016 for different horticultural traits. The cross combination, AHRG-62 x AHRG-29 was found best for days to produce 50% flowering (46-48 days), days to first fruit harvest (52-54 days), fruit length (15-18 cm) and fruit weight (60-80 g). AHRG-29 x AHRG-41 also performed wellfor different fruit traits.

Performance evaluation of quinoa

Quinoa (*Chenopodium quinoa* Willd.) has recently gained worldwide attention because of its ability to grow in various stress conditions like soil salinity, acidity, drought, frost, *etc*. Received the seed of quinoa from ICAR headquarter and evaluated the performance during *rabi* season of 2016-17. The crop was sown on 30th November, 2016 maintaining spacing of 45 cm (R x R) and 12.5 cm (P x P). The crop took 55-58 days to produce 50% flowering and 115-120 days to seed maturity. Number of primary branches/ plant, inflorescence length, number of inflorescence/ plant and plant height at harvest varied from 30-35, 4-6 cm, 70-90 and 110-130 cm. Seed yield ranged from 20-30 g/ plant.

Fig. 9. *Chenopodium quinoa*: blooming in desert

Drumstick (*Moringa oleifera*)

At Godhra

An extensive survey was made to identify and collection of the germplasm of drumstick on the basis of their morphological characters from diversity rich areas of Gujarat. Two new genotypes planted in field for further evaluation. The evaluation of thirty genotypes of drumstick exhibited wide range of variability with respect to fruit weight (45.6-258.3 g/fruit), fruit length (47.4-89.8 cm), number of seeds (12-29), fruit diameter (17-24.5 mm), fresh weight and dry weight ratio of fruit (2.8-4.4), pulp (1.8-3.6), skin (4.2-5.6), leaves (6.01-8.07), TSS (5.6-9.7%), ascaorbic acid (247.92-589.31 mg/100 g in leaves) and fruiting time (first week of January to last week of April) were observed among the existing genotypes. Drumstick germplasm samples (leaves and fruits) were dried for antioxidant analysis. Based on the observation, it may be inferred that the exploration of wide range of variability to select better genotype and utilize these germplasm for further improvement.

Germplasm block of drumstick

Thar Harsha: Thar Harsha is a new high yielding drought tolerant cultivar of drumstick, developed at Central Horticultural Experiment Station (ICAR-CIAH), Vejalpur, Gujarat and released in 2016. It is an annual type selection from popular variety PKM-1. This single plant selection (CHES-D-1) from original population was made based on the yield, pod length and size, tolerance to drought and major devastating pest such as leaf eating cater pillar and fruit fly. Its pods are of attractive dark green in colour with length of 100.5cm (a long poded type). The plants are densely foliaged and have broad leaves with dark green colour. It is a late flowering and late maturing type which comes to harvest during March-May. It registered superior total pod yield having greater marketable yield (20-30 per cent) as compared to the commercially popular varieties under drought conditions. The pod contains higher protein (9.3g/100g), vitamin C (246mg) and vitamin A content (9783IU) per 100g.

Ivy gourd (*Coccinia indica*)

At Godhra

An extensive survey was made to identify and collect germplasm of ivy gourd on the basis of their morphological characters from diversity rich areas of Gujarat. Twenty five genotypes of ivy gourd were planted in field for further evaluation. The CHES IG-2 was found superior as compared to other genotypes with attractive dark green shining colour with discontinuous strips, round oblong fruit shape without neck, very fast growth behavior, number of fruits per vine (70), single fruit weight (29.4 g) and the average length of fruit (7.6 cm) (Fig. 10).

Spine gourd (*Momordica dioica*)

A benchmark survey was made to identify and collect the germplasm of spine gourd on the basis of their morphological characters from diversity rich areas of Gujarat. The seeds of twenty genotypes of spine gourd were extracted and stored for further evaluation. The evaluation of twenty genotypes of drumstick exhibited wide range of variability with respect to fruit weight (3.70-22.43 g of immature fruit), (4.94-21.3 g of ripen fruit), inter nodal length (3.4-7.1 cm), fruit lenth (3.1-5.4), fruit diameter (4.6-10.2 cm), stylar end (0.3-0.8 cm), peduncle length of fruit (1.1-5.5 cm), peduncle length of leaf (1.1-8.9 cm), leaf length (5.5-8.5 cm) and leaf width (4.56-8.7 cm). The CHES SG-1 genotype was found superior as compared to other genotypes with attractive dark green colour, round shape fruit, very small and soft spines, single fruit weight (22 g) and number of fruits par vine (117) (Fig. 10 and 11).

Other vegetable crops

At Godhra

An extensive survey and collection of germplasm vegetable cowpea, cowpea, dolichos bean and cluster bean was done in diversity rich areas like Kerala (mainly, villages of Calicut, Thrissur, Trivandrum and Kollam), Rajasthan (Jhodpur) and Karnataka (vegetable growing villages of Madikeri, Shivamogaa (Anavatti), Haveri (Ranebennur), Dharwad, Sirsi (North Canara) and Bengaluru). A diverse germplasm of dolichos bean (bush and pole type), vegetable cowpea, cowpea and clusterbean mainly local types as well as released varieties of the state. In Gujarat, survey was done in tribal areas of Dahod and Godhra districts, from where local types of dolichos bean and cowpea germplasm were collected. Number of germplasms (Total – 265) collected so far during above mentioned places as fallows. Dolichos bean (pole type)-50, Dolichos bean (bush type) - 40, Vegetable cowpea-95, cow pea (bush type) - 40 and cluster bean- 40.

Fig. 10. Variability in spine gourd fruits, and seeds

Fig. 11. Variability in leaf characters

CROP IMPROVEMENT

VEGETABLES

Round melon (*Praecitrullus fistulosus*)

Breeding for high temperature tolerance and fruit quality

During spring-summer season of 2016, three advanced breeding material of round melon progenies (AHRM/2015/F_5/1) were sown for field evaluation however, experiment was completely damaged at very early stages of plant growth due to severe hail-storm on 11/03/2016 at production site of ICAR-CIAH farm.

Bottle gourd (*Lagenaria siceraria*)

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

During 2016, three selected progenies of long fruited bottle gourd developed at the institute were tested for growth, fruit quality and yield characters under varietal trial. Advanced progeny AHLS/2015/F_6/01 exhibited superiority for marketable yield with temperature range 43–45 ^{0}C during May–June, and good quality fruit yield and harvesting for prolonged period of time with temperature range 42–43 ^{0}C as rainy season crop. It exhibited earliness for harvesting of marketable fruits and seasonal average is summarized for days to appearance of first male flower (52.42 DAS), days to appearance of first female flower (57.43 DAS) and days to first harvesting (66.23 DAS) and marketable fruit yield/plant (4.56 kg).

Sponge gourd (*Luffa cylindrica*)

Breeding for better quality fruit yield under high temperature conditions

During spring–summer and rainy season of 2016, developed sponge gourd line AHSG/2015/F_5/01 (F_5 pedigree of cross P_4 x P_{16}) was studied for field performance over the seasons. The genotype exhibited superiority for growth, earliness and fruit yield character and seasonal range is given on days to appearance of first male flower (32.41–39.43 DAS), days to appearance of first female flower (36.53–44.32 DAS), days to first harvesting of tender fruits (49.24–52.41 DAS) and marketable fruit yield/plant (1.18–1.42 kg) (Fig. 12).

Fig. 12. Vine growth, flowering and fruit development studies in sponge gourd line AHSG/2015/F5/01 under varying production situations and over the seasons in hot arid agro-climate

Ivy gourd (*Coccinia indica*)

Performance studies on ivy gourd genotype

The gynoecious ivy gourd AHIG-1 producing excellent quality parthinocarpic fruits under high temperature and abiotic stressed conditions of arid region was selected in 2005 and is under performance trial over the years. During spring–summer and rainy–winter season of 2016, AHIG-1 was assessed for fruit growth and yield potential with varying production situation. Tender fruits of the highest marketable quality and vegetable use are ready in 6.28–8.42 days from opening of female flower, and at this stages 'A' grade fruits are 5.83–6.48 cm length, 1.54–1.89 cm diameter and 11.76–13.54 g weight, and yield potential range from 2.85–3.48 kg/plant/season.

Palak (*Spinacia oleracea*)

Testing of palak genotype

Evaluation of locally adapted palak germplasm and purification from the year 2001 at CIAH, Bikaner resulting to stabilization of open pollinated and value added genotype AHLP–1 having excellent vegetable use leaf quality. From 2014 to 2016, the developed genotype was tested at CIAH and farmer's field to assess marketable leaf and seed yield potential, acceptability of produce and promotion of native genotype for cultivation under abiotic stresses and resource constraints production situations. The AHLP–1 exhibited very good initial plant growth for tender leaves and first harvesting was taken at 35–40 days with October sowing. Tender fresh leaves at marketable stages are 9.81–12.54 cm in length, 5.72–8.11 cm in width, 1.748–1.838 g in weight and weight of 100 leaves is 174.8–183.8 g for vegetable purpose. Light green to dark green colour and bigger sized leaves are glossy, smooth, thick, soft and juicy. Tender leaves harvesting at 40, 50, 60 and 70 days is found better for plant growth and seed yield potential. Tender and marketable fresh leaf yield potential is 128.48–235.84 q/ha with varying crop production situations (bed, channel and drip method) under hot arid agro-climate. (Fig. 13).

Fig. 13. Leaf quality and yield potential in palak AHLP–1.

Drumstick (*Moringa oliefera*)

Performance studies on value added *Moringa* genotype

During 2016, the genotype AHMO–1–4s was studied for seed production, nursery raising, field establishment and large scale performance trials both at farmer's field and at ICAR-CIAH, Bikaner.

For germination studies in nursery, freshly harvested seed of mature pods of genotype AHMO–1–4s was used with varying sowing time (first week of June, July and August). Seeds germinated promptly and 62.8 – 76.5 % germination was recorded with varying sowing time and overall good germination (70.33 %) was recorded with single seed sowing under shade-net nursery conditions, and thus exhibited much scope for single and repeated seed sowing and longer period of seedling availability. Nursery raised seedlings were 31.85 – 61.48 (av. 48.68) cm in height (30 - 60 days old), and recorded 54.68 – 78.65 (av. 68.62) per cent field survival. Plants exhibited good vegetative growth as recorded at 60, 90 and 120 days after transplanting and it was 1.08, 1.69 and 2.26 m, respectively.

Well established seedling plants exhibited good initial growth and about 50% plants were in flowering and pod setting stages were observed during November–December. Since, the *Moringa* is highly susceptible to low temperature (< 4^0 C) and frost injuries and thus, based on weather forecasting of the production site, plants were pruned in last week of December. With the on-set of spring–summer season of 2016, pruned plants exhibited vigorous growth during February–March. However, these were badly damaged due to occurrence of severe hail-storm on 11/03/2016. Therefore, damaged plants were further headed-back at 30 - 45 cm height from ground level, and re-sprouting was observed from April 2016.

A good plant growth and limited flowering and pod setting was recorded during rainy-winter season of 2016, and further, plants were pruned in the last week of December when low temperature dips-down, and low temperature (< 2^0C) and occurrence

Fig 14. Plant growth and field plant establishment of AHM01-4s under hot arid region.

of frost conditions were recorded on 9th & 10th January 2017 in the production site. Therefore, it is recommended that *Moringa* plant should be pruned or headed-back at 30 - 45 cm height from ground level in the last week of December month to save established plantations from low temperature and frost injuries under hot arid agro-climate (Fig. 14).

Khejri (*Prosopis cineraria*)

Maintenance and evaluation of khejri genotypes

Fourteen elite genotypes identified by the CIAH from 2002–2005 and collected clonally in khejri germplasm plot for *ex situ* conservation were maintained with good management practices during the period under report. The khejri variety Thar Shobha and Khejri Selection–2 were studied for comparison with reference to growth, flowering, pod quality, bio-mass production and other horticultural significance characters under rainfed conditions. In addition, Khejri Selection–2 was studied for nutritional component in tender pods, harvesting period and pod yield potential.

Brinjal (*Solanum melongena*)

In the breeding for marketable yield in solanaceous crops under abiotic stresses for arid environment. The ANOVA analysis of variance revealed significance differences among all the treatments for all the character under study in Table 10.

In the mean performance in table 11, highest plant height was recorded in genotype V3 (45.28) and lowest in V18 (25.75). In the case of No. of primary branches, highest number is recorded in V17 (8.75), whereas lowest in V20 (3.64). In case of leaf length, highest number is found in V4 (8.60) where as lowest in V20 (5.49), In leaf width, highest was found in V13 (5.33) and lowest in (3.50). In case of fruit length, highest was found in V7 (25.55) and lowest in V11 (11.73). In fruit width, highest was occured in V9 (9.11) and lowest in V11 (3.91). In case of number of fruits, per plant highest was in V18 (16.67) and lowest in V2 (5.57) . Fruit weight highest was found in V20 (201.20). In case of yield, highest yield was found in V18 (2455.32) followed by V17 (2188.14) and lowest was found in V2 (255.32).

Table 10. Analysis of variance for nine quantitative traits in twenty genotypes of brinjal.

S. No.	Character	Mean sum of squares		
		Replications (df = 2)	Treatments (df = 19)	Error (df = 38)
1.	Plant height (cm)	0.9300	69.91**	1.48
2.	Number of primary branches per plant	0.0085	5.051**	0.063
3.	Leaf length (cm)	0.0050	2.131**	0.072
4.	Leaf width (cm)	0.0755	1.01**	0.019
5.	Fruit length (cm)	0.2130	52.64**	0.388
6.	Fruit width (cm)	0.0030	5.639**	0.042
7.	Number of fruits per plant	0.5980	32.251**	0.113
8.	Fruit weight (g)	11.6140	8,337.95**	4.04
9.	Fruit yield per plant (g)	33689.360*	11,51,459.09**	63745.06

*, ** = significant at 5% and 1% levels of significance, respectively.

Table 11. Mean performance of genotypes for growth and yield parameters.

	PH	NPB	LL	LW	FL	FW	NFPP	FW	FYPP
V1	35.40	6.18	6.74	3.68	17.64	4.48	13.28	88.98	1088.17
V2	31.27	4.87	7.11	3.54	16.10	5.13	5.57	45.49	255.32
V3	45.92	8.47	7.45	3.50	13.63	5.38	6.21	85.86	526.51
V4	37.54	5.70	8.60	3.59	14.26	6.14	6.29	195.41	1176.89
V5	31.11	5.56	8.10	3.96	15.56	5.39	5.91	189.34	1204.04
V6	33.23	5.48	8.24	5.15	22.32	6.58	7.32	152.56	1108.30
V7	35.51	5.41	7.26	5.10	25.55	6.91	13.91	150.26	2094.50
V8	35.56	7.05	7.75	4.44	24.84	5.58	8.16	161.22	1297.43
V9	31.46	7.23	6.30	4.54	21.33	9.11	7.22	141.16	1000.44
V10	39.59	7.10	6.67	4.60	14.88	4.74	7.36	128.23	939.80
V11	37.59	7.20	6.57	3.91	11.73	3.91	8.32	61.11	491.79
V12	29.06	5.94	6.40	3.76	11.87	4.90	6.19	61.57	379.55
V13	31.47	5.62	7.67	5.33	12.22	5.26	9.06	63.70	555.81
V14	32.90	7.37	6.64	4.63	12.83	5.77	6.42	62.05	390.62
V15	29.19	6.06	6.84	4.10	15.36	5.58	7.24	81.27	619.77
V16	34.81	7.29	7.15	4.34	19.28	5.22	8.43	109.80	899.12
V17	31.45	8.75	6.19	4.15	15.59	4.66	11.38	194.76	2188.14
V18	25.75	5.59	6.11	3.64	15.19	4.75	16.67	81.20	1324.86
V19	27.33	4.38	5.65	3.56	13.51	8.59	12.67	201.20	2455.32
V20	40.34	3.64	5.49	3.67	19.75	7.77	13.43	161.90	1489.91
Grand mean	33.83	6.24	6.95	4.16	16.67	5.79	9.05	120.85	1074.31
SEm ±	0.702	0.145	0.155	0.080	0.360	0.118	0.194	1.160	145.768
CV (%)	3.546	4.029	3.853	3.338	3.736	3.540	3.716	1.663	23.501
CD (P=0.05)	2.018	0.417	0.444	0.230	1.034	0.340	0.558	3.335	418.983

Table 12. Estimates of variability, heritability and genetic advance as per cent of mean for nine characters in 20 genotypes of brinjal.

S. N	Characters	Mean	Variance		PCV (%)	GCV (%)	h^2 (%)	Genetic Advance	GA as per cent of mean
			Phenotypic	Genotypic					
1.	Plant height (cm)	33.83	24.288	22.81	14.57	14.12	93.91	9.53	28.19
2.	Number of primary branches per plant	6.24	1.726	1.66	21.04	20.65	96.35	2.61	41.76
3.	Leaf length (cm)	6.95	0.76	0.69	12.54	11.93	90.51	1.62	23.37
4.	Leaf width (cm)	4.16	0.35	0.33	14.21	13.82	94.56	1.15	27.68
5.	Fruit length (cm)	16.67	17.80	17.42	25.31	25.03	97.82	8.50	50.99
6.	Fruit width (cm)	5.79	1.91	1.86	23.85	23.58	97.80	2.78	48.04
7.	Number of fruits per plant	9.05	10.83	10.71	36.35	36.16	98.96	6.71	74.10
8.	Fruit weight (g)	120.85	2782.01	2777.97	43.64	43.61	99.85	108.50	89.78
9.	Fruit yield per plant (g)	1074.31	426316.40	362571.34	60.78	56.05	85.05	1143.92	106.48

Table 13. Correlation analysis in brinjal.

Character	PH	NBB	LL	LW	FL	FW	NFPP	AFW	PYPP
PH	1	0.294	0.225	-0.046	0.122	-0.089	-0.197	0.044	-0.159
NBB	0.294	1	0.089	0.132	-0.114	-0.398	-0.313	-0.13	-0.199
LL	0.225	0.089	1	0.314	0.176	-0.212	-0.521	0.111	-0.249
LW	-0.046	0.132	0.314	1	0.401	0.117	-0.078	0.011	0.009
FL	0.122	-0.114	0.176	0.401	1	0.41	0.237	0.393	0.392
FW	-0.089	-0.398	-0.212	0.117	0.41	1	0.13	0.501	0.441
NFPP	-0.197	-0.313	-0.521	-0.078	0.237	0.13	1	0.181	0.656
AFW	0.044	-0.13	0.111	0.011	0.393	0.501	0.181	1	0.807
PYPP	-0.159	-0.199	-0.249	0.009	0.392	0.441	0.656	0.807	1

In the table 12, substantial variability as evidenced from range that contribution towards final phenotypic character was slightly diluted by environmental factor acting on the genetic makeup of the accessions under study. High PCV and GCV was recorded for number of primary branches, fruit length, fruit width, number of fruits per plant, fruit weight and fruit yield per plant. High heritability coupled with high genetic advance as per cent of mean was recorded for all the characters indicating that these character were least influenced by the environmental effects and these character were suitable for selection. Hence simple selection based on phenotypic character may be PCV was higher than GCV, respectively. GCV for all the nine traits under studied emancified remedy for improvement of such traits.

In the table 13, from correlation on character association analysis, it was found that plant yield per plant had significance positive correlation with fruit length, fruit width, number of fruits per plant and average fruit weight, wher as non-significant negative correlation with plant height, number of branches and leaf length. Hence direct selection can be made for these characters for improvement in yield.

Pumpkin (*Cucurbita moschata*)

Thar Kavi: a high yielding, minibox type carotene rich pumpkin variety for dryland developed through hybridization followed by selection from the segregating population of CM16xCM19 at Central Horticultural Experiment Station (ICAR-CIAH), Vejalpur, Gujarat and released in 2016.

Description of variety

Vine length: 2.14 m, moderately vigorous, drought tolerant, female flower produces at 12-13 node and anthesis at 43 days. Fruits are very small in size with yellowish spots over the fruit surface and greenish lines at floral end of the fruit. Plants are very compact and hence more plants population per ha can be accommodated. Moderately resistant to fruit fly, powdery mildew and pumpkin mosaic virus under field conditions.

Trait specific

Harvest stage: 80-85 days after sowing for green fruits and 110-120 days for ripe fruits. Fruit weight: 900g, fruit shape: flat round, fruit colour: Dark green (Immature) & Yellowish (Mature), Color of pulp:

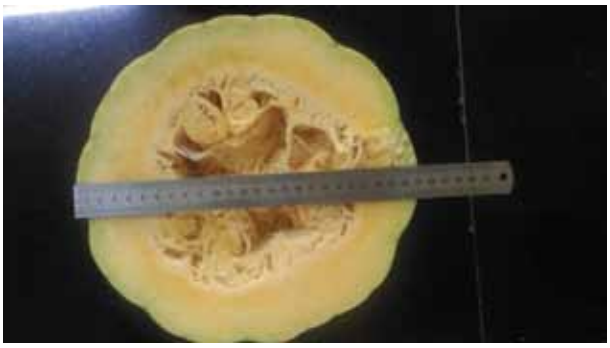


Fig. 15. Fruit of Thar Kavi

Creamy white (Immature) & orange (Mature), No. of fruit per plant: 8, Yield: 7-8 kg per plant, TSS: 8.5 ^{0}Brix, Acidity: 0.87 %, Carotene content: 2.36 mg/100g (Fig. 15).

Tomato

CO-3-237-3: The genotype developed through induced mutation, followed by selection of desirable phenotype in the induced populations, is characteristic with deep red fruit type, which predominantly yields lycopene content (7.9mg/100g). It is highly tolerant to heat stress and drought with high yield potential. The superior phenotype was identified and homogenized based on the horticultural attributes and performance analyzed. It is an indeterminate growth type, each fruit weight about 120-130g, attractive deep red fruits of round in shape. Each plant yields from 4.2 to 4.9kg. The fruits mature in 70-80 days after transplanting, comes under medium maturity type. It is moderately resistance to TCLV disease. This genotype suits for table/processing/export purposes. It has high TSS, high flesh thickness and deep red colour with larger fruits, very high lycopene content (7.9mg/100g) and high carotene content with medium acidity (0.42%).

M-47: The genotype developed through induced mutation, followed by selection of desirable phenotype in the induced populations, is characterized with yellow fruit type, which predominantly yields β-carotene and the lycopene synthesized in it is easily absorbable by the body due to *cis*-isomer type as compared to *trans* form in red genotypes. It is highly tolerant to heat stress having high yield potential. The superior phenotype was identified and homogenized based on the horticultural attributes and performance analyzed. It is semi determinate type, each fruit weight about 105-110g, attractive yellow fruits of flat round in shape. Each plant yields from 3.2 to 3.9kg. It is moderately resistance to TCLV disease. The plants grow up to 123.5cm (semi determinate type), moderately vigorous, densely foliaged dark green leaves having 10.3cm inflorescence length. The genotype suits for table/processing/export purposes. It has high TSS, high flesh thickness and deep yellow fruits. High TSS (5 ^{0}Brix), very low lycopene content (0.5mg/100g) and high carotene content with medium acidity (0.38%).

Bottle gourd (*Lagenaria siceraria*)

The promising genotypes of bottle gourd viz., LS-4xLS3-2, LS-20-1xLS14-1, LS-28xLS-20-2, LS3xLS-2 and LS42xLS32-2 was raised (F_7 generation) under replicated trial to assess the vegetative flowering, fruit and yield related parameters. Significant difference was observed among the promising genotypes for different parameters. Considering the fruiting parameters, the highest number of fruits per plant 17.6 was recorded.

in LS-4xLS3-2, which is round shaped and highly tolerant to heat stress. The genotype LS3xLS-2 was vigorous in growth and earliness. Fruits are attractive green and cylindrical in shape. Fruit size was 600-700 g at optimum at edible stage attains 56-64 days after sowing. The LS-20-1xLS14-1, thump bell shaped recorded lowest number of fruits per plant (11.1).

The LS-28xLS-20-2 was the lengthiest fruit (42.60 cm) with cylindrical shape attains marketable stage at 57-63 days.

Vegetable seed production

Revolving funds of ICAR seed project

For understanding genetic purity and quality yield, experimental trials were conducted and seed production was done in snap melon-AHS-82 (141 kg), kachri-AHK-119 (270 kg), mateera-AHW-19(5.5 kg), cluster bean-Thar Bhadavi (400 kg) and beans (Thar Maghi, Thar Kartiki & Thar Mahi, 3.5 kg) with breeder and TFL crops during 2016–17 under revolving funds of ICAR project. About 815.00 kg seed of arid zone vegetable varieties was produced and distributed to farmers, NGO's, KVK's and national, state and private agencies for spread and further seed chain of institute crop varieties.

CROP MANAGEMENT AND AGRO-TECHNIQUES

Planting models

Khejri based cropping models (Flagship Project)

a) Plant growth and bio-mass production studies in khejri based crop production site

To study khejri based cropping models adopting Horticulture Based Crop Production Site Management Approaches (HBCPSMA), a field of two hectares area of sandy - sand-dune landscape was developed through *in situ* establishment by planting seedling in 2007 and budding of variety Thar Shobha in 2009 under rainfed conditions of hot arid agro-climate. During 2016–17, plant growth and development observations were recorded periodically in response to training–pruning of 7th year's tree age-group and no much difference were observed in respect to growth parameters under investigation in variety Thar Shobha plantations with varying planting models. It is also recorded that close spacing and paired rows (4m x 4m) khejri planting exhibited maximum canopy at about 6 years age and thus this age-group stage of plant growth from which normal training and pruning should be recommended for annual harvesting of tender pod, loong and fuel-wood for the highest bio-mass/year (Fig. 16, 17)

Fig. 16. Studies on plant growth behaviour, training–prunning and biomass production in seedling and budded khejri plantations under rainfed situations of hot arid agro-climate

Fig. 17. Studies on inter cropping of kachri AHK–119 and cluster bean Thar Bhadavi with varying khejri planting models and production technology under hot arid agro-climate

During the period, observations were compiled on growth, yield and bio-mass production in khejri var. Thar Shobha with varying (12) planting models, and based on three years of mean data, Thar Shobha recorded pod yield of 6.58 kg/plant under KM-1, KM-9 & KM-11. Similarly, marketable fruit yield of kachri var. AHK-119 (56.58 q/ha) and tender pod yield of cluster bean var. Thar Bhadavi (54.34 q/ha) was recorded as monsoon supported inter-crop with khejri and adopting recommended techniques of HBCPSMA concept from 2014 to 2017 time period.

b) Crop-genotype-environment studies of production site

During 2016-17, field crop area was maintained with good management and following technological recommendations developed for main and inter-crop cultivation studies adopting HBCPSMA concept. The start of spring-summer season was with uncertainty in weather conditions and severe hail-storm situation on 11/03/2016 was recorded in the production site and resulting to drastic damages to new floriferous growth and newly emerge panicles in khejri and plants were completely defoliated. First time such hail-storm situation was observed by me in last 23 years from establishment of CIAH farm at Bikaner. However, khejri and other native crop-plants such as phog, rohida, lasora and ker recovered quickly due to active growth phase and further new growth started from last week of March.

For kharif season rainfed crop cultivation, total 17 rainy days and about 285 mm rain was recorded from sowing in July to harvesting period (October-November). The inter–crop studies on jharber, ker, cluster bean, kachri and grasses were successful under rainfed situations of hot arid agro-climate, and crop performance was very good for consecutive fifth year and this was only because of adoption of good management practices as per HBCPSMA, follow-up of operations in time schedule with weather based forecasting and distribution of normal rains during crop period in kharif season.

During June as well November–December month, intensive training / pruning operations were performed in khejri, phog, jharber, ker, lasora, kumat and rohida to understand essential practices required for developing frame-work, plant architecture for more numbers per unit area and also growth studies in native crop-plant species for maximum bio-mass harvesting under rainfed and resource constrains situations. The crop-genotype-environment interaction observations were recorded on main and inter–crops for the compilation of experimental results over the years, and it is found very useful for regional crop / weather specific forecasting / field operations to promote desert horticulture.

c) Studies on soil fertility build-up with khejri

A long-term investigation to under-stand soil fertility and scope of improvement in building-up of fertility and nutrient levels was carried-out adopting khejri based crop production site management approaches under hot arid agro-climate at ICAR-CIAH, Bikaner. For the investigation, wide spectrum of varying land-use patterns (47 situations) were studied with or without khejri planting models (3, 6 & 9th years age group) to understand nutrient build-up, soil fertility characters and scope of improvement over the period from 2004-2015 as production site management approach. The soil samples and data were analyzed adopting standard procedures to understand the results of new initiatives and follow-up of action for recommendations / refinements. The analyzed data of varying 47 situations under investigation depicted wide range for soil pH (8.27- 8.92), TDS (37 -130 ppm), EC (0.057 -0.203 ds/m), OC (0.068-0.100 %), N (72.73-107.76 kg/ha), P (8.11- 11.56 kg/ha), K (181.84-246.00 kg/ha) and S (3.50-8.27 kg/ha) and results exhibited that the approach is effective in improving the organic carbon and nutrient status in sandy soils.

The treatment code KS-39 (KM-11, field of khejri plantation of nine years age-group with cluster bean cultivation) exhibited more effectiveness for soil fertility build-up in comparison to different land-use patterns. Based on 6 year age-group, treatment code KS-13 (KM-1, field of 4mx4m khejri plantation with three cluster bean crops during establishment period and normal field crop culture as organic plot) is found more effective for soil fertility build-up in comparison to other land-use patterns of the period. Among khejri models of three years age-group, treatment code KS-12 (KM-9, field of 24mx4mx4m plantation of 3 years of establishment with three rainfed cluster bean crop)

depicted effectiveness for better soil fertility build-up. The analyzed data evidently demonstrated that virgin sand-dune land-scape developed as fields for crop cultivation under hot arid agro-climate can effectively be improved with khejri plantations and three crops of cluster bean for building-up of nutrients status, and it should be developed as systematic khejri based production sites for cultivation of diverse and resource based crop-commodities.

d) Studies on Jharber — a native fruit species

Intensive studies on jharber plantation was undertaken periodically to generate information on growth, foliage and fruiting behaviour and bio-mass production as established inter-crop (6th year) with khejri planting models, and data were compiled. The jharber plantation was also studied as seed generated progenies develop from wide spectrum of germplasm variability collected and established *ex situ* at CIAH for exploitation and commercialization of native crop under rainfed situations of hot arid agro-climate.

The seed generated jharber progenies were in 6th year of its establishment and with uniform growth and fruiting pattern for characterization. Based on passport information and observational studies on population from the year 2010 at CIAH, 39 variable genotypes were identified from the diversity under evaluation and wide range of observations were recorded with developed descriptor to generate information on jharber during 2016-17. Based on field performance over the years, two elite genotypes (R17P1 and R37P1) were identified as most potential for fruit, fodder and bio-mass production under absolute rainfed situations.

e) Studies on boundary plantation and native crop-plant species

During the crop period, studies on growth parameters in khejri, rohida, kumat and lasora seedling was performed as boundary plantations under production site management approach. The seed generated ker progenies were studied to generate C x G x E information for desert horticulture and exploitation with khejri based production sites. Similarly, observations in response to training / pruning were recorded on native species such as phog and khimp to understand growth, development and bio-mass production as naturally perpetuated shrubs of desert eco-system in the khejri based production site (Fig 18 and 19).

Fig. 18. Evaluation of kumat for plant growh and yield potential as seedling and boundary plantation under khejri based crop producion site management apporach & is for organic Panchkutta.

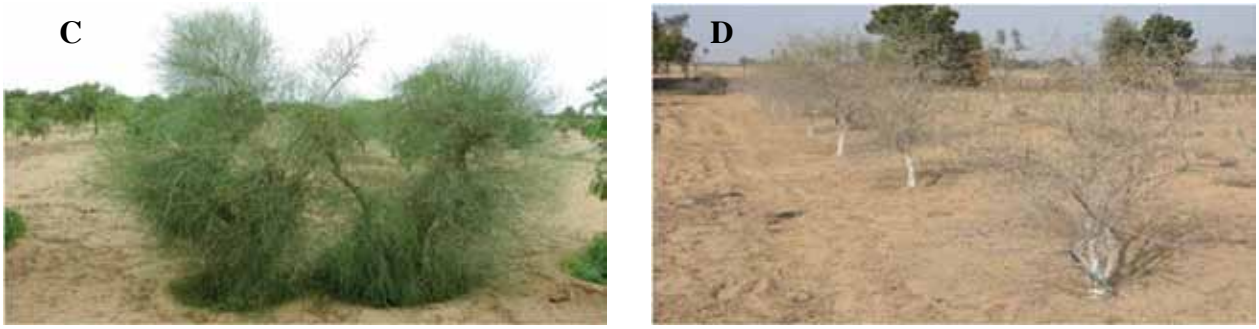


Fig. 19. Evaluation of (a) Lasora, (b) Ker, (c) Phog and (d) rohida under khejri based crop production site management approach.

f) Studies on food value of native crop plant

Nutrient component and food values of 10 native crop-plant genotypes cultivated with khejri based production site was studied for assessment of nutrition yield potential at marketable stages and the produce is used as arid vegetables by desert dwellers. The marketable stage produce in the form of fresh fruits of kachri, snap melon and jharber, tender pods of khejri, cluster bean and khimp, tender fruits of mateera, ker and lasora and mature flower buds of phog were studied for nutritional values.

Evaluation of Fruit Based Diversified Cropping Models for Arid Region

Studies on growth and development of main and component crops

The experiment comprises of eight different cropping models *viz*., *aonla-ber*-cluster bean-fennel (M-1), *aonla-bael*-cluster bean-coriander (M-2), *aonla-khejri*-cluster bean-*ajowain* (M-3), *aonla*-drumstick-cluster bean-dill (M-4), *aonla-khejri*-grass (*L. sindicus*) (M-5), *aonla*-mosambi-cluster bean-mateera (M-6), *aonla*-Kinnow-cluster bean-chick pea (M-7) and *aonla*-mulberry-*kachari*-mustard (M-8). Observations on growth and development was recorded in already twelve years 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.

The annual increment in plant girth was found to be the maximum in *ber* (33.7 mm) followed by *khejri* (28.6 mm), *bael* (21.7 mm), *karonda* (14.5 mm) and moringa (9.4 mm).

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-khejri* (51.4 kg per plant), *aonla-ber* (49.3) followed by *aonla*-Kinnow (37.2 kg/plant) and *aonla*-mulberry (35.9), while the lowest was recorded in *aonla*-moringa (34.6 kg/plant). The higher yield in *aonla* involving *ber* and *khejri* could be due to synergistic crop interaction. The average yield of *bael* was recorded to be 25-30 kg per tree, while a single fruit weighed around 1.36 kg with maximum and minimum fruit weights recorded to be 2.1 and 0.5 kg, respectively. The average yield of *karonda* was recorded up to 13.3 kg/plant planted in between *aonla* plants. Likewise, the yield of *ber* cv. Seb was recorded to be 52.8 kg/plant in model M-1. The yield of *sewan* grass was recorded to be an average of 2.71 kg/m^2 on dry weight basis.

Eco-physiological interaction studies

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

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

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

Physiological Studies

Monthly Relative Water Contents (%) of Fruit Trees

April: *Karonda* (84.36) > *Bael* (81.17) > *Khejri* (79.57) > *Ber* (74.29) > Moringa (74.11).
May: *Khejri* (89.35) > *Aonla* (87.17) > *Karonda* (83.16) > Moringa (73.19)
June: *Karonda* (87.31) >*Aonla* (88.86) > Moringa (83.62) > *Khejri* (81.28) > *Bael* (81.47) > *Ber* (65.17)
July: *Karonda* (86.14) > *Khejri* (86.25) > *Bael* (84.60) > *Aonla* (83.06) > Moringa (70.26) > *Ber* (61.71).
August: *Bael* (89.67) > *Aonla* (87.83) >*Khejri* (81.95)> Moringa (81.70)> *Karonda* (81.49) > *Ber* (80.98).
September: *Aonla* (83.38) > Moringa (79.85) > *Khejri* (78.36) > *Karonda* (74.15) > *Bael* (73.43) > *Ber* (72.19).
October: *Aonla* (85.82) > *Khejri* (80.01) > *Karonda* (79.71) > *Bael* (71.42) > Moringa (59.25)>*Ber* (58.03).
November: *Khejri* (93.84) > *Karonda* (90.47) > *Aonla* (86.17) > *Bael* (84.74) > Moringa (79.06) > *Ber* (56.52).
December: *Aonla* (86.17) > *Khejri* (85.51) >*Bael (84.46)* > Moringa (80.10) > *Ber* (57.38) > *Karonda*(56.98).
January: *Aonla* (86.29) > *Khejri (84.69)* > *Bael (84.42)* > *Moringa* (81.60) >*Karonda* (57.89) > *Ber* (57.57).
February: *Bael (84.57)* > *Khejri* (83.87) > *Moringa* (81.62) >*Ber (64.62)* > *Aonla (57.97)* > *Karonda* (41.32).
March: *Karonda* (84.61) > *Khejri* (82.39) > *Aonla* (81.48) > *Bael* (73.20) > Moringa (65.27) > *Ber* (55.58).

Aonla and *karonda* leaves were observed to maintain the comparatively higher relative water content throughout the period under study followed by *khejri* and *bael,* while the lowest was noticed with *Ber*. Likewise, with regards to the leaf water content, *khejri* and drumstick leaves were observed to be having higher moisture contents, while *aonla and karonda* had lower moisture contents in their leaves.

Leaf Water Contents (%) Pattern of Fruit Trees

April: Moringa (72.64) > *Karonda* (69.59) > *Ber* (61.26) > *Bael* (60.73) > *Khejri* (57.41)
May: *Khejri* (91.34) > *Aonla* (83.41) > *Karonda* (82.70) > Moringa (71.67)
June: *Khejri* (73.58) > *Bael* (69.39) > Moringa (69.01) > *Ber* (63.13) > *Aonla* (63.03) > *Karonda* (56.29).
July: Moringa (73.96) > *Bael* (69.91) > *Khejri* (68.30) > *Ber* (64.28) > *Aonla* (57.82) > *Karonda* (51.25).
August: Moringa (72.63) > *Bael* (65.16) > *Ber* (62.06) > *Karonda* (61.61) > *Aonla* (60.64) > *Khejri* (57.50).
September: Moringa (76.15) > *Khejri* (65.62) > *Ber* (63.30)> *Karonda* (61.52) > *Bael* (61.49) > *Aonla* (61.04).
October: Moringa (66.91) > *Khejri* (65.95) > *Bael* (64.50) > *Ber* (63.75) > *Karonda* (59.06) > *Aonla* (48.97).
November: *Bael* (73.46) > *Khejri* (73.05) >Moringa (71.43)> *Ber* (58.79) > *Karonda* (57.23)> *Aonla* (53.66).
December: *Aonla* (61.29)> *Khejri* (60.84)> *Ber* (60.78) > *Bael* (60.47) > Moringa (59.80) > *Karonda* (57.43).
January: *Khejri* (70.67) > *Aonla* (70.01) > *Ber* (61.51) > Moringa (55.89) > *Karonda* (55.06) > *Bael* (49.84).
February: *Khejri* (65.29) > Moringa (60.45) > *Bael* (58.48) > *Ber* (56.67) > *Karonda* (51.85) > *Aonla* (49.44).
March: Moringa (73.24) > *Bael* (69.78) > *Karonda* (65.56) > *Khejri* (62.4) > *Aonla* (58.75) > *Ber* (54.91).

Studies on flowering regulation, cracking management, rootstock adaptability and value addition in pomegranate under hot arid environment of Rajasthan.

The total area covered under this experiment was 1.25 hectare. Whole area was under drip irrigation system. Project activities were executed as per the technical programme. The survival percentage of pomegranate saplings is till the reporting time was around 95 %. The maximum loss (5 %) in pomegranate was recorded due to termite. The termites feed on roots, shoots and trunks of the pomegranate plant moving upward making the tunnels. Termite management was done with chlorpyriphos application by drip irrigation.

Intensification in production technology of guava, *jamun* and mulberry under hot arid conditions

Initiated with the plantation of 132 mulberry rooted cuttings on 28 October, 2016 in new site i.e., Bolck III, ICAR-CIAH, research farm in lieu of *in situ* establishment of orchard.

At Godhra

Standardization of production technology of mango cv. Kesar and sweet orange cv. Sathgudi

Effect of different mulches on soil properties, growth, yield and quality of mango (Planted in July, 2003) and sweet orange cv. Sathgudi (Planted in July, 2008)

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 grasses.

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 19.60-14.60, 20.50-16.60% in paddy straw and it was recorded 14.70-12.00, 16.30-13.40 % 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 the maximum with paddy straw mulch followed by grasses and black polythene mulch, while minimum was observed in control.

Fruit yield and quality attributes

Plants treated with paddy straw mulch recorded the highest yield (55.10 kg/ plant), followed by grasses (51.10 kg/ plant) and black polythene mulch (48.20 kg/plant) and it was recorded minimum in control (38.20 kg/plant). Maximum TSS (20.40^0 Brix) was noted in paddy straw mulch followed by grasses (20.20^0 Brix) and polythene mulch(20.10^0 Brix), it was recorded least in control (19.50^0 Brix).

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

Experiment was set on in randomized block design which were replicated four times. Intercrops (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 x10 m distance. Economic analysis of mango based cropping system revealed that maximum yield per plot was recorded with mango + bottle gourd combination followed by mango + pumpkin among the different combinations under rainfed conditions of semi-arid ecosystem. Growth pattern of the mango plants is satisfactory.

Effect of organic manure and fertilizers on mango cv. Kesar

A field experiment was conducted in mango cv. Kesar, planted in the year 2008 at 10x10m distance. Soil properties and growth of the mango plants were considerably influenced by the application of different types of cakes, FYM, fertilizers and biofertilizers in different combinations under rainfed conditions of hot semi-arid ecosystem of western India. Maximum plant height (3.40 m), plant spread East- West (2.80 m), north-south (2.65m) and scion girth (45.20 cm) was recorded in T_6-FYM + std. dose of NPK + *Azotobactor* + PSB closely followed by T_8-Castor cake + standard dose of NPK+ *Azotobactor* + PSB. Maximum fruit yield (20.50 kg/ plant), TSS (20.90^0 Brix) was also recorded in T -6, closely followed by T-8.

Pruning trial in mango

For conducting the pruning trial in mango, planting of 200 plants of Kesar mango under high density (5x5 m) has been done in 0.5 ha area. Treatments were imposed after harvesting of the fruits. Peak period of flowering was noted in the month of March. Plants are growing well.

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

Maximum fruit yield per plant (34.20kg) was recorded in paddy straw mulch followed by grasses (31.20 kg/ plant), black polythene mulch (30.00 kg). Minimum fruit yield (24.00 kg/ plant) was recorded under control. Maximum fruit weight (238.10) and TSS (13.60^oBrix) was also recorded in paddy straw mulch, followed by grasses and black polythene mulch.

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

Experiment was laid in randomized block design 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 sweet orange, planted at 5 m x 5 m distance. Maximum yield per plot was recorded with sweet orange + bottle gourd combination followed by sweet orange + pumpkin among the different combinations.

Effect of organic manure and fertilizers on sweet orange cv. Sathgudi

The maximum plant height (2.90 m), plant spread East- West (2.60 m), North-South (2.80m) and scion girth (35.00 cm) was recorded in T_6-FYM + std. dose of NPK + *Azotobactor* + PSB closely followed by T_8-Castor cake + standard dose of NPK+ *Azotobactor* + PSB. Highest fruit yield (12.20 kg / plant) was recorded in T_6.

Standardization of production technology of bael under rainfed semi-arid conditions of western India

Various experiments on canopy management, planting density, cropping models, intercropping, manures and biofertilizers, fruit drop and sun scald were laid out. Observations on various aspects were recorded.

Effect of age of scion shoot and time of budding (*in-situ*) on success and survival of the bael plant (patch budding, detopping and promotion of scion wood)

For getting vigorous and healthy scion shoots in the month of May, the branches (1-2 year old) were detopped in April during leaf less condition of the tree. The multiple axillary shoots arise below the cut portion and attain the length of 50 cm to 60 cm in two months, vigorous and healthy in growth, were used as scion shoot.

Selection of bud wood

(Basal portion of shoot) and immature and undeveloped buds (upper part of the new shoots) were not used for bud selection. Results of the study revealed that the plants grafted in May took the least time (9 days) to sprout closely followed by the June month (13 days) and 14th July (18days); however maximum time (24 days) was taken to sprout when budding was performed in August. The highest percentage of graft success (97.80) was recorded in May closely followed by June (95.50), July (71.20) and August (65.00). The maximum mean length of sprout *i.e.* 67.00 cm was recorded when patch budding was done in May closely followed by June (59.50 cm) and July (54.10 cm) whereas least length of sprout was recorded from the plant budded in August (42.00cm). The highest number of trifoliate leaves (28.00) per plant was recorded from the plants when the budding was done in May and it was minimum in August *i e* 18 leaves. It may be concluded from the study that the May month is ideal time for multiplication of bael in hot rainfed semi-arid conditions.

Integrated Nutrient and Water Management

Effect of different INM treatments on microbial population in bael and Kinnow

Three types i.e. *Azotobactor*, PSB and AMF biofertilizers are intend to use in the different treatments. For making standard doses of biofertilizers same were tested for their microbial load. Accordingly, all three biofertilizers were procured from ICAR-IARI, New Delhi. The *Azotobactor* biofertilizer was tested for bacterial population and 6.5 x 10^6 cfu were recorded and the other quality parameters like colour, moisture and granulation were also recorded and same were found in order. The PSB biofertilizer was tested for *Pseudomonas* population and observed 11.3x 10^9 bacteria population and other physiochemical properties were also found in order. Likewise, VAM was evaluated for the fungal colonies of *Glomus* species and large numbers of hyphae were recorded and also multiplying in the live host material.

Monitoring of microbial population at two depths (0.00 - 0.15 and 0.15 - 0.30 m) during 2016-17 was carried out in bael and Kinnow field experiments of integrated nutrient management (Table 14). The bacterial population in different treatments ranged from 7 to 35 x10^5 cfu g^{-1} soil, fungal from 1.5 to 3.5 x10^5 cfu g^{-1} soil and actinomycetes from 14-28 x 10^5 cfu g^{-1} soil in different INM treatments in Kinnow orchard. Total microbial population was minimum in the absolute control and significantly highest in

the treatment where recommended dose of N, P and K was associated with FYM and consortium of biofertilizers at both the depths (Table 14). Total population as well as individual population of different microorganism increased with involvement FYM and consortium of biofertilizers. This is because most of the soil micro-organisms are chemoheterotrophs which require organic source of carbon as food and oxidation for organic substances provides energy. Under different INM treatments, the total and individual population of different micro-organisms was higher where nutrients were provided by RDF of N, P, K + FYM + PSB + Azotobactor + VAM combinations followed by RDF of N, P, K +FYM + Azotobactor treatment and minimum population of micro-organism were observed in control treatment. In FYM treated plants, C: N ratio was wide which proved more carbon and low rate of mineralization, this might have resulted in increased total population as well as individual microbial population. Total as well as individual microbial population was higher in the surface than subsurface soil.

The data presented in table 15 revealed that status of total microbial population was less in bael orchard in all INM treatments in comparison to Kinnow orchard. The bael orchard was only 7-year old and added only small amount of FYM and biofertilizers. In different treatment of INM in bael, bacterial population ranged from 6.5 to 32.5x 10^5 cfu g^{-1} soil, fungal 1.5 to 3.0 x 10^5 cfu g^{-1} soil and actinomycetes 12 to 25x 10^5 cfu g^{-1} soil. In this crop also, addition of organic matter and biofertilizers increased the total microbial population in the bael orchard.

Table 14. Effect of different INM treatments on microbial population in Kinnow orchard (16 year old plants).

Treatments	0-15 cm depth				15-30 cm depth			
	Bacteria (Cfug^{-1}x 10^5)	Fungal (Cfug^{-1}x 10^5)	Actinomy-cetes (Cfug^{-1}x 10^5)	Total	Bacterial (Cfug^{-1}x 10^5)	Fungal (Cfug^{-1}x 10^5)	Actino-mycetes (Cfu g^{-1}x 10^5)	Total (Cfu g^{-1}x 10^5)
Control	6	2	12	20.0	5	1.0	12	18.0
RDF	14	1.4	16	31.4	12	1.3	14	27.3
RDF + FYM	28	2.0	22	52	24	2.0	21	47.0
RDF +Azotobactor	30	1.4	12	43.4	27	1.5	14	42.5
RDF + PSB	31	1.5	15	47.5	24	1.8	15	40.8
RDF + VAM	10	2.5	13	25.5	11	2.6	10	23.6
RDF+FYM + AZB	32	2.0	20	54	28	1.5	18	47.5
RDF + FYM + PSB	31	1.5	16	48.5	27	1.5	14	42.5
RDF + FYM + VAM	32	3.0	22	57	30	2.5	18	47.5
RDF +FYM + PSB + AZB	32	2.0	23	57	30	2.0	20.0	52.0
RDF + FYM + PSB + AZB + VAM	32	3.0	25	60	30	2.5	22	54.5
SEM±	3.20	0.11	3.25	-	2.63	0.13	3.10	-
CD 5%	8.65	0.33	9.25	-	7.32	0.31	8.90	-

Table 15. Effect of different INM treatments on microbial population (cfu x10^5 g^{-1} soil) in bael orchard.

Treatments	0-15 cm depth				15-30 cm depth			
	Bacteria (Cfug^{-1}x 10^5)	Fungal (Cfug^{-1}x 10^5)	Actino-mycetes (Cfug^{-1}x 10^5)	Total	Bacterial (Cfug^{-1}x 10^5)	Fungal (Cfug^{-1}x 10^5)	Actinomy-cetes (Cfu g^{-1}x 10^5)	Total (Cfu g^{-1}x 10^5)
Control	7	1.5	15	23.5	7	1.5	12	20.5
RDF	14	1.5	17	32.5	12	1.5	13	26.5
RDF + FYM	28	2.0	21	51.0	22	1.5	23	46.5
RDF +Azotobactor	30	1.5	15	46.5	22	1.0	15	48.0
RDF + PSB	32	1.5	10	43.5	26	1.0	12	39.0
RDF + VAM	15	3.0	12	30.0	12.0	2.0	12.0	26.0
RDF+FYM + AZB	35	1.5	15	51.5	23.0	1.5	18.0	42.5
RDF + FYM + PSB	32	1.5	20	53.5	22.0	1.0	20.0	43.0
RDF + FYM + VAM	30	3.5	15	48.5	18	2.5	12.0	32.5
RDF +FYM + PSB + AZB	35	2.0	18	55.0	25.0	1.5	18.0	44.5
RDF + FYM + PSB + AZB + VAM	32	3.5	15	50.5	24.0	2.0	18.0	44.0
SEM±	2.32	0.11	2.50	-	2.55	0.13	2.55	-
CD 5%	7.54	0.28	6.89	-	6.58	0.28	6.85	-

Table 16. Effect of different INM treatments on morphological parameter of Kinnow orchard (16 years old plants).

Treatment	Tree height (m)	Tree Spread		Stem diameter (cm)
		N-S (m)	E-W (m)	
Control	2.85	2.70	2.65	85
RDF	3.10	2.75	2.65	85
RDF + FYM	3.75	3.05	3.00	85
RDF +Azotobactor	3.50	2.75	3.00	85
RDF + PSB	3.50	3.00	2.95	85
RDF + VAM	3.50	2.95	2.85	85
RDF+FYM + AZB	4.50	3.10	2.95	80
RDF + FYM + PSB	4.15	3.10	3.00	80
RDF + FYM + VAM	4.15	3.10	3.00	90
RDF +FYM + PSB + AZB	4.00	3.35	3.00	92
RDF + FYM + PSB + AZB + VAM	4.55	3.50	3.00	95
SEM±	0.24	0.18	0.19	7.20
CD 5%	0.58	0.49	0.42	21.00

Effect of different INM treatments on morphological parameters of Kinnow

The data presented in table 16 revealed that significantly maximum plant height (4.55 m) was recorded in RDF of N, P, K + FYM + PSB + *Azotobactor* + VAM treatment and minimum was in control (2.85 m). The pattern in plant height revealed that addition of RDF along with FYM and consortium of biofertilizers has the highest increment in plant growth. Likewise plant spread in both the directions was also more in the same INM treatment. The data on stem diameter was also significantly differed among INM treatments and maximum stem diameter was recorded in RDF + FYM + PSB + AZB + VAM and RDF +FYM + PSB + AZB treatments.

Effect of INM treatments on yield and fruit quality parameters of Kinnow

The fruit weight, fruit yield, TSS, acidity and juice recovery were measured in different INM treatment and data given in table 17 revealed that maximum fruit weight (230 g) was recorded in RDF of N, P, K + FYM + PSB + *Azotobactor* + VAM which was significantly at par with RDF of N, P, K +FYM + *Azotobactor* treatment. The minimum fruit weight (125 g) was recorded in control treatment. The fruit yield was estimated and maximum fruit yield (23.50 t/ha) was recorded in RDF of N, P, K + FYM + PSB + *Azotobactor* + VAM treatment and minimum (9.0 t/ha) yield was estimated in control treatment. The TSS was measured in mature fruits from all treatment and recorded in the range of 12.50 to 15.00 ° brix and data revealed that addition of FYM, inorganic fertilizers increased the TSS content. The acidity content was the maximum in control and inorganically fertilized treatments, while FYM reduced the juice acidity. The juice recovery was ranged from 40 to 55 per cent and maximum juice (55 %) was recorded in those treatments where FYM was the component of the treatment (Table 17).

Table 17. Effect of different INM treatments on yield and fruit quality parameters of Kinnow orchard (Average age of plant: 16 years).

Treatment	Fruit weight (g)	Fruit yield (t/ha)	TSS (° Brix)	Acidity (%)	Juice (%)
Control	125	9.00	12.50	0.85	40.00
RDF	160	12.00	12.00	0.70	50.00
RDF + FYM	225	15.50	12.50	0.60	55.00
RDF +Azotobactor	185	12.00	12.50	0.60	50.00
RDF + PSB	165	12.50	12.50	0.70	55.00
RDF + VAM	170	12.50	12.50	0.70	50.00
RDF+FYM + AZB	195	20.00	15.00	0.70	55.00
RDF + FYM + PSB	200	20.50	15.00	0.70	55.00
RDF + FYM + VAM	205	19.50	15.00	0.70	55.00
RDF +FYM + PSB + AZB	225	20.50	15.00	0.65	55.00
RDF + FYM + PSB + AZB + VAM	230	23.50	15.00	0.65	55.00
SEM±	13.05	2.01	0.65	0.26	1.25
CD 5%	40.50	5.45	1.80	NS	3.65

Evaluation of benefit : cost ratio of different INM treatments in Kinnow fruit crop

The benefit : cost ratio of different INM treatments was evaluated for 16 year old crop Kinnow fruit crop. The fixed cost was worked out having the all type of activities carried out in each treatment except the defined treatment. Simultaneously cost of each treatment was also worked and then both fixed and treatment cost were added for each treatment. The yield was also estimated on hectare basis. The gross income of each treatment was worked out by taking cost of the produce @ Rs. 8000 /t. After that net income was evaluated after deducting the total cost from the gross income of each treatment. Finally benefit cost ratio was worked out of each treatment. The maximum benefit cost ratio (3.08) was recorded in treatment T_{10} and minimum (1.59) was in treatment T_4 (Table 18). The data revealed that adding of FYM with recommended dose of NPK increased the benefit cost ratio, while adding of AMF did not the benefit in the income.

Effect of different INM treatments on morphological parameters of bael

The parameters on plant height, tree spread and stem diameter were measured and data presented in table 19. The data revealed that maximum plant height (1.35 m) was recorded in RDF of N, P, K +FYM +PSB + *Azotobactor* and RDF of N, P, K + FYM + PSB + *Azotobactor* + VAM treatments and minimum plant height was recorded in control treatment likewise same pattern was recorded in tree spread and stem diameter.

Table 18. Evaluation of benefit cost ratio of different INM treatments in Kinnow fruit crop (16 years old).

Treatments	Fixed cost ('000)	Treat Cost ('000)	Total cost ('000)	Yield (t/ ha)	Gross income ('000)	Net income ('000)	B:C ratio
Control	25	-	25	9.00	72	47	1.88
RDF of N, P and K	25	10	35	12.00	96	61	1.74
RDF + FYM	25	15	40	15.50	124	84	2.10
RDF +AZB	25	12	37	12.00	96	59	1.59
RDF + PSB	25	12	37	12.50	100	63	1.70
RDF + AMF	25	12	37	12.50	100	63	1.70
RDF+FYM +AZB	25	17	42	20.00	160	118	2.80
RDF + FYM + PSB	25	17	42	20.50	164	122	2.90
RDF + FYM + AMF	25	17	42	19.50	156	114	2.71
RDF +FYM +PSB + AZB	25	19	44	20.50	164	120	2.72
RDF+FYM+ PSB + AZB + AMF	25	21	46	23.50	188	142	3.08

The soil physico-chemical properties of the soil under different INM treatments were measured periodically and data presented in table 20 depicts the changes in the different properties over the year. The data revealed that pH of the soil did not change much when only chemical fertilizers were applied but on the application of FYM, pH of the soil lower down. On the application of biofertilizers pH of the soil did not change much. Data regarding the organic carbon status revealed that application of FYM increased the level of OC, while inorganic fertilizers and biofertilizers have not changed the OC status of the soil. Available P and K_2O also have been affected by the application of INM treatments and recommended dose of N, P and K increased the availability of P and K_2O in

the soil and their maximum status were recorded on the application of application of inorganic fertilizers along with FYM. Likewise Availability of zinc and iron content in the soil has also been increased over the application of FYM.

Table 19. Effect of different INM treatments on morphological parameter of bael orchard (Average age of plant: 7 years).

Treatment	Tree height (m)	Tree Spread		Stem diameter (cm)
		N-S (m)	E-W (m)	
Control	0.90	0.30	0.35	22
RDF	1.15	0.35	0.35	22
RDF + FYM	1.20	0.40	0.35	30
RDF +*Azotobactor*	1.15	0.40	0.40	30
RDF + PSB	1.25	0.40	0.40	28
RDF + VAM	1.10	0.40	0.35	28
RDF+FYM + AZB	1.25	0.45	0.40	28
RDF + FYM + PSB	1.25	0.50	0.40	35
RDF + FYM + VAM	1.25	0.50	0.40	35
RDF +FYM + PSB + AZB	1.35	0.50	0.40	35
RDF + FYM + PSB + AZB + VAM	1.35	0.55	0.45	35
SEM±	0.16	0.16	0.16	4.35
CD 5%	0.42	NS	NS	NS

Table 20. Effect of different INM treatments on physico-chemical properties of the soil.

Treatment	pH	Organic carbon (%)	Available P (kg/ha)	Available K_2O(kg/ha)	Available Zn (ppm)	Available Iron (ppm)
Control	8.10	0.13	08.00	170.00	0.50	3.40
RDF	8.20	0.15	15.50	205.00	0.45	3.45
RDF + FYM	7.50	0.28	15.50	220.00	0.62	4.35
RDF +*Azotobactor*	8.00	0.15	15.00	220.00	0.58	3.75
RDF + PSB	8.00	0.15	16.00	220.00	0.58	3.78
RDF + VAM	8.00	0.15	16.50	220.00	0.58	3.80
RDF+FYM + AZB	7.60	0.30	16.50	220.00	0.67	4.85
RDF + FYM + PSB	7.60	0.30	18.50	220.00	0.67	4.85
RDF + FYM + VAM	7.60	0.30	19.50	225.00	0.67	4.85
RDF +FYM + PSB + AZB	7.60	0.30	19.50	225.00	0.67	5.10
RDF + FYM + PSB + AZB + VAM	7.50	0.30	19.50	230.00	0.67	5.10
Initial level	8.20	0.08	08.00	185.50	0.50	3.50

The soil moisture status of the soil under different INM treatment was monitored and results revealed that application of FYM alone or in combination with inorganic and biofertilizers increased the soil moisture status at both the strata. Monitoring of soil status at two depths revealed the more moisture has been accumulated at lower depths (Table 21). Application of biofertilizers alone did not improve the soil moisture status of the soil.

Intensification of research on tissue cultured date palm in hot arid region.

A. Standardization of planting time

This experiment was conducted with following approved technical programme and observations were also recorded as given below.

Treatments :	February, July, October
Cultivars:	Barhee, Khalas, Khuneizi and Medjool
Replication:	Five
Design:	RBD
Observations:	Survival (%), Plant height (m), Plant spread (m x m), emergence of new leaves.

The results of the said experiment are given here:

- In respect of cultivars maximum survival (95%) was recorded in Khalas, Barhee followed in Medjool (90%) and minimum(75%) survival was recorded in Khuneizi cultivar.
- Maximum plant height (215 cm) was recorded in Barhee followed in Khalas (180 cm) and minimum in Khuneizi cultivar (65cm).
- Maximum plant spread (N-S) and (E-W) was recorded in Barhee (1.20 m and 1.25 m) and minimum in Khuneizi cultivar (0.25 m and 0.20m).
- In Khalas and Barhee cultivars, 10-12 new leaves were emerged while in Medjool it was 8-10 and minimum leave emergence i.e., 2-3 was in Khuneizi cultivar.

B. Standardization of pit size for planting

This experiment was conducted with following approved technical programme and observations were also recorded as given below.

Pit size:	2 (1 × 1 × 1m and 0.5 × 0.5 × 0.5m)

Table 21. Effect of different INM treatments on soil moisture of the soil.

Treatment	Soil moisture (%) after 24hrs of irrigation	
	0-0.30m	0.30-0.60m
Control	2.80	3.50
RDF	3.50	3.50
RDF + FYM	5.50	6.00
RDF +*Azotobactor*	3.40	3.50
RDF + PSB	3.50	3.50
RDF + VAM	3.80	4.50
RDF+FYM + AZB	5.50	6.50
RDF + FYM + PSB	500	6.00
RDF + FYM + VAM	6.00	6.00
RDF +FYM + PSB + AZB	6.50	6.50
RDF + FYM + PSB + AZB + VAM	6.00	6.00

Cultivar:	Barhee, Khalas, Khuneizi and Medjool
Replications:	5
Design:	RBD
Observations:	Survival (%), Plant height (m), Plant spread (mxm), emergence of new leaves and spathe emergence, fruit setting

The results of the said experiment are given here:

- The maximum plant height (205 cm) in Khalas and Barhee cultivar with 1 × 1 × 1 m pit size, while minimum plant height (65cm) in Khuneizi cultivar with 0.5 × 0.5 × 0.5m pits size. The maximum leaf emergence was also recorded in cultivar Barhee and Khalas cultivar in the bigger size pit, while the minimum leaves were emerged in cultivar Khuneizi with small pit size. Same trend was also recorded in plant spread also.
- In cultivar Khalas, first time 20% plants have been flowered and first emergence was observed on 18th March, 2017 and last spathe emergence was recorded on 25th March, 2017. In Barhee and Medjool cultivars also, only 10% plants have been flowered first time. In Barhee first emergence was recorded on 22th March 2017 and in Medjool flowering started on 26th March 2017. The Ghanami cultivar (male) spathe emerged on 16th March 2017 and pollens were collected and used for pollination in all female cultivars. Fruiting in some plants have set during the report period.

C. Standardization of crop geometry (plant to plant and row to row spacing)

This experiment was conducted with following approved technical programme and observations were also recorded as given below.

Spacing:	02 (6 × 6m and 8 × 8m)
Cultivars:	Barhee, Khalas, Khuneizi and Medjool
Replications:	05
Design:	RBD

The results of the said experiment are given here:

- In all cultivars i.e. Khuneizi, Khalas, Barhee and Medjool of date palm, impact of spacing (row to row and plant to plant) i.e. 6 x 6m and 8 x8m was not been seen and survival, plant height and spread were not differed significantly in both the spacings.

Nutrients management in vegetables (mateera, kachri, snap melon and cluster bean) of hot arid region of Rajasthan

Nutrient requirement of kachri using omission plot technique under drip irrigation

In order to apply nutrients based upon soil status, it is necessary to know the location specific variability in nutrient supply to overcome the mismatch of fertilizer rates and crop nutrient demand. So, there is a need to develop site-specific nutrient management. Site-specific nutrient management implies the most efficient use and management of nutrients to attain higher levels of *kachri* productivity along with maintaining the fertility of the soil. Research works on site-specific nutrient management for *kachri* crop is scanty. Therefore, a field experiments was conducted at CIAH research farm with popular *kachari* cultivars AHK119 during 2016 in the *kharif* season to investigate the site specific nutrient management on *kachri* performance. The *kachri* crop received differential doses of NPK from inorganic fertilizers as per schedule of treatments. The seven manurial treatments involving NPK through inorganic fertilizer *viz*., 40, 20 and 20 kg/ha of NPK, 80, 40 and 40 kg/ha of NPK, 120, 60 and 60 kg/ha of NPK, 40 and 40 kg/ha of PK, 80 and 40 kg/ha of NK, 80 and 40 kg/ha of NP and without NPK (Absolute control) were replicated 3 times in a randomized block design. Nitrogen dose was applied in three splits *i.e.* 1/3rd at planting, 1/3rd at 25 DAP and rest 1/3rd 50 DAP from fertilizers. PK fertilizers were applied in lines at the planting time as per treatment.

Application of different combinations of NPK doses significantly increased yield of *kachri* as compared to control. Application 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O respectively, gave the highest *kachri* yield (116.4 q/ha) which was significantly higher than all other treatments, but at par with 80, 40 and 40 kg/ha of NPK and 80 and 40 kg/ha of NP. The increase in total yield was 3.46% higher over recommended NPK through fertilizers. Application of 100% NPK increased yield significantly by 118.87% compared to control. Whereas, this treatment gave only 23.22% more *kachri* yield as compared to half recommended dose of fertilizers.

The maximum yield was obtained when 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O (116.4 q/ha) followed by 80, 40 and 40 kg/ha of N, P_2O_5 and K_2O (112.5 q/ha) and 80 and 40 kg/ha of N and P_2O_5 (105.6 q/ha) and 40, 20 and 20 kg/ha of N, P_2O_5 and K_2O (91.3 q/ha). Same trend was observed for per cent yield response of different treatments. Maximum per cent yield response was observed where 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O was applied (126.4%) followed by 80, 40 and 40 kg/ha of N, P_2O_5 and K_2O (118.9%) and 80 and 40 kg/ha of N and P_2O_5 (105.4%) as compared to control (Table 22).

Net return and benefit:cost ratio of the *kachri*

Net return from *kachri* followed similar trend (Table 23) as that of fruit yield with highest values of Rs 77250/ha was observed in 120, 60 and 60 kg/ha of NPK treatment. This was closely followed by 80, 40 and 40 kg/ha of NPK (Rs 75427/ha) and 80 and 40 kg/ha of NP (Rs 69767/ha). 40, 20 and 20 kg/ha of NPK application gave net return of Rs 56213/ha as compared control (Rs 18360/ha). The benefit: cost ratio was highest in the treatment receiving 80, 40 and 40 kg/ha of NPK (2.03) closely followed by 120, 60 and 60 kg/ha of NPK treatments (1.98). Whereas, control gave the lowest B: C ratio (1.60).

Table 22. Requirements of N, P and K fertilizers of *kachri* using omission plot technique under drip irrigation.

Treatments	Yield (q/ha)	Yield response (%)	Yield q/ha	Price/kg	Gross return	Net return	B:C ratio
(1) 40, 20 and 20 kg/ha of NPK	91.3	77.5	91.3	10	91250	56213	1.60
(2) 80, 40 and 40 kg/ha of NPK	112.5	118.9	112.5	10	112500	75427	2.03
(3) 120, 60 and 60 kg/ha of NPK	116.4	126.4	116.4	10	116360	77250	1.98
(4) 40 and 40 kg/ha of PK	82.5	60.4	82.5	10	82450	46420	1.29
(5) 80 and 40 kg/ha of NK	87.6	70.4	87.6	10	87560	52237	1.48
(6) 80 and 40 kg/ha of NP	105.6	105.4	105.6	10	105560	69767	1.95
(7) Without NPK (Absolute control)	51.4	-	91.3	10	51360	18360	0.56
CD at 5%	14.53	-					

Intercrop of *kachri* in *Citrus* orchard using organic and inorganic source of nutrients.

Kachri vegetable produces higher dry matter/unit area and time offers excellent opportunity for intercropping with *Citrus* orchard. It is also a high value cash vegetable in the arid region and thus enhances profitability of the system. Kachri vegetable fits well in different multiple and intercropping systems. Integrated Nutrient Management (INM) implies the most efficient use and management of organic and inorganic sources of nutrients to attain higher levels of *kachri* productivity along with maintaining the fertility of the soil. A field experiments were conducted at CIAH research farm with popular *kachri* cultivar AHK119 during 2016 in the *kharif* season to investigate the role of application of inorganic and FYM source of nutrient on *kachri* performance as a intercrop in citrus orchard. The *kachri* crop received differential doses of NPK from inorganic fertilizers or FYM as per schedule of treatments. The six manurial treatments consisting of control, 100% NPK from inorganic fertilizers, 75% (I)+7.5 t/ha FYM, 50%(I)+ 15 t/ha FYM, 25%(I)+ 22.5 t/ha FYM and 30 t/ha FYM were replicated 3 times in a randomized block design. Nitrogen dose was applied in three splits *i.e.* 1/3rd at planting, 1/3rd at 25 DAP and rest 1/3rd 50 DAP from fertilizers and FYM as per treatment was applied in furrows at the planting time.

Application of organic and inorganic sources of nutrients significantly increased growth parameters and yield of *kachri* as compared to control. Maximum vine length (cm), Number of branches, fruits/plant and fruit production/plant (g/plant) were observed when organic and inorganic sources at equal proportion (application of 50% NPK from inorganic fertilizers and 15 t/ha FYM) was applied followed by 75% (I)+7.5 t/ha FYM, 50%(I)+ 15 t/ha FYM, 25%(I)+ 22.5 t/ha FYM and 30 t/ha FYM. Application of 50% NPK from inorganic fertilizers and 15 t/ha FYM) gave the highest *kachri* yield (114.47 q/ha) which was significantly higher than all other treatments. The increase in total yield were 76.41, 96.18, 107.07, 76.34 and 71.65% higher over control by the application of 100% NPK from inorganic fertilizers, 75% (I)+7.5 t/ha FYM, 50%(I)+ 15 t/ha FYM, 25%(I)+ 22.5 t/ha FYM and 30 t/ha FYM (Table 23).

The maximum per cent yield response was observed where 50%(I)+ 15 t/ha FYM was applied (107.07%) followed by 75% (I)+7.5 t/ha FYM (96.18%) as compared to control (Fig. 20).

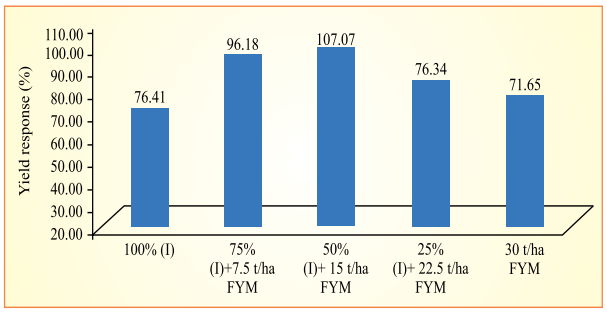


Fig. 20. Effect of organic and inorganic source of nutrient on yield response (%) of *kachri*

Table 23. Role of organic and inorganic source of nutrient on performance of *kachri*.

Treatments	Yield (q/ha)	Average of weight of fruit	DM (%)	(Dry m yield)
Control	55.28	28.25	9.25	5.11
100% (I)	97.52	33.24	10.25	10.00
75% (I)+7.5 t/ha FYM	108.45	33.56	10.14	11.00
50%(I)+ 15 t/ha FYM	114.47	38.47	9.78	11.20
25%(I)+ 22.5 t/ha FYM	97.48	31.45	10.78	10.51
30 t/ha FYM	94.89	35.64	11.24	10.67
CD at 5%	16.80	6.45	1.46	1.66

Net return and benefit: cost ratio of the *kachri*

Net return from *kachri* followed similar trend as that of fruit yield with highest values of Rs 78033/ha was observed in 50%(I)+ 15 t/ha FYM treatment. This was closely followed by 75% (I)+7.5 t/ha FYM application (Rs 72195/ha) and 25%(I)+ 22.5 t/ha FYM (Rs 60862/ha). The benefit: cost ratio was highest in the treatment receiving 50%(I)+ 15 t/ha FYM (2.14) closely followed by 75% (I)+7.5 t/ha FYM (1.99). Whereas, control gave the lowest B:C ratio (0.73) (Table 24).

Effect of *Rhizobium* biofertilizer in reducing the requirement of nitrogen fertilizer in cluster bean in hot arid region of North-Western Rajasthan

Microorganisms inoculation have shown a good promise and have emerged as an important component of integrated plant nutrients supply (IPNS). The present studies were conducted to evaluate the effectiveness of *Rhizobium* cultures for improving growth and yield of cluster bean under fertilized conditions. The cluster bean crop received differential doses of N with and without *Rhizobium* viz. control, 15 kg N/ha, 30 kg N/ha, 45 kg N/ha, 60 kg N/ha, *Rhizobium* biofertilizer, *Rhizobium* biofertilizer +15 kg N/ha, *Rhizobium* biofertilizer +30 kg N/ha, *Rhizobium* biofertilizer +45 kg N/ha and *Rhizobium* biofertilizer +60 kg N/ha.

Seed inoculation of cluster bean with *Rhizobium* biofertilizer +60 kg N/ha gave higher yield of grain seed cluster followed by *Rhizobium* biofertilizer +45 kg N/ha as compared to other treatment combinations. Saving of N requirement for different target yield by the seed inoculation of *Rhizobium* between 13- 30 kg/ha N was explored.

Effect of graded dose of N application increased the yield of the cluster bean with or without inoculation of *Rhizobium*. Application of 60 kg N/ha along with *Rhizobium seed* inoculation gave highest vegetable cluster bean as well as grain yield, which was 1.05 q/ha higher as compared to 60 kg N/ha application (Table 25). Maximum mean cluster bean vegetable as well as grain yield was obtained with *Rhizobium* as compared to without *Rhizobium* treatment.

Table 24. Role of organic and inorganic source of nutrient on growth attributes of *kachri*.

Treatments	Yield (q/ha)	Price/kg kachri	Gross return (Rs/hectare)	Net return (Rs/hectare)	B:C ratio
Control	55.28	10	55280	23280	0.73
100% (I)	97.52	10	97520	61447	1.70
75% (I)+7.5 t/ha FYM	108.45	10	108450	72195	1.99
50%(I)+ 15 t/ha FYM	114.47	10	114470	78033	2.14
25%(I)+ 22.5 t/ha FYM	97.48	10	97480	60862	1.66
30 t/ha FYM	94.89	10	94890	58090	1.58

Table 25. Effect of N and *Rhizobium* inoculation on growth parameters of cluster bean crop

Treatments	Vegetable cluster bean (q/ha)		Seed cluster bean (q/ha)		Straw yield (q/ha)	
	Without *Rhizobium*	With *Rhizobium*	Without *Rhizobium*	With *Rhizobium*	Without *Rhizobium*	With *Rhizobium*
control	20.4	38.01	5.74	6.22	85.42	68.58
15 kg N/ha	28.35	50.11	8.19	9.93	130.42	104.5
30 kg N/ha	42.25	55.43	11.89	14.33	176.25	139.83
45 kg N/ha	50.92	75.29	15.74	17.85	213.67	173.17
60 kg N/ha	65.09	83.15	17.22	21	228	207.42
Mean	207.01	301.99	58.78	69.33	833.76	693.5

Per cent increase in yield by the application of 15, 30, 45 and 60 kg/ha along with seed inoculation with *Rhizobium* was higher comapred to per cent increase in yield by the application of 15, 30, 45 and 60 kg N/ha .

Nutrient requirement of cluster bean using omission plot technique to determine the requirements of P and K fertilizers

An experiment was conducted on nutrient requirement of cluster bean using omission plot technique to determine the requirements of P and K fertilizers. The cluster bean crop received differential doses of PK viz., 30 kg/ha each of P_2O_5 and K_2O, 60 kg/ha each of P_2O_5 and K_2O , 90 kg/ha each of P_2O_5 and K_2O , without P +60 kg/ha K_2O, without K+60 kg/ha of P_2O_5 and without PK (Absolute control) replicated 3 times in a randomized block design. Nitrogen dose was applied in three splits *i.e.* 1/3rd at planting, 1/3rd at 25 DAP and rest 1/3rd 50 DAP from fertilizers.

PK fertilizers were applied in furrows at the planting time as per treatment. Application of 90 kg/ha each of P_2O_5 and K_2O gave higher grain yield of cluster bean followed by 60 kg/ha each of P_2O_5 and K_2O and without P +60 kg/ha K_2O as compared to other treatments. Same trend was observed for per cent yield response of different treatments (Table 26).

Micronutrient applications in mateera under arid conditions irrigated under drip

A field experiments were conducted at CIAH research farm with popular mateera cultivars Thar Manak during 2016 in the *kharif* season to investigate the role of application micronutrient nutrient on performance of mateera under drip irrigation. The mateera crop received differential doses of different micronutrient as per schedule of treatments. The seven treatments consisting full recommended NPK, NPK+Zinc Sulphate @ 15 kg/ha at the of planting, NPK+ Iron Sulphate @ 15 kg/ha at the of planting, NPK+ Manganese Sulphate @ 15 kg/ha at the of planting,NPK+ Copper Sulphate @ 15 kg/ha at the of planting, NPK+ Zn, Fe, Mn and Cu Sulphate @ 15 kg/ha each at the of planting and NPK +Zn+Fe Sulphate @ 15 kg/ha each at the of planting were replicated 3 times in a randomized block design.

Micronutrients were applied as per treatments and irrigation was given through drip. Application of Zn, Fe, Mn and Cu Sulphate @ 15 kg/ha each at the time of planting was found superier and gave maximum yield (249 q/ha) followed by Zn+Fe Sulphate @ 15 kg/ha each at the of planting (245 q/ha) and application of Zn Sulphate @ 15 kg/ha each at the of planting as compared to other treatments. Same trend was observed for TSS DM(%), DM yield and av. fruit wt. of different treatments (Table 27).

Table 26. Site specific nutrient management in cluster bean crop.

Treatment	Vegetable cluster bean		Seed cluster bean		Straw yield (q/ha)
	Yield (q/ha)	Yield response (%)	Yield (q/ha)	Yield response (%)	
30 kg/ha each of P_2O_5 and K_2O	27.48	135.9	6.74	50.8	77.12
60 kg/ha each of P_2O_5 and K_2O	41.25	254.1	9.06	102.7	114.45
90 kg/ha each of P_2O_5 and K_2O	43.45	273.0	11.25	151.7	112.45
Without P +60 kg/ha K_2O	35.36	203.5	6.48	45.0	67.48
Without K+60 kg/ha of P_2O_5	39.48	238.9	10.65	138.3	85.46
Without PK (Absolute control)	11.65	--	4.47	--	54.75
Mean	33.11	184.22	8.11	81.39	85.29

Table 27. Micronutrient application in mateera.

	Yield q/ha	TSS (%)	DM (%)	DM yield (q/ha)	Av fruit wt (kg)	No.of fruit/ha
Full recommended NPK through chemical fertilizer	175	6.9	5.7	9.9	1.9	9211
T1 +Zinc Sulphate fertilizer @ 15 kg/ha at the of planting	225	8.3	6.6	14.9	1.9	11842
T1+ Iron Sulphate fertilizer @ 15 kg/ha at the of planting	221	7.2	5.7	12.7	1.7	12775
T1+ Manganese fertilizer @ 15 kg/ha at the of planting	185	6.3	5.9	10.9	1.7	11212
T1+ Copper Sulphate fertilizer @ 15 kg/ha at the of planting	182	7.7	5.5	9.9	1.8	10225
T1+Zn, Fe, Mn and Cu @ 15 kg/ha each at the of planting	249	7.9	6.1	15.2	2.1	11857
T1+Zn+Fe @ 15 kg/ha each at the of planting	245	8.3	6.7	16.4	2.0	12129

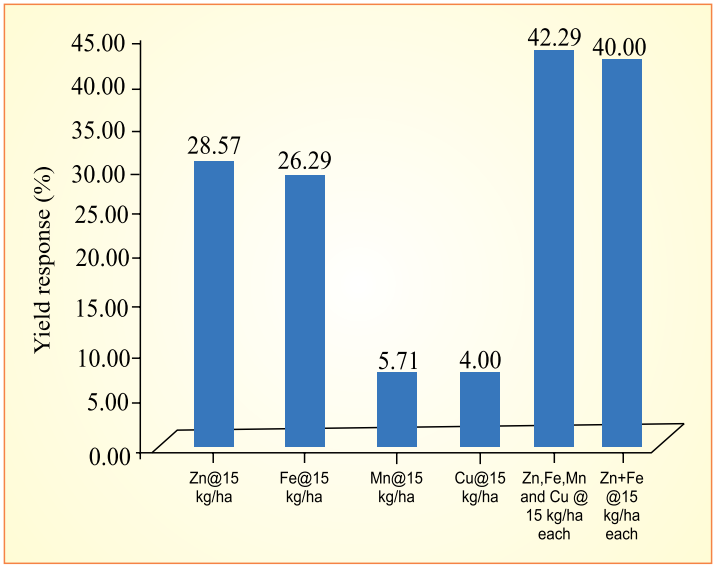


Fig. 21. Yield response % of micronutrient application

The maximum per cent yield response was observed where full recommended NPK through chemical fertilizer Zn, Fe, Mn and Cu @ 15 kg/ha each at the time of planting was applied (42.29%) followed by Zn+Fe @ 15 kg/ha each at the time of planting (40%) as compared to control (Fig. 21). Whereas, Zinc Sulphate fertilizer @ 15 kg/ha at the time of planting gave 28.57% yield response followed by 26.29% when Iron Sulphate fertilizer @ 15 kg/ha at the time of planting was applied.

Effect of boron application on performance of mateera in the arid region

Boron applications have been reported to promote flowering, fruit set and yield in some fruit trees. Boron has a role in pollen germination and growth; however it does not completely explain the increased fruit set and yield. A field experiment was conducted at CIAH research farm with popular mateera cultivars Thar Manak during 2016 in the *kharif* season to investigate the role of

boron application on mateera performance. The mateera crop received differential doses of different micronutrient as per schedule of treatments. The six treatments consisting of control, 50 ppm boron foliar application at 25, 35 and 45 days, 100 ppm boron foliar application at 25, 35 and 45 days, 2 kg/ha Borax soil application at time of planting, 4 kg/ha Borax soil application at time of planting and 6 kg/ha Borax soil application at time of planting. Application of 100 ppm boron foliar application at 25, 35 and 45 gave higher yield (226 q/ha), number of fruit (16143/ha) and average fruit size (1.4 kg) followed by 50 ppm boron foliar application at 25, 35 and 45 days and 6 kg/ha Borax soil application at time of planting as compared to control. Same trend was observed for per cent yield response of different treatments (Fig. 22). 23.5, 33.8, 0.9, 8.8 and 34.1% higher number of fruit/ha was obtained by the application of 50 ppm boron foliar application at 25, 35 and 45 days 100 ppm boron foliar application at 25, 35 and 45 days 6 kg/ha Borax soil application at time of planting, 2 kg/ha Borax soil application at time of planting, 4 kg/ha Borax soil application at time of planting as compared to control (Table 28).

Table 28. Effect of boron application on performance of mateera under drip irrigation.

Treatmants	Yield (q/ha)	TSS (°B)	DM (%)	DM yield (q/ha)	Av. fruit wt. (kg)	No. fruits / ha	No. of fruits more com-pare to control	Vine length (cm)	No. of branch-es	Av. No. of male flowers (5 plant)	Av. No. of female flowers (5 plant)
Control	187	8.33	6	11.22	1.55	12065	-	55.2	2.2	1.6	0
50 ppm boron foliar application at 25, 35 and 45 days	216	9.73	5.2	11.23	1.45	14897	2832	91.6	3.2	4.2	0.8
100 ppm boron foliar application at 25, 35 and 45 days	226	8.65	5.14	11.62	1.4	16143	4078	73	3.2	2.4	0.6
2 kg/ha Borax soil application at time of planting	190	8.74	5.4	10.26	1.56	12179	114	73.8	2.6	2.4	0.2
4 kg/ha Borax soil application at time of planting	210	9.05	5.86	12.31	1.6	13125	1060	69	2.8	2.2	0.2
6 kg/ha Borax soil application at time of planting	218	9.32	5.96	13.02	1.35	16181	4116	97	3.6	6.6	0.6

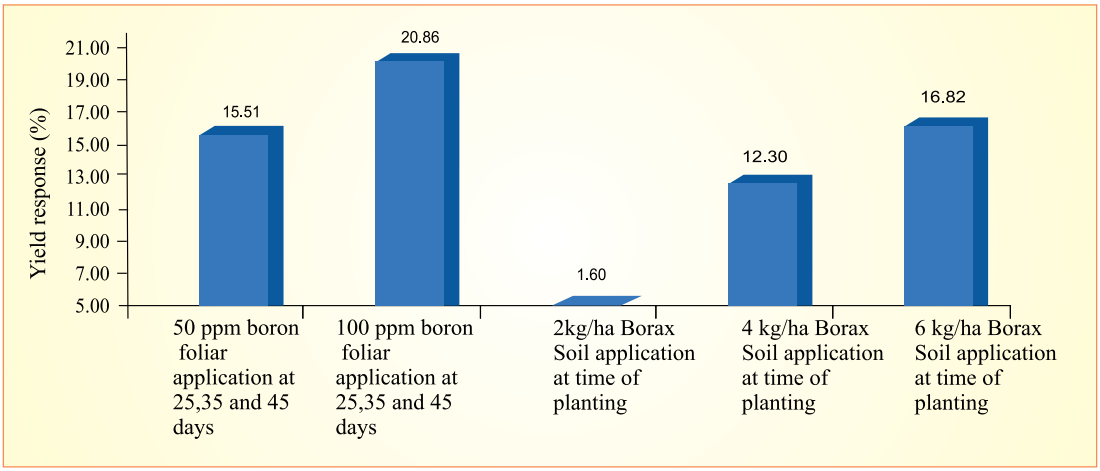


Fig. 22. Yield response of mateera under different levels of micronutrients.

Nitrogen requirement of snap melon under drip irrigation

Rajasthan soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash. This has become a major constraint to production and productivity in the arid region. Thus, there is an urgent need for correction of individual nutrient deficiency and for arresting its further spread. Nitrogen is a first limiting nutrient in arid region, thus has a great influence on crop growth, yield and its quality.

The Rajasthan soils are generally deficient in organic matter, thus unable to release N at a rate required to maintain adequate N supply to the growing plant. Therefore, application of nitrogen in form of fertilizers, manures and biofertilizer becomes indispensable to meet N needs of the crop. ln view of this, the present studies were undertaken to quantification of nitrogen for improving growth and yield of snap melon under fertilized conditions.

An experiment was conducted on nitrogen requirement in snap melon under drip irrigation in hot arid region. The snap melon crop received differential doses of N viz., control, 30 kg N/ha, 60 kg N/ha, 90 kg N/ha, 120 kg N/ha. Effect of graded dose of N application increased the yield of the snap melon. Application of 90 kg N/ha gave highest snap melon yield (219 q/ha) which was 5 q/ha higher as compared to 120 kg N/ha application. These treatments gave 294 and 303 % higher yield as compared to absolute control, respectively. The yield of snap melon obtained with 60 kg N/ha (195 q/ha) was statistically at par with that of 90 kg N/ha (214 q/ha). Per cent increase in yield by the application of 30, 60, 90 and 90 kg N/ha was 122.6, 260.3, 294.1 and 303.2%, respectively.

Nitrogen use efficiency

Nitrogen use efficiency of snap melon was significantly influenced by the graded doses of nitrogen application. Nitrogen use efficiency (kg grains/kg N) showed considerable variation. Nitrogen use efficiency (NUE) was maximum (235.3 kg snap melon /kg N) at 60 kg N/ha application and maximum NUE was observed when, minimum dose of N was applied (Table 29). In general, increasing dose of N decreased the N use efficiency in all the treatments. The snap melon yield obtained in presence of with respect to varying N levels fitted well in quadratic model. For different target yields, N required in presence was calculated. For producing 60 to 200 q/ha target yield snap melon, 1.44 to 65.88 kg N/ha is needed (Table 29 & Fig. 23). The results of this study indicated the beneficial effects of drip irrigation on snap melon yield.

Table 29. Effect of N levels on snap melon yield, yield response and nitrogen use efficiency.

Treatments	Yield (q/ha)	Yield response (%)	NUE (kg/kg N)	Vine length (cm)	No. of vine	Av. No. of male flowers (5 plant)	Av No. of female (5 plant)
N levels (0 kg/ ha)	54	-	-	77	3.8	4.2	0.8
N levels (30 kg/ ha)	121	122.6	221.7	103	4.8	10.8	0.8
N levels (60 kg/ ha)	195	260.3	235.3	111	4.2	6.2	0.6
N levels (90 kg/ ha)	214	294.1	177.3	101	4.6	7	0.2
N levels (120 kg/ ha)	219	303.2	137.1	106	4.4	10.2	0.6
CD at 5%	21.45	-	-				

Quadratic equation	N requirement for different target yield							
$y = -0.014x^2 + 3.115x + 50.55$ $R^2 = 0.989$	60	80	100	120	140	160	180	200
N requirement under drip irrigation for different target yield	1.44	8.15	15.33	23.09	31.60	41.14	52.20	65.88

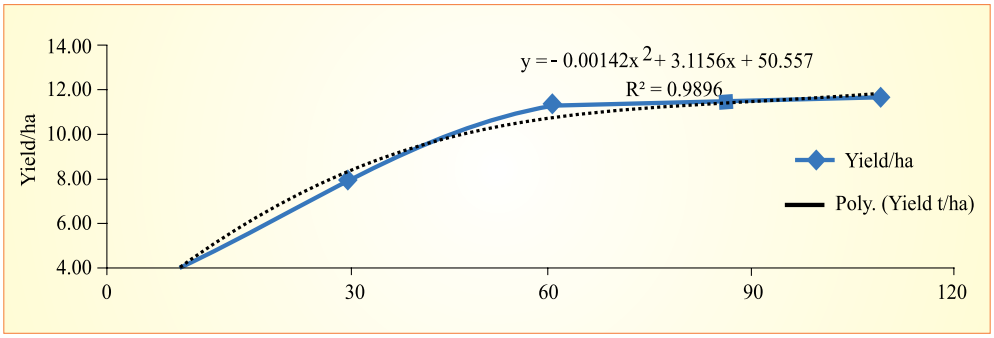


Fig. 23. Yield response under different levels of Nitrogen.

Diagnosis and management of Fe deficiency in Karonda

Micronutrients deficiency was noted in the karonda plants under fruit based cropping models for correction of deficiency which was characterized by symptoms of yellowing on younger leaves, the intervinal areas become chlorotic yellow, the veins remaining green. development of dark spot on leaves at advanced stages, the leaves become nearly white, different sources of nutrient namely Iron, Zinc, Manganese, Copper were applied through soil and foliar application (as given below).

S.No	Name of Chemical/ Treatment	Concentration
1	Iron Sulphate	0.03% spray at 15 days intervals (three spray)
2	Zinc Sulphate,	0.2% spray at 15 days intervals (three spray)
3	Iron Sulphate	20 gm/plant through soil application
4	Zinc Sulphate,	20 gm/plant through soil application
5	Iron Sulphate + Zinc Sulphate	Each 20 gm/plant through soil application
6	FYM	30 kg /plant through soil application
7	Control	

Plant treated with $FeSO_4$ recovered as newly emerged leaves were green in colour while plant treated with others nutrients did not recovered. This confirms the yellowing of younger leaves; chlorotic yellow and inter-venial chlorosis was due to Fe deficiency (Fig. 24).

A B

Fig. 24. (A) Plants in control and (B) Plants given $FeSo_4$ treatment

Citrus canker management

Citrus canker is one of the most feared of *Citrus* diseases, affecting all types of important *Citrus* crops. The disease causes extensive damage to *Citrus* and severity of this infection varies with different species and varieties and the prevailing climatic conditions. Recently canker has been detected in *Citrus* block in the CIAH farm. The diseased plants are characterized by the occurrence of conspicuous raised necrotic lesions that develop on leaves, twigs and fruits. Lesions can be detected by drawing the fingers over the surface of infected tissues. On leaves, first appearance is as oily looking, circular spots, usually on the abaxial surface. Canker causes fruit losses ranging from premature fruit drop due to abscission to non marketable quality due to lesions. Plant treated with Streptocycline 0.03% spray at 15 days intervals (three spray), Copper oxychloride 0.25% spray at 15 days intervals (three spray), Bordeaux mixture 1% spray at 15 days intervals (three spray), Streptocycline (0.03%)

+ Copper oxychloride (0.1%) each spray at 15 days intervals (three spray) and Agrimycin 0.03% spray at 15 days intervals (three spray). Application of Streptocycline (0.03%) + Copper oxychloride (0.1%) spray at 15 days intervals (three spray) was more effective followed by Streptocycline 0.03% spray at 15 days intervals (three spray), Copper oxychloride 0.25% spray at 15 days intervals (three spray), Agrimycin 0.03% spray at 15 days intervals (three spray) and Bordeaux mixture (1%) 1% spray at 15 days intervals (three spray). The disease incidence under different treatment is given in table 30.

Introduction and evaluation of different potato varieties and their agronomic efficiency in North-Western Rajasthan

An experiment was conducted at farmers field to evaluate the different potato cultivars including processing varieties during 2016- 17. Farmers were selected and seeds of seven potato cultivars were distributed to them. Varieties included Kufri Khyati, Kufri Garima, K. Chipsona, K. Pukhraj, K. Frysona, K. Surya and K. Jyoti. Surface soil samples were taken before planting of potato crop for their physico-chemical properties employing standard techniques. Well sprouted potato seed tubers were planted in the 2nd week of November during the years. One third of the N was applied as DAP in side-band along with a uniform dose of 100 kg P_2O_5 through DAP and 150 kg/ ha K_2O through muriate of potash at planting while the remaining N was applied through urea at 40 and 60 days after planting *i.e.* at the time of earthing up. Recommended package of practices were followed for raising the crop, haulms were cut at 100 days and harvesting was done 15 days later.

Table 30. Disease incidence in fruit after different treatments.

S.No	Name of Chemical/Treatment (Concentration)	Disease Incidence fruits (%)
1	Control	78
2	Streptocycline 0.03% spray at 15 days intervals (three spray)	38
3	Copper oxychloride 0.25% spray at 15 days intervals (three spray)	43
4	Bordeaux mixture (1%) 1% spray at 15 days intervals (three spray)	48
5	Streptocycline (0.03%) + Copper oxychloride (0.1%) 0.03% +0.1% each spray at 15 days intervals (three spray)	27
6	Agrimycin 0.03% spray at 15 days intervals (three spray)	41

Table 31. Performance of potato cultivars at Farmers field in different locations at Bikaner district of Rajasthan.

	Kana Ram	Ganesh	Vishnu Pareek	Gehlot	Bega Ram	Ravinder	Mean
K Khyati	119.0	207.3	260.1	233.3	215.8	380.4	236.0
K Garima	162.8	330.1	258.0	277.8	226.1	430.3	280.9
K Chipsona	153.1	281.0	241.7	350.0	197.2	601.3	304.0
K Pukhraj	174.7	205.6	144.4	121.2	234.6	261.1	190.3
K Frysona	337.3	368.4	281.3	333.3	219.8	485.8	337.7
K Surya	330.8	262.0	161.7	221.4	217.5	351.1	257.4
K Jyoti	129.3	139.4	286.6	142.0	201.5	319.8	203.1
Mean	201.0	256.3	233.4	239.9	216.1	404.3	258.5

Tuber yield varied significantly from variety to variety at different locations of Bikaner district. Maximum mean tuber yield, which was significantly higher over other varieties, was obtained from Kufri Frysona (337 q/ ha) followed by Kufri Chipsona (304 q/ ha) and Kufri Garima (280 q/ha/ ha) while minimum yield was observed in Kufri Pukhraj (190 q/ha) and Kufri Jyoti (203 q/ ha). While, K. Khyati and K. Surya gave 236 and 257 q/ha potato yield, respectively (Table 31).

Performance of potato cultivars at Experimental farm of ICAR-CIAH, Bikaner under sprinkler irrigation

Cultivation of potato under sprinkler irrigation system, revealed that tuber yield varied from variety to variety (Fig. 25 and 26) under sprinkler irrigation. Kufri Chipsona (535 q/ ha) gave maximum mean tuber yield, which was higher over other varieties followed by Kufri Jyoti (480465 q/ ha) and Kufri Garima (431 q/ha/ ha) while minimum yield was observed in Kufri Pukhraj (339 q/ha) and Kufri Khyati (388 t/ ha). While, K Jyoti and K Surya gave 465 and 399 q/ha potato yield.

Performance of potato cultivars at Experimental farm of ICAR-CIAH, Bikaner under drip irrigation.

Drip irrigation is an irrigation method that applies water slowly to the roots of plants, by depositing the water either on the soil surface or directly to the root zone, through a network of valves, pipes, tubing, and emitters. It is highly used in the sandy soils where water holding capacity is low. The advantages of drip irrigation are, sophisticated technology, maximum production per mega litre of water, increased crop yields and profits, improved quality of production, less fertilizer and weed control costs, environmentally responsible, with reduced leaching and run-off, labour saving, application of small amounts of water more frequent. Therefore, an experiment was conducted on potato cultivation in drip irrigation. Maximum yield was obtained from Kufri Frysona 435 q/ ha) followed by Kufri Chipsona (428 q/ ha) and Kufri Jyoti (345 q/ ha/ ha) while minimum yield was observed in Kufri Pukhraj (203 q/ha) and Kufri Garima (324 q/ ha). While K Khyati and K Surya gave 333 and 341 q/ ha potato yield. Similarly, maximum yield was

Fig. 25. Potato cultivation under sprinkler irrigation

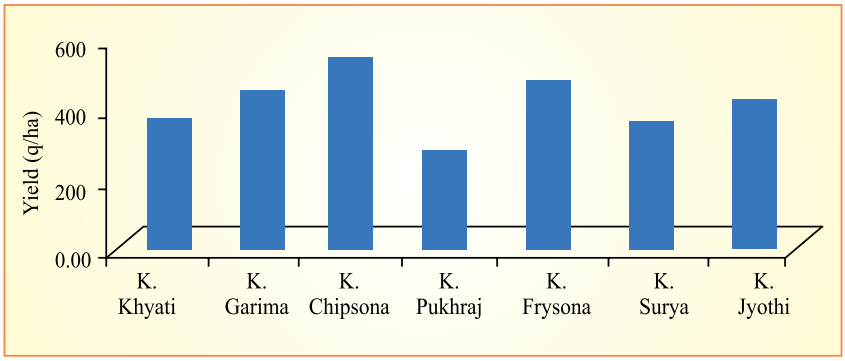


Fig. 26. Yield of potato under sprinkler irrigation (q/ha)

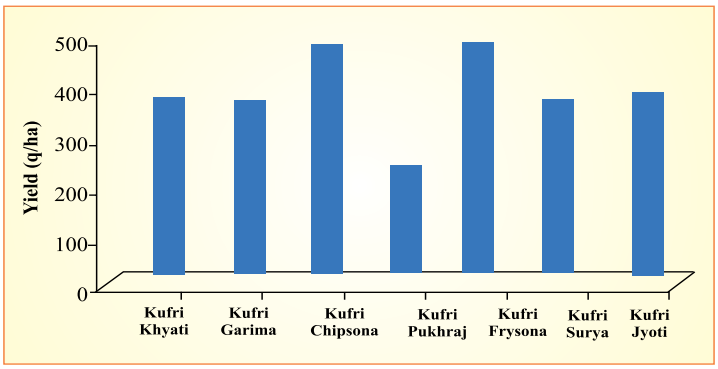


Fig. 27. Yield under drip irrigation

obtained from K. Frysona 435 q/ ha) followed by Kufri Chipsona (428 q/ ha) and Kufri Jyoti (345 q/ ha/ ha), while minimum yield was observed in Kufri Pukhraj (203 q/ha) and Kufri Garima (324 q/ ha) under drip irrigation (Fig. 27).

Nitrogen requirement of radish under drip irrigation

An experiment was conducted on nitrogen requirement in radish under drip irrigation in the rabi season. The radish crop received differential doses of N *viz.,* control, 40, 80, 120, 160 kg N/ha. Effect of graded dose of N application increased the yield of the radish. Application of 80 kg N/ha gave highest radish yield (187 q/ha) which was 122 q/ha higher as compared to without N application. This treatment gave 86 % higher yield as compared to absolute control. The radish yield obtained with 120 kg N/ha (193 q/ha) was statistically at par with that of 160kg N/ha (195 q/ha). Similarly, yield under 120 kg N/ha was statistically at par with that of 80 kg N/ ha. Per cent increase in yield by the application of 40, 80, 120 and 160 kg N/ha was 123, 186, and 194 %, respectively and maximum increase in radish yield was at 80 kg N/ha application.

Agronomic efficiency

Agronomic efficiency of radish was influenced by the graded doses of nitrogen application. Agronomic efficiency (q radish/kg N) showed considerable variation. Agronomic efficiency (AE) was maximum (1.53 q radish /kg N) under 80 kg N/ ha) and maximum Agronomic efficiency (AE) was observed when minimum dose of N was applied. In general, increasing dose of N decreased the agronomic efficiency (AE) in all the treatments. Whereas, per cent decrease in Agronomic efficiency (AE) was more when high dose of N was applied (Table 32, Fig. 28).

Rhizobium seed treatment of vegetable pea for reducing the requirement of nitrogen under drip irrigation

An experiment was conducted on contribution of *Rhizobium* biofertilizer in reducing the

Table 32. Performance of radish under drip irrigation with different levels of N.

N Level (kg/h)	Av. Wt of shoot (g)	Av. Wt of root (g)	Av. Root Length (cm)	Av. Shoot length (cm)	Root Diameter (cm)	No. of rootlets	Yield (q/ha)
0	70	150	23.4	28	7.4	19	65
40	148	146	26.7	30	9.1	30	124
80	108	180	30.0	31.5	10.0	24	187
120	136	200	32.1	32.2	10.6	30	193
160	158	172	32.5	34.7	10.9	28	195
CD at 5%	18.25	25.47	5.26	4.12	1.6	6.35	27.86

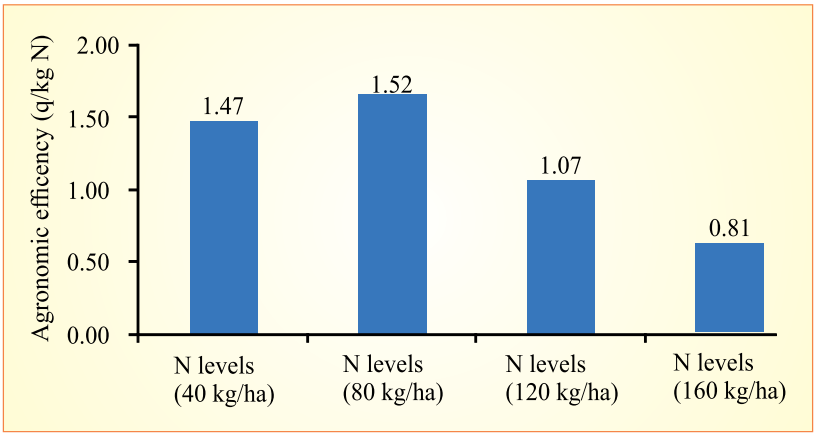


Fig. 28. Agronomic efficency (q/kg N) of radish under drip irrigation with different levels of N

requirement of nitrogen fertilizer in vegetable pea. The vegetable pea crop received differential doses of N with and without *Rhizobium viz.*, control, 20 kg N/ha, 40 kg N/ha, 60 kg N/ha, 80 kg N/ha, *Rhizobium* biofertilizer, *Rhizobium* biofertilizer +20 kg N/ha, *Rhizobium* biofertilizer +40 kg N/ha, *Rhizobium* biofertilizer +60 kg N/ha and *Rhizobium* biofertilizer +80 kg N/ha. Seed inoculation of vegetable pea with *Rhizobium* biofertilizer +60 kg N/ha gave higher yield of vegetable pea followed by *Rhizobium* biofertilizer +80 kg N/ha as compared to other treatment combinations. Saving of N requirement by the seed inoculation of *Rhizobium* between 15-25 kg/ha N was expected. Effect of graded dose of N application increased the yield of vegetable pea with or without inoculation of *Rhizobium*. Application of 60 kg N/ha along with *Rhizobium seed* inoculation gave highest vegetable pea yield (1505 g/plant) under drip. This treatment gave higher yield as compared treatments (Table 33).

Table 33. Performance of vegetable pea with and without *Rhizobium* seed treatment under drip irrigation.

N Levels (kg/ha)	With Rhizobium seed inoculation					
	Pod length (cm)	Pod width (cm)	NSP	No. of pods/ plant	Av pod weight of 10 pods (g)	Pod yield/plant (g)
0	8.5	3.3	8.8	14.8	53.3	788
20	9.1	3.8	8.4	16.4	60.4	992
40	9.5	3.7	8.6	17.3	54.8	949
60	9.7	3.8	8.0	24.7	60.9	1505
80	9.5	3.9	9.0	25.5	58.5	1305
Without Rhizobium seed inoculation						
	Pod length (cm)	Pod width (cm)	NSP	No. of pods/ plant	Av pod weight of 10 pods (g)	Pod yield/plant (g)
0	7.8	3.1	8.3	11.1	42.1	567
20	8.4	3.3	7.9	12.3	47.7	715
40	8.7	3.3	8.1	13.0	43.3	683
60	9.1	3.5	7.5	18.5	48.1	1084
80	9.1	3.7	8.5	19.8	47.3	1284

At Godhra

Nutrient management in chironji, custard apple, jamun and tamarind

A leaf sampling survey in custard apple was carried out in August 2016 in Poyali, Hathnimatha, Nathpura, Bakrol, Saraswa, Labdodhar Zingerri and Vejalpur villages in Panchamahals district of Gujarat, Bhabhor, Kothi and Vadli villages (Pavijepur Tk) in Chotaudaipur district and Baina village (Devagad bariya-TK) in Dahod district of Gujarat. Samples were washed, dried, powdered and preserved for nutrient analysis for establishing nutrient norms like DRIS and CND norms for diagnosing nutrient needs of custard apple. Nutrient analysis is in progress. The survey results of Baina village (Devagad bariya_TK) in Dahod district of Gujarat revealed that in Custard Apple Phosphorous content of samples (32 No) collected varied from 1105 ppm to 2102 ppm with an average value of 1617 ppm and with a standard deviation of 261.08 ppm (Coefficient variation of 16.14) Potassium content of samples (32 No) collected varied from 4920 ppm to 16220 ppm with an average value of 7775 ppm and with a standard deviation of 2630.62 ppm (Coefficient variation of 33.83). Calcium content of samples (32 No) collected varied from 1.443% to 3.126% with an average value of 2.124 % and with a standard deviation of 0.375% (Coefficient variation of 17.65). In custard apple, monthly analysis of leaf samples near Horti-Silvi-Pastoral System drastic differences were observed in nutrient contents from August to January. Phosphorous content of leaves was 1650 ppm in August and reduced to 900 ppm in January month. Potassium content of leaves was 7060 ppm in August and reduced to 3840 ppm in January month. Calcium content of leaves was 1.92 % in August and increased to 4.4 % in January month. Magnesium content of leaves was 1.02% in August and increased to 3.16 ppm in January month. Sulphur content of leaves was 1647 ppm in August and reduced to 3840 ppm in January month. The nitrogen content variation in different months of the year in custard apple collected from same orchard of custard apple revealed that the highest nitrogen content was observed in October month (7.60%) and reduced to 3.4% in November, 3.36% in December and 2.96 % in February in green leaves and reduced to 2.74% in yellow leaves of February month. In the same orchard, from new flesh of leaves obtained in Februry 2017 4.54% nitrogen was obtained.

CROP PHYSIOLOGY AND BIOTECHNOLOGY

Development of phytochemical markers for arid horticultural crops

Wood apple

A total of 11 germplasm lines of wood apple were collected from Central Horticultural Experiment Station, Vejalpur (Godhra). Young leaves from different genotypes of wood apple were collected separately and immediately fixed in ethyl alcohol for 24 hrs. Total genomic DNA was extracted from 100mg of leaf from each sample discretely by using the DNeasy® Plant Mini kit (QIAGEN, India Pvt. Ltd.) following with some modification. The lysis was achieved by the addition of 400 µl warm (65 ^{0}C) lysis solution modified by the addition of 10mg/ml PVP (polyvinyl polypyrrolidone), 10mg/ml SDS (Sodium Lauryl Sulphate) and 4 µl of Proteinase K stock solution (100mg/ml) prior to grinding. After grinding the samples were collected into the 1.5 ml eppendorf tube separately. The samples were centrifuged for 30s at low speed (4000g) and 4µl RNase. A stock solution (100mg/ml) was added to each tube, followed by mixing until no tissue clumps were visible. Rest of the protocol followed as per standard procedure. To remove RNA, genomic DNA was treated with RNase and stored at -20 ^{0}C. The quality of DNA was checked by electrophoresis in 0.8 % agarose gel.

PCR conditions and DNA amplifications

Kit RPID comprising of 25 decamer random primers were screened out for the present investigation. To optimize the PCR amplification conditions, experiments were carried out with varying concentrations of DNA template, primers, Taq polymerase, as well as dNTPs. To determine the optimum amplification conditions and also to ensure the reproducibility of the results, the reaction conditions were standardized using a study and tested at least twice. This study was carried out with two primers (RPID 05 and RPID -06) using a range of DNA concentrations

(1, 1.5, 2 and 2.5 µl from the diluted DNA Stock of 200ng/µl) and three different cycles (35, 40 and 45 cycles). All the PCR reactions were carried out in 25 µl varying concentrations of template DNA, 1x TopTaq PCR buffer, 1x Q-Solution, 200 µM of each dNTP, 1.25 U TopTaq DNA polymerase, 10 pmol of primer (Qiagen, India Pvt. Ltd.) and the reaction programmes were set at 94 ^{0}C for 3 min followed by 40 cycles of 94 ^{0}C for 30 Sec, 36 ^{0}C for 1 min and 1 min elongation at 72 ^{0}C, and a final extension at 72 ^{0}C for 7 min in a thermal cycler Genemate Series (Analytica Biotech, USA). After completion of the amplification, 2.5 µl CoralLoad dye was added to the samples, and the amplified DNA was analyzed on 1.2% agarose gel pre-stained with ethidium bromide in 1X TAE buffer at 65 - 90 V for 2.5 h. along with O "GeneRuler 100 bp DNA ladder Plus (Thermo Scientific, India Pvt. Ltd.). The gels were observed on the gel documentation system (Gene Genius Bioimaging System) and photographed.

RAPD data analysis

All the amplified bands were counted manually along with their size. Computer analysis of RAPD patterns were performed as described by Halmschlager *et al.* (1994) in which the band pattern obtained from agarose gel electrophoresis was digitalized by hand to a two-discrete-character-matrix (0 and 1 for absence and presence of RAPD-bands, respectively). The data of all primers were combined. The analysis data was based on the Nei and Lee coefficient (Nei and Lee, 1979). Dendrograms were constructed by the unweighted paired group method of arithmetic average (UPGMA) based on Jaccard's similarity coefficient by using NTSYSpc-2.02e version 2.0.1.5 software (Applied biostatistics, Inc).

Optimization of the concentration of DNA for PCR reaction set-up

Genomic DNA was successfully extracted from ethanol dried young leaf of wood apple (*Madhuca longifolia*), using a modifications from the commercial the DNeasy® Plant Mini kit procedure. The approximate DNA concentration in the extracts was 1000 ng/µl. The original concentration of the DNA extracts was too high for reliable amplification, showing poor amplification with faint, smeared products. The optimal DNA concentration for amplification of *Madhuca longifolia* DNA was found to be 4.0 µl of 1:3 dilution (approximately 200 ng), whilst the optimum annealing temperature was 36 ^{0}C and the optimum No. of PCR cycles was 40**.**

Polymorphism and Marker Efficiency

The fragment amplified was in the range of 300 to 4500bp while the smallest but easily recognizable fragment was approximately of 300 bp. Most bands were concentrated between 500 to 2500 bp. The number of bands scored for each primer varied from 2 to 16. The highest number of bands (16) was generated with primers RPID-24 & RPID-25, while the lowest number (2) was obtained with primers RPID-2 and RPID-13. The 22 primers yielded a total of 192 fragments, of which 139 amplicons (72.40%) were polymorphic, the number of polymorphic bands per primer ranged from 1 to 15 (Table 34, Fig. 29). It was observed that the scored 53 RAPD-PCR fragments were monomorphic (27.61%) The primer RPID-24 and RPID-25 were highly polymorphic primer as 93.75% of bands were polymorphic. Similarly, 15 more primers were also informative primers as 60% or more of the amplicons were polymorphic. The results of the RAPD-PCR analysis indicated that some polymorphic RAPD bands are present were found to be shared among more than one genotype.

Genetic relationships among accessions and cluster analysis

Cluster analysis based on similarity values (Table 35) classified genotypes into two distinct clusters (I & II, Fig. 29). The first cluster (I) included nine genotypes, whereas the second cluster (II) included only one genotype *viz.,* CHESW-10 (Fig. 30). The cluster I was further divided into two sub-clusters labeled (I-A, I-B). The sub-cluster I-B has only two genotypes *viz.,* CHESW1 and CHESW-2 whereas the all other genotypes falls in IB.

Table 34. List of primers and degree description of the polymorphism obtained among 10 mahua genotypes.

S. No	Name of Primer	Size of Bands	No. of Total Band	No. of Polymorphic bands	No. of monomorphic bands	Polymorphic Pecentage	PIC
1	RPID-1	360-4500	13	8	5	61.54	0.270
2	RPID-2	400-700	2	1	1	50.00	0.087
3	RPID-3	400-2000	8	3	5	37.50	0.425
4	RPID-4	600-1500	5	4	1	80.00	0.492
5	RPID-5	300-2500	13	10	3	76.92	0.426
6	RPID-6	400-2500	10	4	6	40.00	0.397
7	RPID-7	400-1800	8	4	4	50.00	0.252
8	RPID-9	500-1400	8	5	3	62.50	0.407
9	RPID-10	300-2500	9	6	3	66.67	0.451
10	RPID-11	300-1800	8	5	3	62.50	0.425
11	RPID-12	500-3500	8	8	0	100.00	0.312
12	RPID-13	600-1100	2	1	1	50.00	0.298
13	RPID-15	600-2500	8	5	3	62.50	0.351
14	RPID-16	550-2500	11	9	2	81.82	0.364
15	RPID-17	600-2000	7	3	4	42.86	0.372
16	RPID-18	400-2400	8	8	0	100.00	0.494
17	RPID-19	550-2500	7	5	2	71.43	0.419
18	RPID-20	550-1900	8	8	0	100.00	0.449
19	RPID-21	1000-2900	6	3	3	50.00	0.382
20	RPID-23	250-2100	11	9	2	81.82	0.475
21	RPID-24	400-3100	16	15	1	93.75	0.485
22	RPID-25	300-3000	16	15	1	93.75	0.500
	Total		**192**	**139**	**53**		

Table 35. Dice Jaccard's similarity co-efficient matrix of 10 different genotypes of mahua.

Genotypes	CHESW1	CHESW2	CHESW3	CHESW4	CHESW6	CHESW8	CHESW9	CHESW-10	CHESW11	CHESW12	CHESW13
CHESW1	1.000										
CHESW2	0.735	1.000									
CHESW3	0.737	0.617	1.000								
CHESW4	0.709	0.583	0.819	1.000							
CHESW6	0.747	0.618	0.837	0.876	1.000						
CHESW8	0.732	0.593	0.767	0.784	0.777	1.000					
CHESW9	0.631	0.540	0.776	0.825	0.819	0.707	1.000				
CHES-10	0.633	0.534	0.604	0.591	0.616	0.700	0.518	1.000			
CHESW11	0.611	0.577	0.693	0.772	0.755	0.644	0.692	0.584	1.000		
CHESW12	0.687	0.585	0.805	0.915	0.884	0.770	0.800	0.613	0.791	1.000	
CHESW13	0.574	0.526	0.638	0.685	0.648	0.617	0.574	0.554	0.744	0.706	1.000

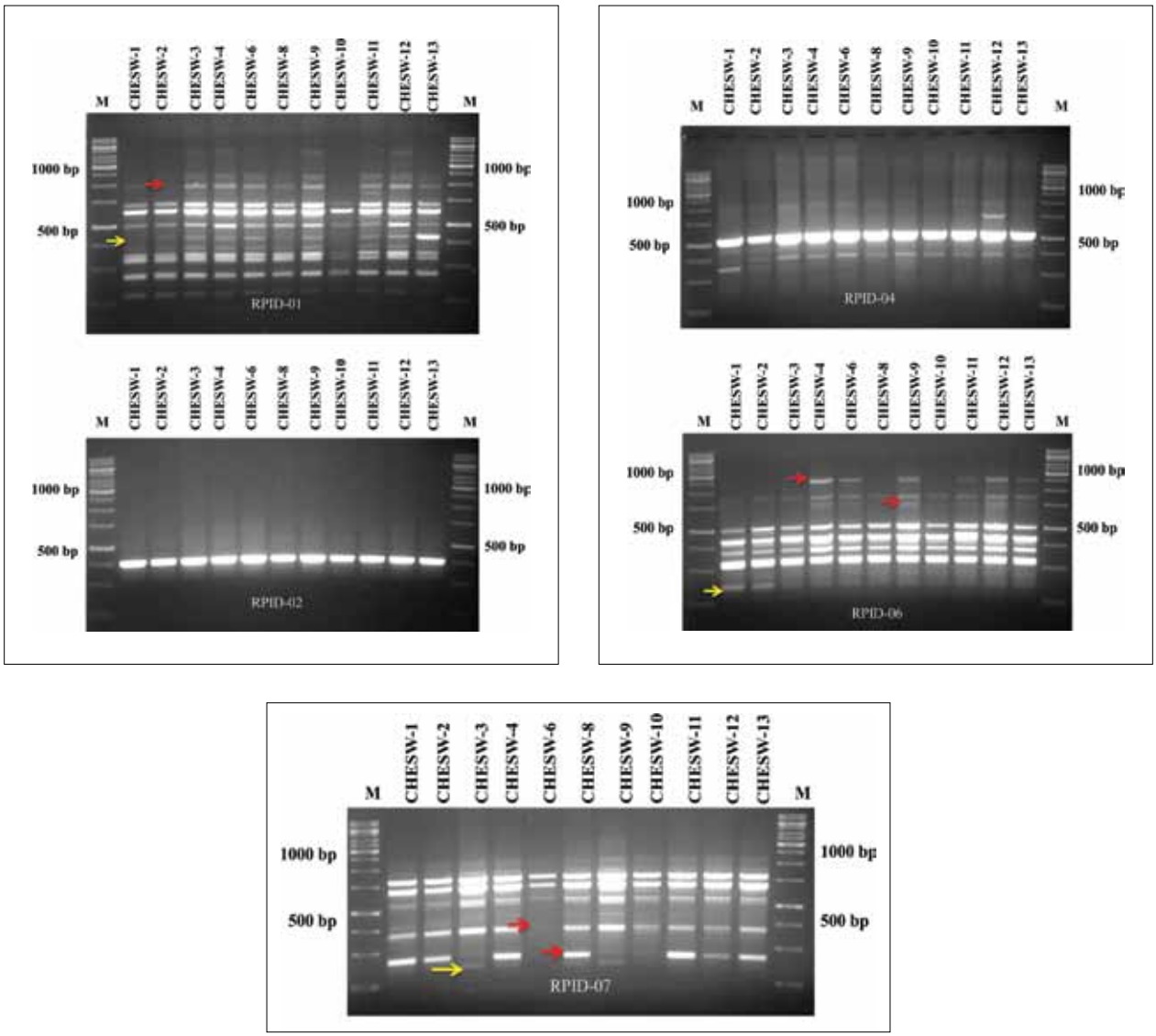


Fig. 29. RAPD profiles of wood apple genotypes developed under different primers.

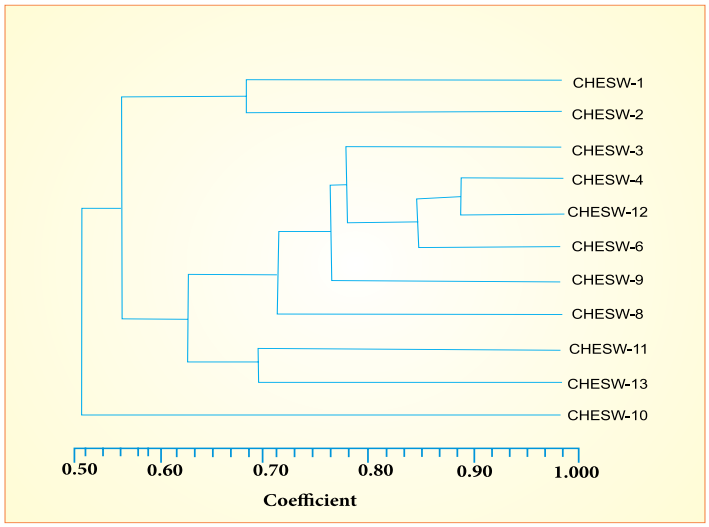


Fig. 30. Phylogenetic tree of 11 wood apple germplasm derived from UPGMA cluster analysis of RAPD markers.

BIOTECHNOLOGY

At Bikaner

Standardisation and commercialization of micropropagation techniques of horticultural crops under hot arid agro-eco system: Date palm cvs. Halawy and Khalas

Maintenance of somatic embryo cultures

The growing cultures of date palm cv. Halawy and Khalas of different stages such as callus, embryogenic callus and germinated somatic embryos were periodically sub-cultured on different media compositions. The elongated shoots were transferred in rooting media with low concentration of NAA. After 2-3 subculturing on the same media, the microshoots were subcultured on higher concentration of NAA for better root formation. Several aspects such as period of subculturing, light intensity, temperature of culture room and media composition were studied on callus proliferation and somatic embryo formation. Cell suspension culture was also initiated for callus and embryo multiplication. The secondary hardening of the plants is continuing in green house under 30± 2°C temperature, 60-70 % RH and 10000-15000 lux light intensity. The plants have attained 25-35 cm height. The hardening temperature was gradually increased upto 35 °C. Several potting mixtures of sand, clay and sheep manure were tried for better growth and development of plants (Fig. 31).

Evaluation of tissue cultured cactus pear

Morphological observation on growth and development of tissue culture plants of cactus pear recorded under greenhouse and open environment conditions. Under open condition the plants were severely damaged by wild animals and squirrels. Further, the plants showed slow growth of leaf pad (cladodes) whereas the plants under greenhouse remains safe and yield & quality of leaf pads was better than open condition. Under greenhouse leaf pads can be harvested regularly at 15-20 days intervals with an average yield of 1.5 kg tender cladodes.

Identified 02 promising genotypes, one for multipurpose i.e. for fruit, cladode and fodder and another for prolific fruit bearing.

Opportunities of several economic products such as fruit, squash of fruit, colour from fruit and cochineal, cladodes for culinary and salad were explored and demonstrated to several beneficiaries.

Fig. 31. Shoot elongation and secondary hardening of tissue culture plants of date palm

CROP PROTECTION

At Bikaner

Disease management

Studies on effect of environmental factors on mosaic disease in ridge gourd

Four variety/germplasm (Thar Karni, AHRG-28, AHRG-57 and Bikaner Local) of ridge gourd were sown on 25th July, 2016 in the field at Pathology Block of the Institute. Studies on effect of environmental factors on mosaic disease were carried out to know the favourable climatic conditions for the development of the disease. During 2016, the initiation of mosaic disease first appeared on 23rd August, 2016 in ridge gourd germplasm and weekly observations were taken on mosaic disease and per cent disease index (PDI) was calculated. Weekly meteorological data like average maximum temperature, minimum temperature, maximum RH, minimum RH, rainfall, number of rainy days, wind velocity, evaporation and bright sun shine hours (BSSH) per day were taken from observatory of ARS, SKRAU, Bikaner. It was found in above 04 variety/germplasm that range of minimum PDI (2.22-6.67%) of mosaic disease was recorded at average maximum temperature (34.4 ^{0}C), minimum temperature (26.2 ^{0}C), av. maximum RH (86.0%) and minimum RH (61.6%), av. rainfall (16.0 mm) and bright sun shine hours (6.2) on 34th standard week while range of maximum PDI (12.44-26.64%) was found at average maximum temperature (36.3 ^{0}C), minimum temperature (23.50 ^{0}C), av. maximum RH (84.7%) and minimum RH (47.9-61.6%), rainfall (24.2 mm) and BSSH (6.6) on 40th standard week of the year (Table 36).

Evaluation of different varieties/genotypes of watermelon for resistance against mosaic disease under field conditions

Fifteen watermelon varieties/genotypes such as Durgapura Lal, Asahi Yamato, AHW/BR-1, AHW/BR-5, AHW/BR-7, AHW/BR-8, AHW/BR-11, AHW/BR-13, AHW/BR-14, AHW/BR-16, AHW/BR-17, AHW/BR-25 AHW/BR-28, AHW/BR-30 and AHW/BR-31 were evaluated for resistance against Mosaic disease under field conditions during summer season of 2016. Per cent disease index (PDI) of mosaic disease was from 4.67 to 31.33% in different genotypes/varieties of this crop. Among them, none was found immune. Only one variety 'Asahi Yamato' was found tolerant against mosaic disease with PDI (4.67%), 06 genotypes were categorized as moderately resistant and 03 as moderately susceptible, while remaining 05 genotypes were susceptible under field conditions.

Table 36. Effect of environmental factors on development of mosaic disease in ridge gourd.

Standard week	Max. temp. (^{0}C)	Min. temp. (^{0}C)	Max. RH (%)	Min. RH (%)	Total rain-fall (mm)	No. of rainy days	Wind velocity (km/h)	Evap-oration	BSSH	Range of PDI
34	34.4	26.2	86	61.6	16	1	5.2	6.1	6.2	2.22-6.67
35	34.4	25.1	88.1	65	39.2	3	4.2	6.6	6.3	5.33-9.33
36	34.8	24.5	79.4	51.9	0.0	0	9.9	9.4	10.0	7.56-13,33
37	37.3	24.3	75.3	42	0.0	0	6.9	9.1	10.2	8.44-16.44
38	40.8	24.7	72.1	29.3	0.0	0	5	10.7	10.3	9.78-18.22
39	39.4	23.7	71.9	32.6	0.0	0	5.5	10.2	10.0	10.67-22.22
40	36.3	23.5	84.7	47.9	24.2	1	3.7	7.2	6.6	12.44-26.64
41	37.1	21.2	69.3	41.7	4.2	1	6.6	7.8	9.8	11.56-23.07
42	36.3	19.7	69	26.1	0.0	0	6.1	7.2	9.9	8.89-17.78
43	35.3	19.3	68	26.4	0.0	0	6.7	6.8	9.8	6.67-12.89

Screening of muskmelon genotypes for resistance against wilt disease under field conditions

Fifteen muskmelon genotypes (AHMM/BR-1, AHMM/BR-38, AHMM/BR-41, AHMM/BR-42, AHMM/BR-44, AHMM/BR-46, AHMM/BR-47, AHMM/BR-51, AHMM/BR-53, AHMM/BR-54, MHY-3, RM-43, RM-50, AHMM/BR-48 and AHMM/BR-49) were evaluated for resistance against *Fusarium* wilt under field conditions during summer season of 2016. Wilt disease appeared and per cent disease index (PDI) was found from 3.33 to 30.67% in different genotypes of muskmelon. Among them, none was found immune. Only 03 genotypes like AHMM/BR-42, AHMM/BR-41 and AHMM/BR-51 were found resistant against *Fusarium* wilt disease, 08 genotypes (AHMM/BR-44, AHMM/BR-53 AHMM/BR-47, AHMM/BR-46, MHY-3, AHMM/BR-1, AHMM/BR-49 and AHMM/BR-38) were categorized as moderately resistant and remaining 04 genotypes such as AHMM/BR-48, RM-43, RM-50 and AHMM/BR-54 were found moderately susceptible (Table 37).

PEST MANAGEMENT

At Bikaner

Survey of insect-pests, their natural enemies and pest management strategies for cucurbits in arid region of Rajasthan.

The periodical observation on major insect-pests of arid fruits and vegetables was carried out at fortnightly intervals. The screening of ber genotypes was done against fruit fly resistance.

Twenty five varieties/ genotypes of ber were selected for final evaluation trials against fruit fly resistance during 2016-17 at CIAH Farm. The varieties/ genotypes, Katha, Illaichi and Tikadi were resistant; BS-75-1, Safeda, Dandan, Gola, Goma Kirti, Jogia, Narma, Reshmi, Mundia, Seb ZG-3, Akharota and Umran were moderately resistant; Banarasi Karaka, Banarasi Pawandi, Chhuhara, Kaithli, Thar Bhubraj and Thar Sevika were susceptible, whereas Sanur-3, Sanur-4 and Sanur-5 were the susceptible varieties/ genotypes of ber. The per cent fruit infestation was highest in Sanur-3 (82.17 %) and lowest in Tikadi (10.87 %) followed by Katha (13.07). The flavonoid, tannins and phenols contents had significant negative

Table 37. Screening of muskmelon genotypes for resistance against wilt disease under field conditions.

S. No.	Name of genotypes	PDI	Disease Reaction
1.	AHMM/BR-1	19.33* (25.99)	Moderately Resistant
2.	AHMM/BR-38	22.67 (28.33)	Moderately Resistant
3.	AHMM/BR-41	7.33 (15.67)	Resistant
4.	AHMM/BR-42	3.33 (10.41)	Resistant
5.	AHMM/BR-44	14.67 (22.31)	Moderately Resistant
6.	AHMM/BR-46	19.33 (30.49)	Moderately Resistant
7.	AHMM/BR-47	16.67 (23.84)	Moderately Resistant
8.	AHMM/BR-51	9.33 (17.75)	Resistant
9.	AHMM/BR-53	16.00 (23.36)	Moderately Resistant
10.	AHMM/BR-54	30.67 (33.61)	Moderately Susceptible
11.	MHY-3	18.67 (25.56)	Moderately Resistant
12.	RM-43	25.33 (30.13)	Moderately Susceptible
13.	RM-50	29.33 (32.79)	Moderately Susceptible
14.	AHMM/BR-48	28.0 (31.93)	Moderately Susceptible
15.	AHMM/BR-49	20.0 (26.39)	Moderately Resistant
CD (0.05) = 5.13	CV = 12.14		

* Values in parenthesis are angular transformed value

correlation with the percent fruit infestation. The length of fruit, width of fruit and pulp: stone ratios were significantly high in susceptible and low in resistant varieties/ genotypes. However, the pericarp thickness was significantly low in susceptible and high in resistant varieties/ genotypes. The pericarp thickness had significant negative correlations whereas fruit length, fruit width and pulp: stone ratio had significant positive correlations with the percentage fruit infestation in ber (Table 38 and 39).

Development of IPM modules against ber fruit fly: A significant difference in fruit fly population

Table 38. Per cent fruit infestation of fruit fly on different varieties/ genotypes of ber during 2016-17.

S. No.	Varieties/ genotypes	Per cent fruit infestation	Resistance category
1	BS-75-1	30.13 (33.23)	MR
2	Safeda	23.00 (28.64)	MR
3	Banarasi Karaka	61.47 (51.62)	S
4	Banarasi Pawandi	62.30 (52.13)	S
5	Chhuhara	63.30 (52.70)	S
6	Dandan	34.60 (36.00)	MR
7	Gola	34.90 (36.18)	MR
8	Goma Kirti	26.37 (30.86)	MR
9	Illaichi	15.23 (22.96)	R
10	Jogia	42.83 (40.86)	MR
11	Kaithli	56.57 (48.76)	S
12	Narma	38.23 (38.14)	MR
13	Mundia	46.93 (43.22)	MR
14	Reshmi	49.53 (44.71)	MR
15	Sanur-5	79.13 (62.83)	HS
16	Seb	24.03 (29.34)	MR
17	Tikadi	10.87 (19.21)	R
18	Umran	25.50 (30.27)	MR
19	ZG-3	33.40 (35.28)	MR
20	Katha	13.07 (21.17)	R
21	Akharota	28.83 (32.44)	MR
22	Sanur-3	82.17 (65.06)	HS
23	Sanur-4	81.63 (64.64)	HS
24	Thar Sevika	62.23 (52.07)	S
25	Thar Bhubraj	70.40 (57.04)	S
SEm±		1.31	
LSD (P = 0.05)		3.74	

*Values in parenthesis are angular-transformed, R- resistant, MR- moderately resistant S- susceptible and HS- Highly susceptible

Table 39. Correlation coefficient (r) between per cent infestation of fruit borer with different allelochemicals and antixenotic fruit traits of ber varieties/ genotypes.

	Percent fruit borer	Phenols content (mg/100g)	Tannins content (mg/100g)	Flavonoid content (mg/100g)*	Fruit length (mm)	Fruit width (mm)	Pericarp thickness (mm)
Phenols content (mg/100g)	-0.947**						
Tannins content (mg/100g)	-0.915**	0.907**					
Flavonoid content (mg/100g)*	-0.914**	0.883**	0.955**				
Fruit length (mm)	0.422*	-0.249^{NS}	-0.410*	-0.422*			
Fruit width (mm)	0.128^{NS}	-0.072^{NS}	-0.141^{NS}	-0.113^{NS}	0.595**		
Pericarp thickness (mm)	-0.853**	0.853**	0.888**	0.915**	-0.244^{NS}	0.038^{NS}	
Pulp: stone ratio	0.471*	-0.435*	-0.596**	-0.630**	0.437*	0.391^{NS}	-0.482*

**Significant at P = 0.01 (two-tailed) * Significant at P = 0.05 (two-tailed)

was observed under different modules. The results showed that IPM module-III registered significantly lower fruit fly population (10.90 %) followed by module-II (21.38 %). The highest fruit fly population was observed under control module (57.95 %) (Table 40 & Fig. 32). The marketable yield of ber fruits differed significantly under different modules during the year 2016-17. The fresh fruit yield of ber was observed in the order of organic module-III (84.28 kg/ plant)> module-II (78.08 kg/ plant)> module-I (73.93 kg/ plant)> module-IV (64.55 kg/ plant) and least under control module (54.08 kg/ plant) in year 2016-17. It can be inferred from the results that IPM module-III was highly effective and gave higher yield of marketable ber fruits.

Efficacy of different insecticides and botanicals against lemon butterfly

The efficacy of seven insecticides and botanicals tested against lemon butter fly, *Papilio demoleus* in bael revealed that spinosad 45 SC proved to be the most effective, followed by Malathion 50 EC. The Acephate, dimethoate and imidacloprid were ranked middle in order of their efficacy whereas, the Neem based formulations, *viz.*, NSKE and neem oil were proved to be the least effective in reducing the lemon butter fly population (Table 41).

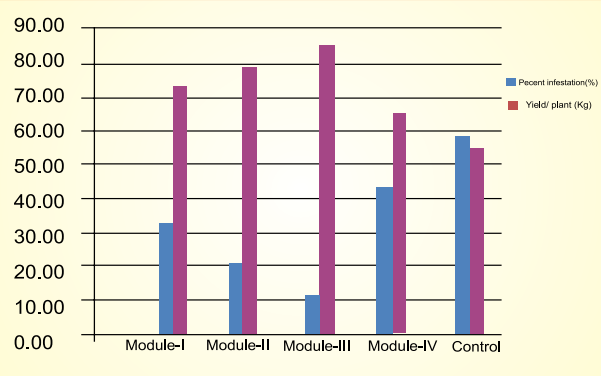


Fig. 32. Association of fruit fly incidence with yield in different management modules of ber crop during 2016-17

Table 40. Incidence of fruit fly and yield of plant in different management modules of ber crop during 2016-17.

Treatments	Per cent infestation (%)	Yield per Plant (Kg)
Module-I (T1)	33.40 (35.24)	72.93 (58.84)
Module-II (T2)	21.38 (27.49)	78.08 (62.58)
Module-III (T3)	10.90 (19.22)	84.28 (67.21)
Module-IV (T4)	43.70 (41.36)	64.55 (53.60)
Control (T5)	57.95 (49.56)	54.08 (47.35)
SEm±	1.05	1.46
LSD (P = 0.05)	3.26	4.56

* Values in parenthesis are angular-transformed

Table 41. Efficacy of different insecticides and botanicals against lemon butterfly during 2016-17

S. No.	Insecticides/ Botanicals	Per cent reduction in lasora bug population			
		First application		Second application	
		After 1day	After 7 day	After 1day	After 7 day
1.	Acephate	73.88	78.21	75.31	79.90
2.	Malathion	82.48	93.88	85.81	96.43
3.	Dimethoate	70.58	74.52	71.13	76.83
4.	Imidacloprid	67.71	67.83	65.68	68.45
5.	Spinosad	82.60	94.43	86.01	96.92
6.	NSKE	47.05	50.91	48.17	53.10
7.	Neem oil	53.66	56.71	55.32	58.21
8.	Control	0.00	0.00	0.00	0.00

POST HARVEST MANAGEMENT AND VALUE ADDITION IN ARID HORTICULTURAL CROPS

At Bikaner

Exploitation of arid fruits and vegetables for value addition and commercialization

Value addition in aonla

Aonla is one of the important minor fruit crop with commercial significance. It is under culitvation in India since time immemorial and is highly valued for it nutritional value especially its rich content of vitamin C (400-600 mg/100 g). The fruits also posess significant amounts of tannins that protect the ascorbic acid from oxidation. Traditionally the aonla fruits are used for making preserve (Murabba), pickle, candy, jam, jelly, squashes etc. With the changing life style of consumers there is a great need for developent of novel food products with incorporation of healthy and natural food components. A mouth freshner product was developed using aonla as the base material.

Development of aonla based mouth freshener

Fresh fruits were used for development of aonla based mouth freshener. The major ingredients used are grated aonla pulp, crushed beet root, Saunf and sugar candy. Aonla being the base material serves as a nutrient base, Beet root extract acts as a source of natural food colorant, Sugar candy acts as a sweetening agent and Saunf gives the required flavor and aroma for the product. The quantities/ proportion of these ingredients were standardized [Aonla: Beet root: Sugar: Saunf = 1:1:1:0.25]. The storage life of the developed product is being done currently (Fig. 33).

Value addition in date palm

Date fruits distinguish themselves from other fruit in that they have a botanical maturity and at least 3 distinct commercial maturation levels, the sweet Khalal (*doka*), the Rutab (*dang*), and the Tamer (*pind*) stages. The moisture content of the date fruits keeps decreasing with advancement of their maturity stages making them self-stable. Once the date fruits attain *doka* stage, the weight gain decreases and the sugar content increases. Only when the dates are left to ripen further on the palm they will turn into *dang* and *pind*, with the availability of the favourable climatic conditions. The major constraint of date fruit under Indian conditions is that, the dates are forced to harvest at the Khalal (*doka*) stage of development due to unfavourable climatic conditions *i.e.* the onset of seasonal rains during the months of July and August, when the date fruits are about to reach the *dang* and *pind* stages, leading to mycelial growth on the fruit surface caused by high moisture and humidity. Hence, most of the Indian

Flowchart for preparation

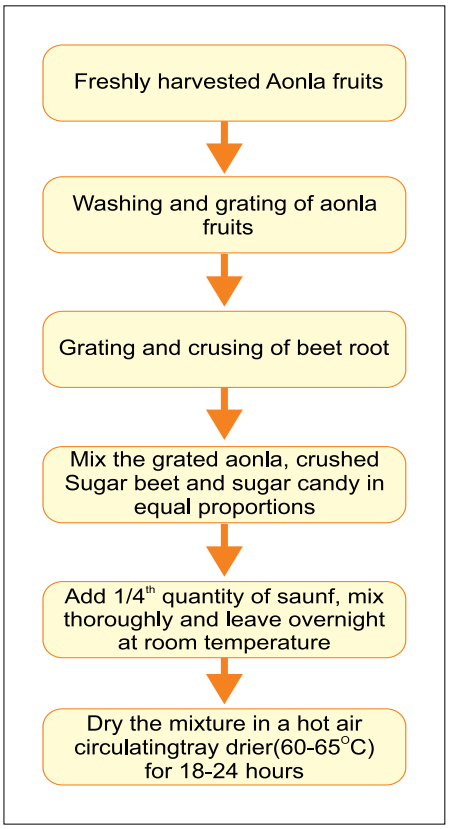


Fig. 33. Aonla based mouth freshener

dates are forced to enter fresh market where their prices are volatile due to high perishability. Also, not all the cultivars grown in India are suited for fresh consumption due to varying levels of astringency present in them. Hence, there is a great demand for alternative processing technologies for *doka* staged date fruits. Under such circumstances, we attempted standardization of dry date (*chhuhara*) processing techniques from the date cultivar Medjool.

Doka fruits cv. Medjool was also tried to prepare soft date (pind) through giving low temperature (keeping in freez at -10 ^{0}C for 48hrs.) and drying. It was observed that keeping at -10 ^{0}C for 48hrs and drying treatment was suitable, which may be standardized for soft date making.

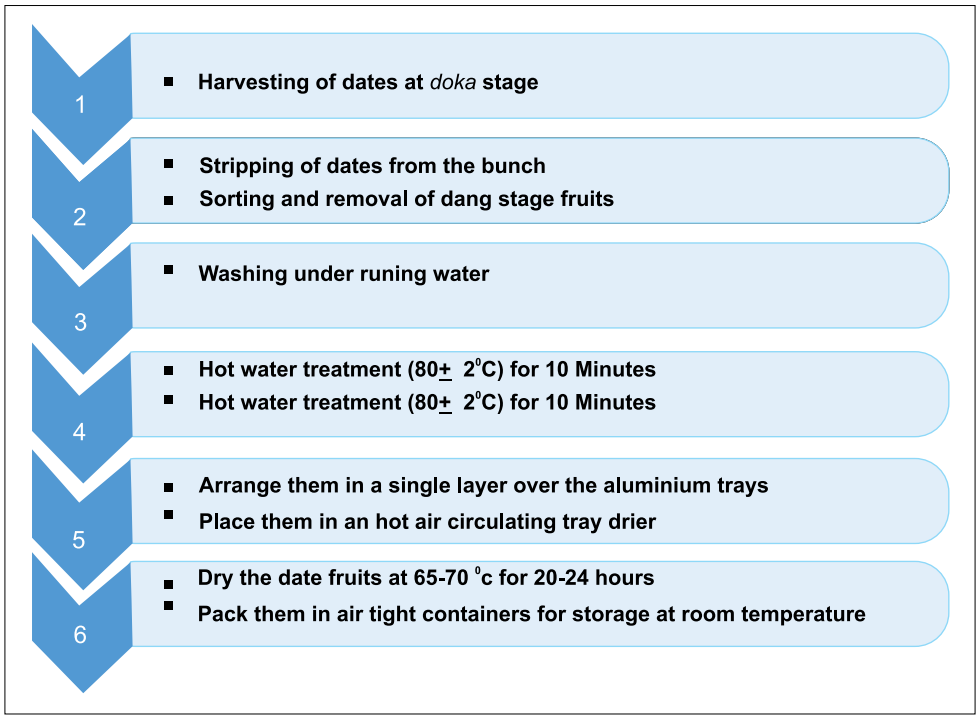
Preparation of dry dates (Chhuhara)

The date fruit of cv. Medjool were harvested at fresh doka stage, followed by stripping from the strands, washing under running water to remove the traces of dust and dirt. Later the fruits were dipped in boiling water (80 ± 2 °C) for different time periods (5, 10 and 20 minutes), and were dried in air circulating tray drier at a temperature of 70°C for 30 to 35 hours. Among different time periods of hot water dipping, 10 minute dipping was found to be optimum for the Medjool fruits in preparation of dry dates (*chhuhara*). The recovery percentage was in the range of 55 to 56 per cent (Fig. 34).

Air drying to remove moisture | Drying in air circulating Tray drier | Dry date (Chhuhara)

Fig. 34. Different steps in preparation of dry dates.

Flow chart depicting dry dates preparation



Development of kachri based curry powder

The dehydrated kachri fruits with highest recovery percentage were used for the preparation of ready-to-use cooking powder. The base material used for making this product is kachri powder. Other ingredients used in the preparation of this product are moringa leaf powder, curry leaf powder, Snapmelon fruit powder, coriander, cumin, fenugreek, ajowain, fennel, blackpepper, mustard, and Cinaamon. The proportion of these components to be used for making this product has been standardised (Fig. 35).

Fig.35. Kachri based curry powder.

At Godhra

Standardization of maturity indices in bael varieties

Bael fruits remain intact on the tree for longer duration (9-11 months) which depends up on the variety and climatic condition prevailing to locality. The different varieties were studied to standardize the maturity under hot semi-arid conditions are mentioned below (Table 42).

Table 42. Maturity indices of bael varieties.

Varieties	Acidity (%)	Vitamin C (mg/100g)	Total phenol (%)	T.S.S pulp (°Brix)	T.S.S. mucilage (°Brix)	Total sugars (%)	Reducing sugars (%)	Non reducing sugars (%)	TSS: Acid ratio	Time taken from fruit setting to ripening	Flesh colour	Pulp colour
CISH-B-1	0.34	19.75	2.82	31.40	46.28	18.00	4.79	13.27	92.35	280	Yellowish green	Whitish yellow
CISH-B-2	0.42	17.37	2.74	31.34	42.23	17.38	4.25	13.13	74.61	365	Greenish	Whitish light yellow
Thar Neelkanth	0.46	17.57	2.53	32.89	41.21	18.56	4.89	13.67	40.34	320	Yelloish green	Deep Yellow
NB-16	0.48	18.19	2.54	36.10	45.60	18.06	4.03	14.03	75.20	320	Light yellow	Yellow
NB-17	0.33	18.28	2.43	34.78	48.52	16.60	4.50	12.04	105.39	310	Yellowish green	Light yellow
NB-5	0.31	21.93	2.48	33.21	46.15	18.50	4.75	13.75	116.80	350	Greenish yellow	Yelloish white
NB-7	0.38	18.98	2.47	31.67	49.45	17.25	3.30	13.95	83.34	340	Yelloish green	Yelloish
NB-9	0.33	19.20	2.45	35.29	46.83	19.84	4.68	15.16	106.93	350	yellow	Dark Yellow
Pant Aparna	0.34	17.25	2.47	34.23	39.40	19.53	4.89	14.44	100.67	320	yellow	Yellow
Pant Shivani	0.47	19.54	2.48	35.49	48.55	17.77	3.54	14.23	75.51	280	Dark yellow	Dark yellow
Pant Sujata	0.42	16.18	2.51	33.25	44.47	18.03	3.38	14.65	79.16	330	Light yellow	Dark yellow
Pant Urvashi	0.49	17.53	2.44	37.45	49.87	17.15	4.00	14.00	76.42	320	Lemon colour	Light yellow
Goma Yashi	0.30	24.08	2.55	38.48	43.43	18.75	4.12	15.00	128.2	290	Yellow	Dark yellow
Thar Divya	0.35	19.67	2.83	36.78	49.00	17.51	4.50	13.00	105.08	275	Yelloish to light yellow	Deep yellow
C. D. at 5%	0.042	1.73	0.22	3.45	4.33	1.75	0.38	1.29	10.20	---	--	----

Effect of Zero Energy Cool Chamber and post harvest treatments on storage life of Jamun cv. Goma Priyanka

An experiment was conducted to evaluate the efficacy of different post harvest treatments viz., 1 - Control, 2- Zero Energy Cool Chamber (ZECC), 3 - Calcium chloride 1.0 %, 4 - Calcium chloride 1.5 %, 5- Calcium chloride 1.0 % + ZECC, 6- Calcium chloride 1.5 % + ZECC, 7 - Mustard oil 2.0 % emulsion, 8- Mustard oil 2.0 % emulsion + ZECC, 9 - Potassium sulphate 2 %, 10- Potassium sulphate 2 % + ZECC on storability and fruit quality attributes during storage. Goma Priyanka jamun fruits when treated with calcium chloride 1.5 % and kept in Zero Energy Cool Chamber recorded 4 days shelf life with comparatively better fruit quality, while untreated control had 2 days shelf life. However, Zero Energy Cool Chamber alone recorded 3 days shelf life.

Studies on preparation of pickles of wood apple and bael

Fully developed matured fruits of wood apple and bael were selected and outer covering of fruits were cracked open to take out the pulp. Fruit pulp was mixed with all ingredients like chili powder, jeera, asfoetida, salt, turmeric powder, coriander and mustard oil appropriately. Pickle was packed in a well sterilized bottle. Taste, aroma and colour of the pickle increased with increase in storage.

AGRICULTURAL EXTENSION

Study on rural wisdom and resources of arid horticultural importance

Under the extension research project entitled as "A study on rural wisdom and resources of arid horticultural importance, different studies were under taken as per objectives and targets of the same. The major achievements of this project during 2016-2017 were as follows.

(1) Collection of information/data, documentation and evaluation of the potential rural resources/ rural wisdom based technologies of arid horticultural importance

(a) Potential land races/germplasm/wild species of arid fruits and vegetables for the crop improvement and arid horticultural development

During the reported time of period, the targeted data / information about the socio-economic and psychological characteristics of the respondents/farmers (122) were collected and evaluated. Some of the land races/germplasm or traditional arid vegetables and fruits like *Khimp* (*Leptadenia pyrotechnica* (Fork.) Decne), *phog* (*Calligonum polygonoides* L.), *ker* (*Capparis decidua* Edgew), and mango (*Mangifera indica*), wild kundaru (*Coccinia* spp.) wild *kakoda*

Bush of khimp

Pods of khimp: Potential traditional vegetable

Single stemmed cluster bean (Veg.)

Santhi (Traditional leafy vegetable)

Local landrace of okra

Local landrace of kakora

Local landrace of kundaru

Fig. 36. Potential gerplasm of arid fruits & vegetables

(*Momordica* spp.), amaranth (*Amaranthus* spp.), okra, *gokhgru, santhi, khejri* (*Prosopis cineraria* (L) Druce) in which sangari/pods wearing takes place in the month of September to October. The cactus (*Opuntia ficus indica*), *local mushroom (Agaricus* spp*),* spiny local brinjal (*Solanum* spp.*), Mat kachar* (*Cucumus* spp.), single stemed local clusterbean (*Cyamopsis* spp.*)*, moringa, *bathua (Chenopodium album), a*maranth (*Amaranthus* spp.), *gajara* (green leaves of carrot), *sogari* (tender pods) of reddish, tumba (*Citrullus colocynthis*), local jhar ber, fenugreek (*Trigonella foenum-graecum),* and some other forms of local vegetables were observed during the local survey and farmer's field visit and documented with their imortance in local areas (Fig. 36). The above land races/germplasm/wild species or genotypes may play a crucial role in crop improvement/introduction of new variety, genotype or new crop in the field of arid horticulture. The above land races/ wild species or genotypes of arid vegetables may be boon for breeding/ crop improvement programme and introduction of new variety, genotype or new crops of vegetable in the field of arid horticultural crops of the country.

(2) Collection and documentation of the potential rural wisdom based traditional technologies

Among the rural wisdom based technologies (RWBT), the ideas and traditional techniques of processing and value addition of arid vegetables/ fruits like preparing the sweets and other products of bael, pickle of kachri, dehydration of sangari, pickle of mature *sangari (*pods), *namakin of khokha* powder of *sangari* of *khejri*, dehydrated slice (khelare) and leathery *papad* of snapmelon for vegetables purpose, red chilli mix dry chutney of *kachri* and snapmelon, *jem* of *phalsa,* pickle of cluster bean, *jam,* dry *murbbah* and pickle of *karonda,* pickle of kachri and snapmelon, pickle of cactus pear, sweet slice of snapmelon, soop of local *mushroom,* ice-cream and toffee/chocolates of date fruits, preparation of *aonla* pickle, aonla *laddu, aonla churma*, freezed aonla canddy, aonla supari *and* mouth freshener of *aonla*, pickle, churan and *murahbba* of *tumba,* dehydrated leaves of *bathua,* dehydrated slice (foflia) of roundmelon, preparation of squash and pickle of cactus (*Opuntia ficus indica*), preparation of *laddu, etc.,* were collected from local people, farmers, secondary sources, field workers and documented and refinement work on the same was carried out. Surveyed the local areas and markets were also conducted and the data/ information about marketing system and business route of vegetables processing/ dehydration techniques of traditional vegetables like *sangari, kumat, ker, kama gatta, kachri gote/slice,* slice *(khelara)* of snapmelon, *foflia* (pieces) of *tinda, fogle (*dehydrated mature flower buds of *fog* plant*),* fenugreek leaves, *desi ber,* pods of *khimp,* etc. were collected and documented. The validation, refinement and standardization works on some of the important rural wisdom based traditional technologies of value addition was carried out. Thus, some new concepts/ methodologies of value addition and processing of arid fruits and vegetables were generated during the reported period of time. Some concepts of eco-friendly pesticides/bio-pesticides extract of kachri & *tumba* fruits and leaves, mixing of *tumba* fruits cake in the soil, spray of extract of leaves of oak and ker, olive, tobacco, dusting of powder of tobacco leaves, etc. were collected and documented and synthesized in scientific mode.

(3) Initiation on validation, refinement and standardization of the processes and products

The information/ data (from respondents, secondary and online sources) on rural wisdom based traditional technologies/ ideas processes / techniques and value added products of arid horticultural crops were collected. Further, the work of validation, refinement and standardization on so collected traditional technologies/ ideas and self developed hypothesizes/ ideas was carried out. During the reported period, the following efforts were made in this direction.

(i) The validation, refinement, standardization and development of the processes, products and methodology / technique of preparing the pickle of *aonla* and *karonda*.

Methodology / technique of preparing the pickle of aonla

⬇

Selection and harvesting of healthy fruits of aonla

⬇

Washing fruits with clean water

⬇

Cut the aonla fruits with the help of knife in desirable pieces & remove the fruit stone

⬇

Mix 70 - 100g normal salt in 1.0 kg aonla pieces and put for 24 hours

⬇

Remove the salty water flow out from the pieces & dry the pieces 2-3 hours at room temperature to remove excess water

⬇

Take 100 - 120 ml mustard oil (@ per kg aonla processed pieces) and pour in a pan and warm it up to 80 - 90 degree centigrade .

⬇

Now put cumin 10g and a pinch of aesfoitida powder in warmed oil in pan and cook them a movement

⬇

Now, slightly fry the so processed pieces of aonla in warmed mustard oil with cooked cumin aesfoitida in a pan.

⬇

Gently, juxtapose mixing of spices/ condiments (powder of aesfoitida, red chilli, turmeric, cumin, and seeds of fenugreek, fennel, kalongi, etc.) while frying pieces of aonla fruits with mustard oil

⬇

After mixing & slight rousting of the above material for 5 -6 minutes, switch off the gas chulha and take down the pan of mix prepared material of pickle and cool down the same.

⬇

After cooling, the prepared material of pickle is filled in any suitable glassware

⬇

Warm the mustard oil (up to 80 - 90 degree centigrade), pour a pinch of cumin and powder of aesfoitida in it and get it cool down and pour the same in glassware of pickle until sinking of the prepared material of pickle.

⬇

Put pickle at a neat and clean. Thus, pickle of aonla is ready to serve after 3 - 5 days of preparation and has long self-life.

⬇

Pickle of aonla fruit (var. NA-7)

Methodology/ technique of preparing the pickle of mature sangari of khejri

⬇

Selection and harvesting of healthy mature sangari of khejri

⬇

Washing the sangari with clean water

⬇

Cut the sangari in pieces of desirable size (3 - 4cm)

⬇

Blanching the pieces in hot water solution of alum (@ 10g / litre water)

⬇

Remove the pieces from the pieces in hot water solution of alum & dry the same for 2 -3 hours at room temperature to remove excess water

⬇

Mix 200 - 300g pulp of unripe mango (Keri) in 1.0 kg of so dried pieces of sangari & put them as it is for 3 - 4 hour at room temperature and turn them time to time also

⬇

Slightly fry the so processed pieces of sangari with mustard oil in a pan

⬇

Gently, juxtapose mixing of the salt, spices/ condiments (powder of aesfoitida, red chilli, turmeric, cumin, and seeds of fenugreek, fennel, kalongi, etc.) while frying pieces of sangari with mustard oil

⬇

After mixing & slight frying of the above material for 8 - 10 minutes, switch off the gas chulha and take down the pan of mix prepared material of pickle and cool down the same.

⬇

After cooling, the prepared material of sangari pickle is filled in any suitable glassware

⬇

Warm the mustard oil and get cool it and pour the same in glassware of pickle until sinking of the prepared material of sangari pickle and put it at a neat and cool place. It is ready to serve after 2 - 3 of preparation and has long self-life.

⬇

Pickle of mature sangari of khejri

(ii) The validation, refinement/standardization of dehydration processing techniques of *sangari* of *khejri*

The information and innovative ideas about traditional processing techniques of dehydration *of green sangari* of *khejri* were collected (from farmers and secondary sources) and a study was conducted to validate, refined and standardize the same. In this study, tender and healthy *sangari* (pods) of *khejri* were selected, harvested and washed with clean water. The five samples (200g each) of these *sangari* were made for the different treatments (T_1 - T_5). The major purpose of this study was to observe the change in colour and taste of the *sangari* after treatment and dehydration. Another purpose was to observe the recovery of greenish colour of the *sangari* after soaking/boiling in water before preparation of vegetable or pickle of the same. The treatments T_1 to T_5 during dehydration of *sangari* and the observation of the study were as follows.

- T_1 : Boiling (2 minutes) of the sampled *sangari* (200g) in brine (salt) water solution (10g salt / lit. water).
- T_2 : Boiling (2 minutes) of the sampled *sangari* (200g) in alum water solution (10g alum / lit. water).
- T_3 : Boiling (2 minutes) of the sampled *sangari* (200g) in sugar water solution (10g sugar / lit. water).
- T_4 : Boiling (2 minutes) of the sampled *sangari* (200g) in normal water.
- T_5 : No boiling of the sampled *sangari* (200g) at all.

In the study, it was observed that during the treatments/boiling the green colour of the *sangari* changed into dull greenish-yellow under all treatments. But after drying (at shady place at room temperature), the colours of the *sargari* (T_1) boiled in brine (salt) water solution for 2 minutes became light greenish-brown with some flexible nature. The colours of the *sargari* (T_2) boiled in alum water solution for 2 minutes became better greenish-brown having more flexibility. The colours of the *sargari* (T_3) boiled in sugar water solution for 2 minutes became brownish- black after drying with some flexibility. *Sargari* (T_4) boiled with normal water for 2 minutes became more brown and less green having some brittle nature after drying/ dehydration. In case of the *Sargari* (T_5) did not boiled at all became most brown and less greenish with most brittle in nature after drying/ dehydration. Further it was also recorded that after water soaking and re-boiling of the treated dehydrated *sangari,* the recovery in its greenish colour with quality was best under treatment T_2 i.e. the *sangari* boiled in alum water solution followed by *sangari* boiled in brine (salt) solution of water (T1). The recovery in greenish colour with quality (after water soaking and re-boiling) of the treated dehydrated *sangari* under treatment T_5 i.e. the *sangari* did not boiled at all was found the poorest among all.

(ii) The other initiation carried out with respect to validation and refinement/standardization of rural wisdom based traditional process techniques and products value addition of arid horticultural crops so collected were: dehydration of tender pods of *khimp* (*Leptadenia pyrotechnica)* dehydration of *sangari* fo *khejri*, dehydration of kachri and round melon, dehydration of tender *lasoda* fruits (on/before stone formation, pickle of karonda, dehydration and pickle of cactus, dehydration of ber, processing of tender fruits of *ker* (*Capparis decidua), murrabah* of *tumba* fruits, dry chutney of kachri, powder of sangari khokha, cake/sweets of date fruits, Kinnow powder, namkeen of cluster bean, *aonla paak (Churama), aonla laddu, kachchuran* of *kachri,* etc. (Fig. 37).

T_1 T_2 T_3 T_4 T_5

Pickle of karonda | Sweets of date fruits | Aonla paak (Churama) | Kachchuran of kachri | Aonla Laddu

Fig. 37. Some products validated and refined from arid fruits & vegetables.

(4) Synthesis/generation of technological new concepts/methods

In extension, a "Concept" is a term that expresses an abstract idea formed by generalizing from particulars and summarizing the related observations. On the basis of traditional/ indigenous knowledge, some concepts related to value addition, plant protection, etc., in the field of arid horticultural and other crops were generated and developed during the year under this project. The some concepts of value addition of arid fruits and vegetables like dehydration of tender *lasoda* fruits (on/before stone formation stage), dehydration and pickle of cactus, dehydration of ber, processing of tender fruits of ker (*Capparis decidua), murrabah* of *tumba* fruits, ice-cream of bael, toffee/ sweets of date fruits, *aonla paak (Churama), kachchuran* of k*achri* were synthesized, refined and tested to strengthen the wing of value addition/ post harvest management of the Institute. With the help of traditional/ indigenous knowledge, various concepts of eco-friendly pesticides/bio-pesticides used by the farmers to protect their arid horticultural crops were evolved. Such major were spray of extract of leaves & fruits of tumba, oak and tobacco; wrapping of plastic and grease bands around trees, spraying milk waters with salt, burning of mustard/sesamum oil in crop fields, etc.

(b) Extension programmes and activities

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 2016–17. Out of these; the major interventional activities/extension programmes carried out under this project during the year 2016 – 17 are being mentioned in short below.

- **Farmers' training programmes:** Four farmers' training programme (on/off campus) and were coordinated and conducted on 31.01.17 to 01.02.17, 03.02.17, 08.02.17 and 15.02.17 to 16.02.17 at Sarahrupayat village, Kolasar, at the Institute and at the Institute, respectively related to "improved agro-techniques of arid vegetable production and "Integrated insects-pests management in arid horticultural crops".
- **Farmers' school: Two farmers' school** on improved variety of (AHS-82) of snap melon were organised (with the help of ATMA, Bikaner) during the *kharif* season 2016-17 at Chak No. 489 RDL, Saraykunjiya village and Chak No. 1 BLD, Ranisar village of Bikaner district.
- **Conducting front line demonstrations/ adoptive trial / method demonstrations :** During the reported period of time, 04 frontline demonstrations of improved varieties of arid vegetable crops *viz-* AHS-82 (snap melon) and AHK- 119 (*Kachri*) were conducted at Saraykunjiya (Chak No. 489 RDL) and (Chak No. 1 BLD, Ranisar), Sarahrupayat village of Bikaner district and KVK, Chomu of Jaipur district. Twenty field demonstration/ adoptive trials of 07 improved varieties (Kufri Frysona, Kufri Chipsona, Kufri Garima, Kufri Khyati, Kufri Surya, Kufri Pukhraj and Kufri Jyoti) of potato were also conducted of farmers' field. In addition, 26 method demonstrations about improved agro-techniques of arid fruits and

vegetable production, value addition, in-situ budding, etc were given to the Institute visiting farmers/ extension functionaries and on farmers' field during the visits to farmers' fields or interaction.

- **Participation in farmer's fair and arranging technological exhibitions:** During the reported period of time, the following 07 exhibitions of arid horticultural technologies were organized/ displayed.
  - Participated and displayed the technological exhibition in National seed distribution farmers' fair and farmers' *Sangosthi* organised by NRCSS, Ajmer during 18 -19 Sept., 2016. In this fair the exhibition of the Institute was awarded with First Prize for the best display of the exhibition.
  - Another exhibition was oorganized during the celebration of 'Field Day on Seed Production of Groundnut', by CSWRI, RRS, Bikaner in collaboration with ICAR-DOGR, Junagadh, Gujarat, on September 28th, 2016 at RRS-CSWRI, Bikaner.
  - Three days exhibition was displayed at Jaipur during the Global Rajasthan Agritech Meet (GRAM) -2016 organized by Government of Rajasthan at Jaipur from 09.11.16 to 11.11.16 and also participated in *Chopal* Programmes of the same.
  - Seven Days exhibition of the Institute was displayed in *Vikash Pradarshani* organized by State Govt., at Bikaner from 13.12.16 to 19.12.16 during the visit of Hon'ble Chief Minister, Govt.of Rajasthan, Smt. Vasundhara Raje.
  - Three days exhibition of the Institute was displayed during Western Regional Agriculture Fair organized at SKRAU, Bikaner (Raj.) from 18.02.2017 to 20.02.2017
  - Four days exhibition of the Institute was displayed during 17th All India Agricultural Universities Youth Festival orgnize at RAJUVAS, Bikaner (Raj.) from 22.02.2017 to 25.02.2017.
  - Another exhibition of the Institute was displayed during the "*Krishi Unnati Mela*" organized at in IARI, Pusa, New Delhi 15.03.17 to 17.03.17. In this *Mela,* the exhibition of the Institute was honoured with **Second Best Award** for the best display of the exhibition.
- **Technological impact assessment:** During the reported period of time, the major initiatives taken under the work of technological impact assessment are as follows.

(i) Impact assessment of adoption of improved variety of *kachri* (AHK-119): Presently, farmers are earning net income of Rs. 127000 - 192000/ha/ season by adopting/growing improved variety of kachri: AHK-119. More than 20,000 farmers were growing it during rainy (*Kharif*) season and about 12000 farmers grew it during summer season, area covering more than 6000 ha and 3700 ha, respectively. More than > 80% farmers of the hot arid regions want grow it on their fields. Some the farmers (2-3%) have started to multiply and production its seeds at a small scale. After adoption of this variety, increased 48% market demand and 26% supply for batter quality of kachri in local markets. Increased (23 - 27%) earning of the farmers from value added products of the kachri. Increased the awareness, interest and knowledge among 40,000 farmers about scientific cultivation and benefit of this variety. Increased the competition (74%) among the kachri growing farmers for improved production. More than 80 % farmers responded that growing of this variety (AHK-119) leads to mild agro-climate of the crops field and significant reduction (61%) in soil erosion with increased organic matter in the soil.

(ii) Impact assessment of adoption of improved variety of snapmelon (AHS-82): Presently, farmers are earning net income of Rs. 108000- 167000/ha/ season by adopting/growing improved variety of snapmelon: AHS- 82. More than 13000 farmers were growing it during rainy (*Kharif*) season and

about 3200 farmers grew it during summer season, area covering more than 4000 ha. and 1600 ha, respectively. More than 60% farmers of the hot arid regions want grow it on their fields. Some the farmers (2-3%) have started to multiply and production its seeds at a small scale. After adoption of this variety, increased 28% market demand and 22% supply for batter quality of snapmelon in local markets. Increased (21- 26%) earning of the farmers from value added products of the snapmelon. Increased the awareness, interest and knowledge among 32,000 farmers about scientific cultivation and benefit of this variety. Increased the competition (53%) among the kachri growing farmers for improved production. More than 80 % farmers responded that growing improved variety (AHS-82) maintaining the mild agro-climate of the crops field, significant reduction (54 %) in soil erosion and it increases in organic matter of the soil. Day by day the area under pomegranate in is increasing and farmers are very eager to grow pomegranate orchards and some of them getting more than 2.0 lakhs gross income per year per hectare. As a result of development of arid horticultural technologies, some of the farmers/ persons (2 -3%) have started to produce planting material of arid fruits like *ber,* pomegranate, Kinnow, lasora, lemon, etc., by establishing nurseries. Increased the arid horticultural technological knowledge, awareness, and interest among > 60% farmers of the areas where FLDs and trainings were of improved varieties of arid fruits and vegetables conducted.

Visit and Research - Extension -Farmers-Interface-Meetings (REFIM), held at the Institute: More than 400 farmers (both men& women), >150 school students, >100 supervisors**,** professionals, and other personnel were visited to the Institute's farm/experimental blocks and held > 24 Research-Extension- Farmers- Interface-Meetings (REFIM) with them to acquaint/ expose them with latest arid horticultural technologies as developed by the Institute.

Research- Extension - Farmers- Interface-Meetings (REFIM) held at farmer's fields: During the reported period, held >20 Research-Extension-Farmers- Interface- Meeting (REFIM) with farmers and their fellow farmers while visiting their fields. Such kind of meetings was also held at the site of the demonstrations and farmers school.

Lectures: During the reported time, 22 lectures on different topics related to improved technologies/ package of practices of arid horticultural crop production were delivered during farmers training programmes, farmer's schools, to visiting farmers/ at farmer's fields, visiting extension worker/ NGO personnel.

Visit to farmers' fields and organization of farmer's interest groups / commodity groups/ SHG: More than 26 of farmer's fields were visited and they were provided with technical guidance/ assistance in overcome their problems related to arid horticultural crop production. The farmer's meeting/ interactions were carried out to guided and provided solution to their problems. During the reported period, the work on organization of Farmer's Interest Groups / Commodity Interest Groups/ Self-Help Groups were also initiated at the different sites/ locations/ villages of Bikaner districts (Rajasthan) where front line demonstrations of improved varieties of arid fruits/vegetables crops and their agro-techniques were conducted. Moreover, 12 Groups of farmers which had interest in propagation/ multiplication and growing of the improved varieties of ber, Kinnow, pomegranate, bael, *khejri* (*Thar Shobha), ber, kachri (*AHK-119), snapmelon (AHS-82) and *mateera* (Thar Manak), etc. were also organized. Later on, these groups were fallow upped and they were visited to the Institute and had essential technological interaction/ discussion with them to meet their interest. They were also motivated to adopt other improved arid technologies on their fields.

Inter-Intuitional linkages / programmes organised /assisted: Strengthen functional linkage with sister organization / Institutions of the ICAR, KVKs, ATIC and Directorate of Extension of SKRAU, Bikaner, CAZRI regional station Bikaner, state Govt. Deptt. of agriculture/ horticulture, CAD/IGNP departments, press media persons, NGOs, etc. to facilitate the transfer of CIAH technologies on local

farmer's field and to encourage the arid horticultural development. The above institutions were assisted and cooperated as and when they required our assistance and help in successful completion of their programmes like extension programmes, trainings, interface meetings, assistance in technological campaign/ programmes, technological support and advice, other issues related to human resource development.

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

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

Providing technical literature: About 250 copies of technical folders and bulletins (technical literature) were provided to the farmers /extension workers/ NGOS, during their visit, farmer's fair, exhibitions, meetings, etc.

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 time to time during the reported time. Other important activities like farmer's visits and research-extension-farmers-interface meetings, conduction of technological front line demonstrations/ adaptive trials on farmer's fields, method demonstrations, farmer's trainings, celebration of farm innovators day, visit to farmer's fields and organization of farmers interest groups to acquaint them with latest improved technologies arid fruits and vegetables crop production, organization of technological exhibitions, providing technical literature to farmers/ clients, online technical guidance and mobile advisory service/ ICT / e-extension based programmes, etc. were carried out during the reported time for the popularization of innovative arid horticultural technologies amongst the farmers / clients.

Initiatives for commercialization of technologies: To encourage the commercialization of arid fruits and vegetables and their production technologies, various extension programmes and activities like technological front line demonstrations, method demonstration, exhibitions, training and visits, farmers meeting and interactions, commodity interest group organizations, press publicity, distribution of technical literature, etc., works were carried out. As a result of above activities, several farmers have started the commercial production of improved varieties of arid vegetables and fruits at large scale. Some of the farmers have started the production of seeds of the improved varieties of arid vegetables and planting materials of arid fruits like ber, bael, khejri, Kinnow, limon, etc., for commercial and business point of view. Moreover, the initiatives were taken for the popularization and commercialization of scientifically refined/ standardized and processed value added products of arid fruits and vegetables like pickle of mature *sangari* of *khejri,* pickle of aonla, pickle of kachri and snapmelon, pickle and jam of *karonda*, dehydrated slice of *kachri and snapmelon,* sweet slice and leathery *papadi* of snapmelon, aonla laddu, dehydrated sangari of khejri, ice-cream date palm fruits, etc.

Farmers field visit: Visited to orchards at 2BSM, Bikaner regarding problems in pomegranate leaves curling, fruit cracking & oozing in stems, etc on 04.5.2016; Krishi farm, Kanasar on 10.10/ 2016 regarding pomegranate and ber cultivation

Farmers-Scientist interaction /discussions for technical guidance : Farmers from Sirsa (Haryana) on 15.6.16 regarding date palm cultivation; Sri Anil Saraf, from Kolkatta regarding date palm production in Rajasthan and processing unit establishment on 8.7.2016; farmers from Malkisar & Nachna for date palm on 18.7.16; Shri Mukesh Kumar from Suratgarh on 26.10.16 for Papaya cultivation ,Sri Kandpal, from Ratangarh for Jojoba and date palm cultivation, and Shri Sandeep from Jhunjhunu on 11.1.2017 for date palm& jojoba cultivation Shri Kanshi Ram from Goddu, Bajju regarding pomegranate cultivation; Sri Kasim Khan from Jamsar for guidance for Aloe and pomegranate cultivation on 14.3.17.

Field visit and Group discussion: Group discussion with 50 farmers from Jaipur on 10.8.2016; group of farmers (20) from Churu distt. on 14.2.2017, Trainees of Short course from SKRAU, Bikaner on 7.12.2016 to discuss research activities of the Institute and uses of horticultural crops as fodder, 19 PG Students group with faculty from Govt Dungar College Bikaner visited on 04.1.2017 to the Institute.

Interaction and discussion with Scientists from PAU, Ludhiana on 20.2.2017 regarding arid fruits.

Participated for Display of Institutes exhibition/ stall in Kisan Mela held at SKRAU, Bikaner on 30.4.2016.

Exhibitions organized


Visit of farmers/students/officials to the Institute (ICAR-CIAH)






Farmers' field visit






Research-extension-farmers-interface meetings






CHES, Godhra

A total of 2090 visitors which include the farm men 1618, women 166, extension workers 68, students 238, who visited CHES from government and Non-government organizations during the 2016-2017.

One day exposure visit to CHES by 238 RAWE Students from Navsari Forestry and Horticultural College and SPEE College of Agril. University, Gujarat.

Training to ATMA farmers

No.	Department/ Agency ATMA	No. of Farmers		Total	Topic	Date
		Male	Female			
1	Dahod,	30	--	30	Production technology of bael Dr. A.K. Singh	25-07-2016
					Production technology of Drums Stick. Dr. Lalu Prasad Yadav	
					Production technology of custard apple Dr. Vikas Yadav	
					Minor fruits Sweet Orange and Mango cultivation Dr. Sanjay Singh	
					Soil testing and fertilizer recommendations Dr. V.V. Apparao	
2	Garbada	18	12	30	Cultivation of lime Dr. D.S.Mishra	26/07/2016
					Cucurbits production technology Dr. Lalu Prasad Yadav	
					Production technology of custard apple Dr. Vikas Yadav	
					Production of minor fruits Sweet Orange and Mango cultivation Dr. Sanjay Singh	
					Production technology of Aonla Dr. A.K. Singh	
3.	Zalod	20	10		New improved varieties of Mango for Gujarat Dr. D.S. Mishra	27/07/2016
					Soil testing and fertilizer recommendations Dr. V.V. Apparao	
					Production technology of custard apple Dr. Vikas Yadav	
					Cultivation minor fruits Sweet Orange and Mango cultivation Dr. Sanjay Singh	
4.	Devgarh Baria	30	--	30	Propagation techniques in Aonla and Bael Dr. A.K. Singh	28/07/2016
					Soil testing and fertilizer recommendations Dr. V.V. Apparao	
					Raising of fruit plants nursery Sh. Nihal Singh	

No.	Department/ Agency ATMA	No. of Farmers		Total	Topic	Date
		Male	Female			
					Cultivation in minor fruits Sweet Orange and Mango. Dr. Sanjay Singh	
					Production technology in Saragva (Drums Stick) Dr. Lalu Prasad Yadav	
5.	Limkheda	30	--	30	Production technology of Drums stack and kitchen gardening Dr. Lalu Prasad Yadav	29/07/2016
					Raising of fruit plants nursery Sh. Nihal Singh	
					Soil testing and fertilizer recommendations Dr. V.V. Apparao	
					Advance production technology of Custard Apple Dr. Vikas Yadav	
					New production technology of Guava Dr. D.S. Mishra	
6.	Dhanpur	--	--	30	Raising of fruit plants nursery Sh. Nihal Singh	
					Cultivation of Aonla in Gujarat Dr. A.K. Singh	
					Production technology of Dr. Vikas Yadav	
					New technology of Mango cultivation Dr. D.S. Mishra	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
7.	Sanjeli	05	25	30	Kitchen gardening Sh. Nihal Singh	01/08/2016
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Nutraceutical and therapeutical value of Aonla and Bael Dr. A.K. Singh	
					Nutritional value of Drumstick Dr. Lalu Prasad Yadav	
					Cultivation of Citrus fruits Dr. D.S. Mishra	
8.	Fatepura	22	08	30	Production technology of saragva Dr. Lalu Prasad Yadav	02/08/2016
					Production technology of Custard Apple Dr. Vikas Yadav	
					Propagation techniques in hot semi arid fruits Dr. A.K. Singh	

No.	Department/ Agency ATMA	No. of Farmers		Total	Topic	Date
		Male	Female			
					Minor fruits Mango And sweet orange Dr. Sanjay Singh	
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
9.	Dahod	27	--	27	Meditational properties of Bael and economies Dr. A.K. Singh	15/02/2017
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Scientific production of custard apple Dr. Vikas Yadav	
					Drip irrigation and fertigation for quality fruit production Dr. D.S. Mishra	
					Soil testing and fertilizer recommendations Dr. V.V. Apparao	
10	Garbada	28	--	28	Production technology of Custard apple Dr. Vikas Yadav	16/02/2017
					Production technology of Bael Dr. A.K. Singh	
					Guava production technology Dr. D.S. Mishra	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Raising of nursery Sh. Nihal Singh	
11	Zalod	27	--	27	Production technology of Aonla Dr. A.K. Singh	17/02/2017
					Production technology of Citrus fruit Dr. D.S.Mishra	
					Scientific production technology of Custard apple Dr. Vikas Yadav	
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
					Management of fruit orchards Sh. Nihal Singh	
12	Fatepura	--	28	28	Soil testing and fertilizer recommendation Dr. V.V. Apparao	18/02/2017
					Production technology of Wood apple Dr. Vikas Yadav	
					Production technology of Guava Dr. D.S. Mishra	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	

No.	Department/ Agency ATMA	No. of Farmers		Total	Topic	Date
		Male	Female			
					Propagation techniques in hot semi arid fruits Dr. A.K. Singh	
13	Limkheda	27	--	27	Medicinal value of Bael and Aonla Dr. A.K. Singh	20/02/2017
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Production technology of custard apple Dr. Vikas Yadav	
					Production technology of Guava Dr. D.S. Mishra	
14	Dhanpur	27	--	27	Post harvest value products of bael and Aonla Dr. A.K. Singh	21/02/2017
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Production technology of Wood apple Dr. Vikas Yadav	
					Production technology of Guava Dr. D.S. Mishra	
15	Dev Garh Baria	27	--	27	Production technology of Bael and Aonla Dr. A.K. Singh	22/02/2017
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Production technology of Guava Dr. D.S. Mishra	
					Raising of fruit plant nursery Sh. Nihal Singh	
16	Sanjeli	13	14	27	Propagation techniques in hot semi arid fruits Dr. A.K. Singh	23/02/2017
					Soil testing and fertilizer recommendation Dr. V.V. Apparao	
					Minor fruits Mango and Sweet orange Dr. Sanjay Singh	
					Propagation techniques in custard apple Dr. Vikas Yadav	
					Orchard management Sh. Nihal Singh	

3. TRAINING AND CAPACITY BUILDING

TRAINING ATTENDED

Dr. R. Bhargava

- Self management through personal profiling from 24-27 May, 2016 at SIAM, Jaipur
- Intellectual property and technology management from 13-18 June, 2016 at NAARM, Hyderabad.

Dr. R.S. Singh

- Self management through personal profiling from 24-27 May, 2016 at SIAM, Jaipur

Dr. D. K. Sarolia

- Competency enhancement for effective implementation of training function by HRD nodal officers of ICAR from 23-25 Feb., 2017 at NAARM, Hyderabad

Dr. D. S. Mishra

- Attended a refresher course on "Agricultural Research Management" from Nov., 15-26, 2016 at ICAR-National Academy of Agricultural Research Management, Rajendranagar, Hyderabad.

Dr. Vijay Rakesh Reddy S.

- Winter school on Recent advances in PHM of fruits and flowers for minimization of qualitative losses from 2-22 Nov., 2016 at IIHR, Bangaluru

Dr. Kamlesh Kumar

- Attended one month Institute Orientation Training programme at ICAR-CIAH, Bikaner during 11 April - 10 May, 2016.
- Attended three months Professional Attachment Training on "Pyramiding physiological traits contributin drought tolerance to polyembryonic rootstocks of mango (*Mangifera indica* L.) at ICAR-CISH, Lucknow during 12 May - 10 August, 2016.

Dr. Ajay Kumar Verma

- Attended one month Institute Orientation training programe at ICAR-CIAH, Bikaner from 11 April to 10 May, 2016.
- Attended three months Professional Attachment Tratining on "Parental Polymorphism Survey in Inter-specific Population of tomato through SSR and RAPD markers" at ICAR-IIVR, Varanasi from 12 May to 10 August, 2016.

Sh. Sanjay Patil

- Competency enhancement programme for technical officers of ICAR from 30 Nov., 2016 to 9 Dec., 2016 at NAARM, Hyderabad.

Sh. M. K. Jain

- E-procurement from 21-22 July, 2016 at NDRI, Karnal

Sh. D. C. Joshi

- Various modlues of ERP from 20-25 March, 2017 at IASRI, New Delhi

Sh. B. R. Khatri

- Cyber security for ICAR technical persons from 28 Sep.,-5 Oct. 2017 at IASRI, New Delhi
- E-procurement from 21-22 July, 2016 at NDRI, Karnal

Sh. B. R. Baria

- Principle & Production technology of hybrid seed in vegetables from 27 Sep.-8 Oct., 2016 at IIVR, Varanashi

Sh. Rakesh Meel

- Technical mgt. & business planning for entrepreneurship development from 13-18 March, 2017 at NAARM, Hyderabad

Sh. Ramdeen Khamiyada

- Reservation & roster preparation from 27-29 April, 2016 at NAARM, Hyderabad
- E-procurement from 21-22 July, 2016 at NDRI, Karnal

Sh. Raj Kumar

- Management development programme on public procurement from 24-29 October, 2016 at NIFM, Faridabad.

Sh. H. S. Patel

- E-procurement from 21-22 July, 2016 at NDRI, Karnal

TRAINING CONDUCTED

Dr. Sanjay Singh

- Conducted training from 18-21 Jan., 2017 on 'competency development for skilled supporting staff (As per skill deficiency area)' sanctioned by CIAH, Bikaner.

Dr. R. S. Singh

- Organized Agricultural Education Day programme on 22.7.2016 for students/teachers at CIAH, Bikaner and 100 participants were attended the programme. Agriculture education day was also organized at CIAH on 3.12.2016 in which 80 students/teachers were participated.
- Conducted Orientation training programme of ARS Probationer Scientist (Dr.Ajay Kumarr Verma, Scientist, (Vege. Sci.) and Dr. Kamlesh Kumar, Scientist (Fruit Sci.) for four weeks at ICAR- CIAH, Bikaner from11.4.2016 to 10.5.2016.

Dr. M. K. Jatav

- Farmer's schools were conducted on snap melon at Sarahkunjiya village, block Bikaner and Ranisar village block Khajubala under Bikaner in collaboration with ATMA.
- 20 FLDs on performance of potato cultivars at Farmers field at different locations in Bikaner district of Rajasthan.
- Front line demonstration on improved varietiey (AHS-82) and packages and practices of snap melon production at Sarahkunjiya village, block, Bikaner and Ranisar village, block, Khajubala under Bikaner District

Dr. S. M. Haldhar

- Conducted two days Farmers-Scientist Interface training as coordinator on 'IPM in arid horticulture crops' at ICAR-CIAH, Bikaner during 15-16 February, 2017
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Dr. Lalu Prasad Yadav

- Conducted one day on-farm training to the sixty tribal farmers on "up-liftment of tribal farmers through scientific cultivation of vegetables dated 11.01.2017 at Samalkuwa, Gogumba.

4. WOMEN EMPOWERMENT

PROGRAMMES/ACTIVITIES FOR EMPOWERMENT OF FARM WOMEN

During 2016-17, more than 150 farm women were visited to the Institute and had research-extension-farmers-interface meetings with them. They were exposed and educated about modern arid horticultural crop production technologies, value addition techniques of arid fruits and vegetables by delivering lectures and visiting them to the Institute. More than 500 farm women were also exposed and educated about modern arid horticultural crop production technologies, value addition techniques of arid fruits and vegetables by during displaying the technological exhibitions of the Institute in different farmers' fairs/ science congress and during other occasions. Similarly, many farm women were exposed and taught about modern arid horticultural technologies and how can they reduce the drudgery in crop production and post harvest management during farmers' field visit/ discussion/ delivering lecture in rural areas. Moreover, they were motivated to participate actively in main stream of arid horticultural developmental programmes and activities of the Government and Non- Government organizations.

5. AWARDS AND RECOGNITIONS

Dr. P. L. Saroj

- Working as President, Indian Society for Arid Horticulture, ICAR-CIAH, Bikaner (Rajasthan) from October, 2016 onwards.
- Nominated by the Council as Member of Editorial Board, *Indian Horticulture*, Pub. DKMA, New Delhi.
- Working as Executive Councilor, The Horticulture Society of India, New Delhi for third consecutive terms.
- Working as Member Task Force Group, PPV&FRA, New Delhi for finalization of DUS guidelines.
- Acted as Chairman, Town Official Language Implementation Committee of Dakshina Kannada (Karnataka) from 2012-2016.
- Chaired Technical Session on "Cashew Based Cropping Systems" during National Seminar on Plantation Based Cropping Systems for Improving Livelihood Security at ICAR-CPCRI, Kasaragod (Kerala) on 23-6-2016.
- Chaired Technical Session on "Production Technoloogy" During 11th National Symposium on "Noni and Medicinal Plants for Health and Livelihood" at ICAR-IISR, Lucknow from 3-4 December, 2016.
- Chaired Technical Session III during National Seminar on "Climate Resillient saline agriculture: Sustaining livelihood security" organized by CSSRI, Karnal at SKRAU, Bikaner during 21-23 January, 2017.
- Chaired Technical Session on "Canopy Management and Plant Growth Regulators" during Annual Group Meeting AICRP on Fruits at ICAR-Indian Institute of Horticulture Research, Bangaluru (Karnataka) from 4-7 January, 2017.
- Co-chaired Technical Session on "Technologies for Doubling Farmers Income" During 7th Indian Horticulture Congress, organized by Horticultrue Society of India from 15 November, 2016 at IARI, New Delhi.
- Participated as Guest of Honour during 25th Group Meeting of All India Coordinated Research Project on Palm" at CPCRI, Kasargod (Kerala) on 19-5-2016.
- Presided over the Inaugural Function on 30th DCR Foundation Day at ICAR-DCR, Puttur (Karnataka) on 18-6-2016.
- Acted as Guest of Honour during Interface Meeting with Agri-business Management Meeting at College of Agri-business Management at SKRAU, Bikaner on 20-10-2016.
- Acted as Chief Guest during National Conference on "Innovations in Physics and Futuristic Engineering Vision 2030" on 20th November, 2016 at Manda Institute of Technology, Bikaner (Rajasthan).
- ICAR-CIAH, Bikaner received 2nd Best Prize for showcasing of CIAH technologies/exhibits at IARI, New Delhi from 15-17 March, 2017.
- Acted as Guest of Honour during Agrians Sport Meet: 2016 at SKRAU, Bikanere on 17-10-2016.
- Acted as Guest in Western Region Agriculture Fair during Horticulture Session on 19-01-2017 at SKRAU, Bikaner.

- Chaired Scientific Advisory Committee Meeting at KVK, Panchmahal (Gujarat) on 02-02-2017.

Dr. Sanjay Singh

Awards

- Received The Horticultural Society of India Fellowship award -2016

Recognitions

- Attended IMC and PMC meeting as a member at CIAH, Bikaner on 25-4-16.
- Presented keynote lecture on Perspective of challenges and options in development of Horticulture in arid and semi arid conditions. Global conference on perspective of future challenges and options in agriculture organised by ASM foundation at Jalgaon from 28 to 30 May, 2016.
- Acted as Co-chairman in the session entitled 'Fertigation for enhancing the productivity of water and crops in the global conference on perspective of future challenges and options in agriculture organised by ASM foundation at Jalgaon from 28 to 30 May, 2016.
- Presented the lead paper on Genetic resource of under utilized fruits under semi arid ecosystem in western India in the International conference on agriculture, horticulture and plant sciences organised at Delhi during 25-6-2016 to 26-6-2016.
- Acted as Chairman of Session 7 in the International conference on agriculture, horticulture and plant sciences organised at Delhi during 25-6-2016 to 26-6-2016.
- On 16.06.16, attended the Board of Management meeting of NAU, Navsari at Krishi Bhawan, Gandhinagar(as D.G. nominee).
- Acted as a panelist in session 1 entitled new Paradigms in pomegranate production and improvement in profitability of farmers in National workshop on technological changes and innovations in pomegranate on 26 Sept, 2016 at JAU, Junagarh.
- Acted as member in the SAC meeting of KVK, Panchmahals, Vejalpur on 02-2-2017.
- Acted as Programme Director in training entitled 'Competency development for skill supporting staff (As per skill deficiency area)' sanctioned by CIAH, Bikaner for 4 at the station for SSS.
- Acted as chairman in the selection committee at CHES, Vejalpur for the selection of Young Professional on 23-3-2017.
- On 23.08.16, acted as expert in interview of Associate Professor, Medicinal Aromatic Plants, at NAU, Navsari.
- On 30.12.16, acted as expert in the selection committee at JAU, Junagadh for the post of SMS and Asstt.Professor.
- On 03.12.16, attended the meeting at Gandhinagar in the Office of Principal Secretary Agri. to develop the road map for doubling horticultural production.
- On 01.03.17, acted as expert in the selection committee at DMAPR, Boriavi, Anand for the selection of Project Assistant under NMPB funded project.
- On 21.03.17 acted as expert at DMAPR Boriavi, Anand in the selection committee for the selection of Junior Research fellow under DST funded project.

Dr. B. D. Sharma

Awards

- Best Oral presentation : Site specific nutrient management of kachri using omission plot technique in hot arid region of Rajasthan authored by MK Jatav, BD Sharma, DK Samadia and SR Meena in the International Conference on integrating climate, crop, ecology -the emerging areas of agriculture, horticulture, livestock, fishery, forestry, biodiversity and policy issues On 5th June, 2016 Organized by "Krishi Sanskrit" at Jawaharlal Nehru University, New Delhi

Recognitions

- Vice-Chancellor, SKRAU, Bikaner invited as member of the committee constituted to review the case of appointment on the post of Assistant Professor of opening the wait list vide letter No. 4(125)/SKRAU/Rectt/2016 dated 09-06-2016
- Director ATARI, Jodhpur Zone VI has invited to deliver the lecture on Scope and potential of arid horticulture in Rajasthan and Gujarat in the review meeting of KVK of Gujarat and Rajasthan held at AAU, Anand from 3-5th May 2016
- Director, CAZRI, Jodhour invited as convener of the interactive session on soil and water management and Chief Guest in the
- Director, NRCC, Bikaner has invited as Chief Guest on the occasion on International Yoga day on 22-06-2016 at NRCC campus.
- Principal Secretary (Agriculture/Horticulture), Government of Rajasthan, Ms. Neel Kamal Darbari has asked to deliver the presentation on the research highlights of the Institute in officers meeting of the state government.
- Vice Chancellor, SDAU, SK Nagar invited for being the Guest of Honour in the Date Exhibition, Competition and farmers Day at Mundra on 10th June 2016

Dr. Dhurendra Singh

Recognitions

- Convener of prize distribution committee for horticultural crops grower and confirmed prizes in 16 horticulture crops in West Zone of India Farmers Fair organised by SKRAU, Bikaner during 18-20 Feb. 2017

Dr. R. Bhargava

Awards

- Awarded Fellow of Indian Potato Association

Recognitions

- Invited as External Examiner to conduct the Thesis viva examination of Ph.D. student by IASE University, Sardarshahr.

Dr. R. S. Singh

Recognitions

- Worked as expert member of committee for selection for the post of Field Data Consultant under ICARDA funded project at RRS, CAZRI, Bikaner on 14.6.2016.
- Worked as Member of Committee constituted by Director, Horticulture, Govt of Rajasthan and visited to see the Field performance / problems in tissue culture date palm plantations in Anupgarh,Vijay nagar, Thandi, Raisinghnagar Vidhan Shabha Area , Sri Ganganagar District on 12.5.2016 and 22.6.2016 to vill. Kupli, 13AS, PTD, 6-PS, Raisinghnagar with team of committee members.
- Worked as Member of High level Committee as per Minister of Agric. Rajasthan constituted by Director, Horticulture, Govt. of Rajasthan and visited to farmers field of tissue culture date palm plantations with member of committee in villages of Hanumangarh district on 05.7. 2016.
- Worked as Member of Committee constituted by Director, Horticulture, Govt. of Rajasthan and visited for Field performance / problems in tissue culture date palm plantations, Govt. Khajoor Farm Bhojka, Sagra, Jaiselmer on 20.8.2016.
- Worked as Member of Committee constituted by Registrar, SKRAU for inspection of Swachhta abhiyan in SKRAU, Campus/college for award on the occasion of 15 August, 2016
- Worked as Nodal officer, HYPM for on line reporting of targets and achievements during the year.
- Acted as Major guide for PG student, COA, SKRAU, Bikaner for thesis research work at CIAH, Bikaner during 2016-17

Dr. A. K. Singh

Awards

- Received Distinguished Scientist Award by All India Agricultural Student Association (AIASA)

during National agricultural Convention on Opportunities and Agriprenuership for Agricultural Students (OASS) held on 7th October, 2016 at Rajasthan University of Veterinary and Animal Science, Bikaner, Rajasthan.

- Received "ISNS best Research paper on *Morinda* spp.'' for the year 2016 for the research paper ''Characterization of *Morinda tomentosa* genotypes under rainfed conditions of western India", by A. K. Singh *et. al.* 2014, published in *Indian Journal of Agricultural Sciences*, 88 (11): 115-122.
- Received best oral presentation Award for the research paper entitled Thar Diya: A early maturing variety of bael for dryland. In the book of abstracts of Global Conference on perspective of Future Challenges and Options in Agriculture held at jain Hills, Jalgoan from 28th may to 31 May, 2016, p.25-26.
- Received best oral presentation Award for the research paper entitled Profiling of *Morinda tomentosa* Heyne ex Roth accession for leaf, flower and fruit characters under dryland conditions of western India. Noni Search, Eleventh National Symposium on Noni and Medicinal Plants for Health and Livelihood Security held at IISR, Lucknow, 3rd & 4th December, 2016.

Recognitions

- Attended the programme 'Jamun, Kathal aur bael ki dekhbhal' which was live telecasted under Hello Kisan on D.D. Kisan News Channel on 15/04/2016, Doordarshan, Khel Goan, New Delhi.
- Reviewed the research paper of IJAS entitled Association and Path analysis in fenugreek (*Trigonella foenum graecum* L.) ID No 54091 authored by P. P. Singh, Mahendra Gujar and I. S. Narula, May 17, 2016.
- Acted as Convenor of the Session Risk Management and adoption of climate change Global Conference on perspective of Future Challenges and Options in Agriculture held at Jain Hills, Jalgoan from 28th may to 31 May, 2016.
- Nominated as the member of Editorial Board for the Indian Horticulture by D. G., ICAR and Secretary, DARE in August, 2016.
- Acted as panelist during the Technical Session ''Disease Management and Strategies For Smart Production System" in National Workshop on Technological Changes and Innovation in Pomegranate Production and Utilization for Enhancing Farmers' Income held 26/09/2016 at JAU, Junagarh, Gujarat .
- Reviewed the book entitled Managing Postharvest Quality and Losses in Horticultural crops (Edts. K. L. Chadha and R. K. Pal), Published by Daya Publishing House, A division of Astral International Pvt. Ltd., New Delhi during 2016.

Dr. Hare Krishna

Recognitions

- Reviewed research articles for International journals like 'Scientia Horticulturae', 'Journal of Food Quality', 'International Journal of Food Properties', 'Journal of Food Science and Technology', 'Acta Horticulturae', 'HortScience', 'Journal of Agricultural Science and Technology' and Indian journals like 'Journal of Food Science and Technology', 'Indian Journal of Agricultural Sciences', 'Indian Journal of Horticulture' and 'Indian Journal of Arid Horticulture'.

Dr. M. K. Jatav

Awards

- Outstanding Scientist award received in IJTA 3 International Conference on Agriculture, Horticulture & Plant Sciences at New Delhi, India during 25th to 26th June 2016 at New Delhi by Academic Research Journals (India).

Recognitions

- Best Oral presentation on Yield, physical and microbial properties of fruit based Diversified cropping Models for Arid Region of Rajasthan authored by MK Jatav, Hare Krishna, SR Meena and R Bhargava in IJTA 3 International Conference on Agriculture, Horticulture & Plant Sciences at New Delhi, India during 25th to 26th June 2016 at New Delhi organized by Academic Research Journals (India).
- Best Oral presentation on Site specific nutrient management of kachri using omission plot technique in hot arid region of Rajasthan authored by MK Jatav, BD Sharma, DK Samadia and SR Meena in The International conference on integrating climate, crop, ecology -the emerging areas of agriculture, horticulture, livestock, fishery, forestry, biodiversity and policy issues On 5th June, 2016 Organized by "Krishi Sanskrit" at Jawaharlal Nehru University, New Delhi.
- Worked as a member committee for conducting out-door games and preparation of play ground (men & women) during the ICAR zonal sport tournament held at ICAR- NRCC, Bikaner from 24.09.16 to 27.09.16
- Worked as a chairman of Registration Committee on occasion of 21st Group Meeting of AICRP on AZF held at ICAR-Central Institute for Arid Horticulture, Bikaner during 5-7th March 2017.
- Worked as a Rapporteur during the session of "Interaction with farmers and developmental agencies" of 21st Group Meeting of AICRP on AZF held at ICAR-Central Institute for Arid Horticulture, Bikaner during 5-7th March 2017.

Dr. P. P. Singh

Awards

- Secured Second position in the poster on Brinjal Genotype Evaluation in 8th Global conference on Perpective of future Challenges and options in Agriculture to held on 28th to 31st May, 2016; Jain hills, Jalgaon , Maharashtra, India.
- Awarded first position in oral presentation entitled "Variability studies of Aonla genotype for north Eastern Region" in session III held on 4th june,2016 in International conference on Integrating climate, crop ecology-The emerging areas of Agriculture, Horticulture, Livestock, Fishery, Forestry, biodiversity and policy Issues at Jawaharlal Nehru University, New Delhi.
- Awarded first position in oral presentation entitled "Himalayan region a new Hope for frost tolerant Aonla (*Emblica officinalis*) species exploration for cultivation in Hot Arid climates" in International conference on Agriculture, Food Science, Natural resources management and Environment Dynamics: The technology, people and Sustainable Development at Department of Agricultural and Extension, Bidhan Chandra Krishi ViswaViddyalaya, Mohanpur, Nadia, West Bengal, India.

Recognitions

- Acted as 'Convener' in Technical session 07 entitled "Risk management and adaptation to climate change" in 8th Global conference on Perpective of future Challenges and options in Agriculture to held on 28th to 31st May,2016;Jain hills, Jalgaon , Maharashtra, India.

Dr. S. R. Meena

Recognitions

- Displayed the best technological exhibition of the Institute in National seed distribution farmers' fair and farmers' *Sangosthi* organised by NRCSS, Ajmer from 18 -19 Sept., 2016 during which the exhibition of our Institute was awarded with First Prize for the best display of the same.
- Ddisplayed one of the best technological exhibition of the Institute in "*Krishi Unnati Mela* "organized at in IARI, Pusa, New Delhi 15.03.17 to 17.03.17 during which the exhibition of the Institute was honoured with Second Best Award for the best display of the same.

- Member of "committee for conducting out-door games and preparation of play ground (men & women)" during the ICAR Zonal sport tournament held at ICAR- NRCC, Bikaner from 24.09.16 to 27.09.16
- Chairman of " Farmers session and press publicity committee" during the workshop/ 21st Research Workers Group Meet on AICRP-AZF held at ICAR-CIAH from 05.03.17 to 07.03.17
- Rapporteur during the Session "Interaction with farmers and developmental agencies" of the workshop/ 21st Research Workers Group Meet on AICRP-AZF held at ICAR-CIAH from 05.03.17 to 07.03.17

Dr. D. S. Mishra

Recognitions

- Acted as member expert in farmers' scientist interaction during bael day celebration on April 04, 2016 at CHES,Vejalpur (Godhra).
- Attended a meeting with Govt. Officials of Parbhani District, Maharashtra under a programme 'Engagement of Parbhani District Administration with ICAR Institutes for enhancing betterment of farmer's of Parbhani District with the guidance of ICAR Institutions expertise' during August 03-05, 2016.
- Acted as Editor (National) of the NAAS rated Journal HortFlora Research Spectrum (Biosciences & Agriculture Advancement Society), Meerut).
- Reviewed the research paper of India Journal of Horticulture entitled "Effect of mulching and controlled irrigation on fruit characteristics and yield of litchi (*Litchi chinensis* Sonn.) cv. Dehradun" on 28/8/2016.
- Reviewed the research paper of India Journal of Agricultural Sciences entitled "Dynamics of climate and pollinator species influencing litchi (*Litchi chinensis* Sonn.)" on July 01, 2016.
- Reviewed the research paper of International Journal of Agriculture Science entitled "Efficacy of Indole Butyric acid (IBA) on survival and rooting of stem cuttings of star gooseberry (*Phyllanthus acidus*)" on July 9, 2016.
- Reviewed the research paper of International Journal of Agriculture Science entitled "Assessment of nutrient composition of papaya cultivars grown under protected condtions" on Sept. 8, 2016.
- Reviewed the research paper of International Journal of Agriculture Science entitled "Morphologica evaluation of radish (*Raphanus sativus* L.) genotypes in foothill conditions of Uttarakhand" on July 18, 2016.
- Reviewed the research paper of Legume Research entitled "Screening of cowpea (*Vigna unguiculata* (I.) Walp.) for aluminium tolerance in relation to growth, yield and related traits" on Oct.10, 2016.
- Reviewed the research paper of Legume Research entitled "Influence of phosphorus and biofertilizers on growth and yield of cowpea (*Vigna unguiculata*) in acidic soil of North Eastern Himalayan region of India" on March 03, 2017.

Dr. S. M. Haldhar

Awards

- Scientist of the Year Award-2016. *All India Agricultural Students Association (AIASA), NASC Complex, New Delhi dated 07.10.2016*

Recognitions

- Editor of Indian Journal of Scientific Research and Technology (ISSN: 2321-9262, online)
- Editor of World Journal of Anthropology, Entomology and Wildlife (WJAEW)
- Editor of Journal of Environmental and Agricultural Sciences (ISSN 2313-8629)
- Editor of International Journal of Agricultural Sciences and Natural Resources published by American Association of Science and Technology (AASCIT), USA
- Editor of Journal of Zoology (Reg. No. SH/311R/2-16AP/42/09)

Dr. Mukesh Kumar Berwal

Awards

- Best poster award-2016 (S. Kannan, K. B. Hebbar, M. R. Helen, Berwal MK., P. Sugatha. (2016). Interaction effect of elevated CO2 and elevated temperature with water defi cit stress on coconut seedlings. 3rd International Symposium on Coconut Research and Development 10 - 12 December 2016, ICAR - CPCRI, Kasaragod, S5P-01.)

Dr. Vijay Rakesh Reddy S.

Awards

- Awarded the *IARI-Merit Medal* for outstanding academic performance in doctoral degree programme during 54th Convocation of ICAR-IARI held during February 2016.

Recognitions

- Received Best Oral presentation in National Seminar on 'Zero Hunger Challenges-Food Security for All' held during 4-5 January 2017 at Guntur, AP.
- Served as a reviewer for Bio-info publications.

Dr. Kamlesh Kumar

Recognitions

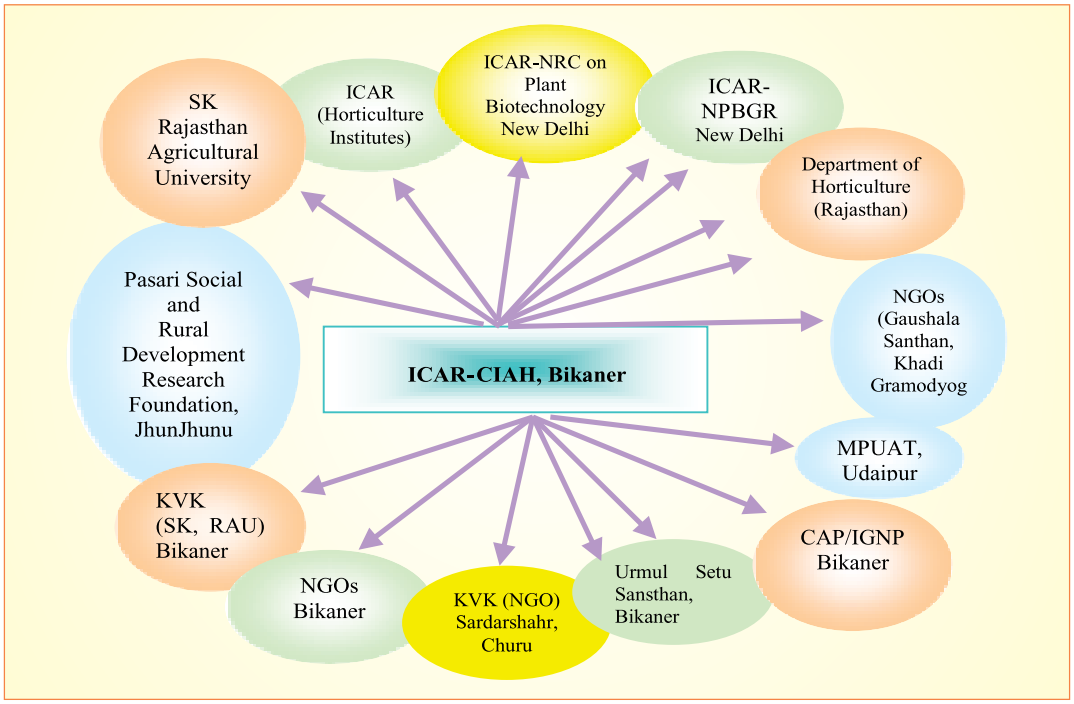
- Best poster presentation award-2016 in National Conference on "Fruit breeding in tropics and subtroics-An Indian perspective at ICAR-IIHR, Bengaluru.

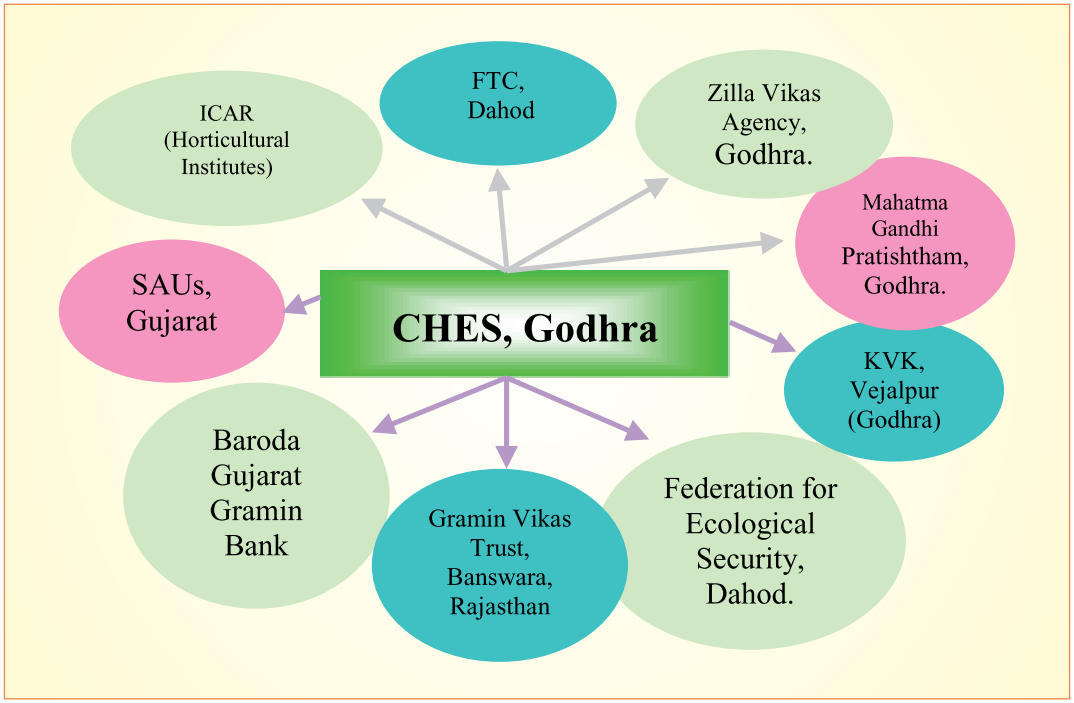
Dr. Ajay Kumar Verma

Recognitions

- Member of organizing committee for National Agricultural Convention on Opportunities in Agripreneurship for Agricultural Students (OAAS) jointly organized by RAJUVAS and AIASA, Rajasthanb on 7 October, 2016.
- Received certificate of appreciation from JNKVV, Jabalpur for performance in ICAR exam during 53rd University Foundation Day on 01st October, 2016.

6. LINKAGES AND COLLABORATIONS





7. EXTERNALLY FUNDED PROJECTS

Bikaner

1. Validation of DUS Testing Guidelines for Cucurbits i.e. Watermelon and Muskmelon

Nodal Officer	:	Director
Name of PI	:	Dr. B.R. Choudhary
Funding Agency	:	Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

Conducted DUS testing of 06 candidate varieties of watermelon during summer 2016 and submitted the report to PPV&FRA, New Delhi. Maintained the seed of 08 reference varieties of watermelon and 12 of muskmelon through inbreeding for further use in DUS testing.

2. DUS Centre on *Ber*

Name of PI	:	Dr. Hare Krishna
Co-PI	:	Dr. R. Bhargava
Funding Agency	:	Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

During the reported period, a new separate block of Indian jujube (*Ber*) is being developed at ICAR-CIAH, Bikaner for the reference varieties as mentioned in National DUS Test Guidelines for *Ber*. These reference varieties are also being maintained at Germplasm block of *ber*. Morphological characteristics of these reference varieties were also recorded so as to confirm the distinctness, uniformity and stability in the described characters.

3. DUS Centre on Date palm Horticultural Crop

Name of PI	:	Dr. R. S. Singh
Co-PI	:	Dr. R. Bhargava
Funding Agency	:	Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

Under the DUS centre on Date palm, the spathe emergence/opening characters, leaflet size, thorns were recorded in 26 date palm varieties and variation was observed among the varieties. Delay in emegence of spathe was noticed in male and female palms during the year. The data on fruiting character was recorded during third year of 'study. However, fruits were damaged in maximum varieties due to continues rain at harvesting time. The draft guidelines for DUS on date palm was prepared and submitted to Chairman, Task force committee and Joint Registrar, PPV&FRA for suggestion/comments and to conduct of TF meeting for further course of action for finalization of DUS guidelines.

4. Validation of DUS Descriptor for Bael

Name of PI	:	Dr. A. K. Singh
Funding Agency	:	Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

A total of twelve varieties *viz.*, Goma Yashi, Thar Divya, CISH-B-1, CISH-B-2, NB-16, NB-17, NB-5, NB-7, NB-9, Pant Aparna, Pant Shivani, Pant Sujata and Pant Urvashi were characterized for their morphological and fruit characters to developed DUS guidelines and these reference varieties are being maintained.

5. Characterization of Aonla Varieties for Developing DUS Test Guidelines

Co-Nodal Centre	:	CHES, Godhra
Name of PI	:	Dr. A. K. Singh
Funding Agency	:	Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

Growth attributing characters

Twelve varieties of aonla (Chakaiya, Banarsi, Francis, Krishna, Kanchan, NA-10, Anand-1, Anand-2, NA-7, Goma Aishwarya, BSR-1 and BSR-2) were characterized for their distinct, stable and uniform characters and are being maintained under field condition.

6. Consortium Research Platform on Agro-Biodiversity

Name of CCPI	:	Dr. R. S. Singh, Dr. Hare Krishna and Dr. A. K. Singh
Funding Agency	:	ICAR Scheme

The project was initiated as Co-operating centre for characterization, documentation, regeneration and conservation of arid fruit crops. The work on morphological characterization of bael (30), aonla (15) and lasoda (15) was carried out during the year. Variation in shape and size of leaves and fruit characters was observed in bael. Fruit shape and size was varied in aonla germplasm. Leaves arrangement was also noticed in lasoda and size of fruits were varied.The documentation in the form a bulletin on Mulberry was published and a research paper was submitted for publication.

Characterization of bael germplasm

A total of thirty bael germplasm were characterized for their morphological and fruit quality attributes under rainfed semi-arid conditions. Variation in growth habit was observed as upright, spreading, semi spreading and drooping type whereas foliage as compact, dense and sparse in all the germplasm. Tree shapes of different genotypes were observed in form of dome, irregular, semi circular, broad vase and elliptical. Different germplasm under study showed variability in the leaf characters *i.e.,* leaflet shape (ovate, ovate to cordate, broadly lanceolate to ovate, broadly ovate, elliptical and elliptical to lanceolate), leaf margin (superficially, prominent; crenate, crenulate), leaf apex (acute, acuminate, slightly aristate and subacute), leaf base (broadly cuneate, round, narrowly cuneate and truncate) and leaf surface (dull rough and shiny smooth) in rainfed semi-arid ecosystem of western India. The bark colour was yellowish grey, grayish yellow, blackish grey, dark grey to light, whereas splitting pattern was irregular intersecting striations having small rectangular blocks. There were wide range of variability found in floral biology *i.e.*, floral bud emergence initiated from last week of April to first week of May and cessation occurred during second fortnight of June, whereas peak period was observed during the last week of May.

The peak period of flowering was observed in the first fortnight of June. The bud size and flower size, petal size and pedicel size ranged between 12-18mm × 24-35mm, 10.00-13 × 7.00 - 9.50mm, 11.50-17.20 mm × 7.10-10.15 mm and 4-10 mm × 2-2.5 mm respectively among all the studied genotypes. Genotypes showed variation in stamen length (6.50-8.50 mm), pollen diameter (41.25 mm - 45.0 mm), ovary length (4-8mm), ovary width (2.50-4.50 mm), style size (1.00-1.50 × 1.50-2.50 mm), stigma size (2.50-3.50 mm x 2.50-3.50 mm) and pollen viability (94.12 - 98.50%), respectively.

The TSS content in pulp varied between 32.33°B-41.20°B, TSS in mucilage 37.17 ° 52.50 ° B, titratable acidity 0.31%- 0.51% ,vitamin C, 12.02 to 22.39 mg/100 g, total sugar 17.14 22.14 per cent, non reducing 13.18 to 16.69 and reducing sugar 3.19 to 3.61, respectively among the genotypes. The total phenols considered to be one of the most desirable characters in *bael* which ranged from 1992 - 3875 mg per 100g in the studied germplasm .

Results of study revealed that the fruit weight, fruit length, fruit girth, number of seeds per fruit, number of seed sacs, shell weight, shell thickness, pulp (%), seed (%) and fibre (%) varied significantly among the germplasm characterized for physical attributes.

Characterization of aonla germplasm

Among the germplasm of aonla (15), growth habit was observed upright, spreading, tall upright, tall spreading, tall drooping and tall semi-spreading. The foliage was visualized as dense and sparse among all the germplasm. The leaflet colour (green to pale yellowish green), shape (oblong, oval to oblong and elliptical), apex (obtuse and acute) among the germplasm. Variations in fruit shape *i.e.*, triangular, flattened oblong flattened oval, and flattened round whereas size of the fruit was observed as small, large and medium. Variation in

trunk colour (grey and whitish grey), inflorescence colour (deep pink, pinkish green and yellowish green), fruit shape (triangular, flattened round and flattened oval), fruit colour (whitish green,, light green, yellowish green, greenish yellow, pinkish yellow) flesh colour (whitish green and yellowish green), fruit stalk (short thin and short thick), fruit stem end cavity (shallow and deep) and stone shape (triangular, oval and oval round) were observed among the characterized germplasm of aonla under semi-arid conditions. The size of leaves in terms of length and breadth ranged between 1.32 -1.70 cm and 0.27-0.40 cm, respectively.

Results of study revealed that the different germplasm of aonla also showed variation in fruit set, fruit retention, fruit weight, fruit length, fruit width, juice per cent, acidity, vitamin c and TSS/ acidity ratio amongst the characterized germplasm of aonla.

7. Network Project on Micronutrient management in Horticultural Crops for Enhancing Yield and Quality

Name of PI	:	Dr. B. D. Sharma
Name of Co-PI	:	Dr. R. Bhargava Dr. B. R. Choudhary
Funding Agency	:	ICAR Scheme

Name of the crops dealt in the project with scientific name

Detailed annual progress report

Name of the crop	Variety	Duration (Long/ medium/short)	Date of sowing/ transplanting	Date of harvest
Muskmelon	RM-50	Short	February 2015	May 2015
Watermelon	Thar manak	Short	February 2015	May 2015

Treatment details

Experiment: Effect of different micronutrients on yield and quality of muskmelon.

Experimental details

1.	Crop	:	Muskmelon (*Cucumis melo* L.)
2.	Sowing time	:	22th February, 2016
3.	Spacing	:	2.0x0.5m
4.	Experimental design	:	Randomized Block Design (RBD)
5.	Replications	:	3
6.	No. of treatments	:	10
7.	Plot size	:	2mx7m=14m^2
8.	Variety	:	RM-50

Details of treatments

			Source
T_1	:	Zn @ 15kg/ha	Zinc sulphate (21% Zn)
T_2	:	B @ 5kg/ha	Borax (11.3% B)
T_3	:	Fe @ 15kg/ha	Ferrous sulphate (20% Fe)
T_4	:	Cu @ 5kg/ha	Copper sulphate (35% Cu)
T_5	:	Mixture of all	
T_6	:	Mixture of all without Zn	
T_7	:	Mixture of all without B	
T_8	:	Mixture of all without Fe	
T_9	:	Mixture of all without Cu	
T_{10}	:	Control	

In all treatments RFD will be applied @ N 100kg/ha, P_2O_5 60 kg/ha and K_2O 60 kg/ha. Half quantity of N and full quantity of P_2O_5 and K_2O will be applied before sowing in channels *i.e.* at the time of field preparation. The remaining half quantity of N will be divided in two equal portions and applied in standing crop at 20 DAS and 40 DAS.

Micronutrient application in muskmelon under arid conditions

Field experiments were conducted at CIAH research farm with muskmelon cultivar, RM-50**,** during 2016 in the kharif season to investigate the role of application of micronutrient on performance of muskmelon. The muskmelon crop received differential doses of different micronutrient as per schedule of treatments. The ten treatments consisting Zn @ 15kg/ha, B @ 5kg/ha, Fe @ 15kg/ha, Cu @ 5kg/ha, Mixture of all, Mixture of all without Zn, Mixture of all without B, Mixture of all without Fe, Mixture of all without Cu and Control and planting were replicated 3 times in a randomized block design.

The maximum fruit yield was recorded T_5 (Mixture of all) and T_9 (Mixture of all without Cu) which was statistically at par with T_7, T_8, T_6 and T_3 and in other treatment yield was significantly less. The TSS was in the ranged of 9.50 to 11.50 and maximum TSS was recorded in T_5 while minimum was in T_{10}. The average fruit weight ranged from 550 to 700g and maximum fruit weight was recorded in T_5 and minimum fruit weight (550g) was in T_{10}. Application of different micronutrient increased the flesh thickness of the fruit and maximum flesh thickness was recorded in T_5 and minimum in T_{10} (Table 43).

Effect priming with iron and boron on germination and yield of mateera (watermelon type)

The laboratory seed priming tests of mateera were performed in a completely randomized design using solutions containing 4 concentrations of iron and boron. There were three replications of priming solution plus three replications of an unprimed control. Seeds were soaked in the required aqueous solutions of chemicals as $FeSO_4.7H_2O$ (Fe 26%, S 11.5%) or H_3BO_4 (B 17%). The priming solution concentrations chosen for the tests were 0.5%, 1.0%, 1.5% and 2.0% each of Fe and B, and a seed treatment with combined 1.5% Fe + 1.0% B. Each treatment involved weighing approximately 10 g of seeds into a plastic cup, adding 20ml of the priming solution and allowing mixture for 12h. Seeds, after soaking were rinsed with distilled water. A portion of the primed seeds were dried and analyzed for Fe and B concentrations in primed and before primed seeds which are presented here (Table 44).

Table 43. Micronutrient application in muskmelon (*Citrulus lanatus*) under arid conditions.

Treatments	Yield (q/ha)	TSS (%)	Av fruit wt (g)	Flesh thickness (cm)
Zn @ 15kg/ha (T_1)	180.00	10.00	650.00	1.75
B @ 5kg/ha (T_2)	165.00	10.00	620.00	1.75
Fe @ 15kg/ha (T_3)	195.00	11.00	650.00	1.75
Cu @ 5kg/ha (T_4)	160.00	09.50	620.00	1.75
Mixture of all (T_5)	220.00	11.50	700.00	1.85
Mixture of all without Zn (T_6)	190.00	10.50	670.00	1.85
Mixture of all without B (T_7)	205.00	11.00	680.00	1.85
Mixture of all without Fe (T_8)	205.00	10.50	650.00	1.80
Mixture of all without Cu (T_9)	220.00	10.50	680.00	1.80
Control (T_{10})	150.00	09.50	550.00	1.60
CD	38.20	00.95	0.52	0.15

Table 44. Effect of concentration of Fe and B in the priming solution on their concentrations in primed mateera seeds.

Micronutrients	Concentrations in		
	Priming solution (%)	Seeds before priming (mg kg^{-1})	Seeds after priming (mg kg^{-1})
Fe	0.5	4.70	32.60
	1.0		48.25
	1.5		55.30
	2.0		58.20
B	0.5	3.30	14.20
	1.0		22.10
	1.5		27.20
	2.0		29.10

For each replicate, 25 seeds were placed in a germinator at 25± 1°C for a germination test in a petri dish containing Whatman filter paper No. 1. Germination was checked once in a day for 10 days. The recorded data were final germination percentage, seedling biomass and seedling vigour index. The final germination percentage (GP) was calculated as the cumulative number of germinated seeds with normal redicles . The seedling vigour index (SVI) was calculated by using the following equation below:

GP = SDW and SSVI, where GP, SDW and SVI are the final germination percentage, seedling dry weight and seed vigour index, respectively.

The effect of studied treatment on the final germination percentage was significant. Seed priming with concentration of 1 and 1.5% Fe and 1% B solely or in combination and 1.5% Fe + 1% B for 12h increased the rate of germination of all mateera seeds compared to an unprimed control. The mean of germination from Fe-primed seeds was 85% but the B-primed seeds, the rate was same as that of unprimed seeds (Table 45). The final germination percentage after 10 days increased in all solutions as compared with the control, except for a 3% and 5% reduction in germination in those seeds primed with the 1.5% and 2% B solutions, respectively.

In the laboratory experiments, the effect of seed treatments with Fe and B solely or in combination on seedling dry weight (SDW) was significant. The highest SDW (25.5mg plant^{-1}) was noticed with 1.5% Fe + 1% B followed by the 1.5% Fe and 1% B treatments (22 and 20mg plant^{-1}, respectively). Lower values for SDW were recorded in the 2% B (11mg plant^{-1}) and control treatments (12mg plant^{-1}). In this experiment the SDW from seeds treated 0.5% Fe was found to be similar to that of the 2% Fe treatment. The difference between the control and seeds primed with 2% B was not significant for SDW.

Table 45. Some of the germination and growth parameters of mateera as affected by priming treatments.

Priming treatments	Final germination percentage (%)	Seedling dry weight (mg plant^{-1})	Seedling vigour index
Fe (0.5%)	80	16.0	1.40
Fe (1.0%)	89	18.2	1.65
Fe (1.5%)	93	23.0	2.11
Fe (2.0%)	78	14.5	1.20
B (0.5%)	86	15.9	1.43
B (1.0%)	90	22.0	1.50
B (1.5%)	79	15.5	1.20
B (2.0%)	78	11.0	0.75
Fe (1.5%) + B (1%)	98	25.5	2.30
Control	83	12.0	0.92
LSD	3.2	2.90	0.27

The seedling vigor index (SVI) responded positively and significantly to seed priming with Fe, B, and Fe + B as compared to that of unprimed seeds. The data show that the SVI can be increased by seed priming with Fe and B up to 1.58 and 1.21, respectively against the control. In the present study, seeds primed with 1.5% Fe had a higher SVI (2.11), but a further increase in Fe concentration in the solution did not increase the SVI. Similarly, when the B concentration increased beyond 1%, the SVI in B-primed seeds was restricted. Priming the seeds with micronutrients makes them able to rapidly imbibe water and revive metabolism and germination. This results in a higher germination rate improved stand establishment, increased drought and pest tolerance, and ultimately higher yields.

8. Network Project on Organic Farming in Horticultural Crops

Name of PI	:	Dr. B. D. Sharma
Name of Co-PI	:	Dr. R. Bhargava, Dr. S. K. Maheshwari Dr. B. R. Choudhary
Funding Agency	:	ICAR Scheme

Name of the crops dealt in the project with scientific name

1. Kinnow mandarin: Hybrid of citrus 'King' (*Citrus nobilis*) × 'Willow Leaf' (*Citrus* × *deliciosa*)

2. Muskmelon (*Cucumis melo L.)*

Detailed annual progress report

Name of the crop	Variety	Duration (Long/ medium/short)	Date of sowing/ transplanting	Date of harvest
Muskmelon	RM-50	Short	February 2015	May 2015
Kinnow mandarin	Hybrid of two citrus mandarin 'King' (*Citrus nobilis*) × 'Willow Leaf' (*Citrus* × *deliciosa*)	Long	February 2015	January 2016

Treatment details

For Muskmelon crop

Treatment	Details
T_1	FYM @ 200q/ha
T_2	Vermicompost @ 50q/ha
T_3	Neem cake@ 5q/ha
T_4	FYM @ 200q/ha+ Biofertilizer*
T_5	Vermicompost @ 50q/ha +Biofertilizer
T_6	Neem cake @ 5q/ha+ Biofertilizer
T_7	FYM @ 100q/ha+ Vermicompost@ 25q/ha
T_8	FYM @ 100q/ha+Neem cake@ 2.5q/ha
T_9	Vermicompost @ 25q/ha + Neem cake@ 2.5q/ha
T_{10}	FYM @ 100q/ ha+ Vermicompost @ 25q/ha +Biofertilizer
T_{11}	FYM @ 100q/ha+ Neem cake@ 2.5q/ha+ Biofertilizer
T_{12}	Vermicompost @ 25q/ ha + Neem cake @ 2.5q/ha+Biofertilizer
T_{13}	Inorganic control
T_{14}	Absolute control

Experimental Design: Randomized Block Design

Replications: Three

Varity used: RM-50

A field experiment was conducted during summer season of 2016 at research farm of ICAR-CIAH, Bikaner to observe the effect of different organic treatments on growth, yield and quality of muskmelon variety RM-50. The experiment was laid down in randomized block design with three replications comprising 14 treatments. The spacing maintained between rows was 2.0m and between plants 0.50m. The statistical analysis of the data presented in table 46 revealed that significant increase in fruit weight (807.93 g), fruit diameter (12.40 cm), flesh thickness (2.11 cm), TSS (11.45%), marketable fruit/ plant (4.07), marketable fruit yield/ plant (3.29 kg) and marketable yield/ ha (230.65 q) with the application of FYM @ 100 q/ ha + vermicompost @ 25 q/ha + biofertilizer (T_{10}) over all treatments however, at par with FYM @ 100 q/ha + vermicompost @ 25 q/ha (T_7). Number of vines/ plant at last harvest (4.80) were significantly increased by FYM @ 100 q/ha + vermicompost @ 25 q/ha + biofertilizer (T_{10}). Application of neem cake @ 5 q/ ha + biofertilizer (T_6) resulted in lowest incidence of wilt (7.14%) closely followed by neem cake @ 5 q/ ha (T_3) with 7.69% incidence of wilt.

Incidence of wilt disease varied from 7.40 to 29.04% in different treatments. Incorporation of neem cake @ 5 q/ha + biofertilizer (T_6) was the most effective with minimum incidence (7.14%) of wilt, followed by neem cake @ 5 q/ha (T_3) with wilt incidence of 7.91%. Next best treatments were observed FYM @ 100 q/ha + neem cake @ 2.5 q/ ha + biofertilizer (T_{11}) and vermicompost @ 25 q/ ha + neem cake @ 2.5 q/ha + biofertilizer (T_{12}) with wilt incidence of 9.47 and 12.31%, respectively which were found statistically at par with another. Maximum incidence (29.04%) of wilt was recorded in control without any treatment, followed by inorganic control (T_{13}) with wilt incidence of 23.06% which were differing statistically with each other. Organic amendments with organic wastes, composts and peats have been applied to control vegetable diseases caused by soil-borne pathogens such as *Fusarium* spp.

Table 46. Effect of different organic treatments on growth, yield and quality of muskmelon during 2016.

Treatments	No. of vines/ plant	Fruit weight (g)	Fruit diameter (cm)	Flesh thickness (cm)	TSS (%)	Marketable fruit/ plant	Marketable fruit yield/ plant (kg)	Marketable fruit yield/ ha (q)	Incidence of wilt (%)*
T_1	3.93	637.20	10.23	1.65	9.86	1.94	1.94	155.49	20.00 (26.48)
T_2	3.87	647.33	10.39	1.57	9.48	2.12	2.12	169.29	20.00 (26.40)
T_3	3.60	567.53	9.52	1.42	9.24	1.54	1.54	123.51	7.69 (15.38)
T_4	4.13	670.53	10.36	1.69	9.81	2.11	2.11	168.88	25.00 (29.83)
T_5	4.07	673.47	10.67	1.74	10.29	2.28	2.28	182.57	16.67 (24.04)
T_6	3.73	666.13	10.44	1.76	9.60	2.19	2.19	174.87	7.14 (15.33)
T_7	4.13	733.47	11.40	1.95	11.21	2.65	2.65	185.52	18.33 (25.30)
T_8	4.00	682.53	10.83	1.65	10.31	2.21	2.21	177.05	14.29 (21.98)
T_9	3.87	668.60	10.55	1.81	10.44	2.23	2.23	178.38	16.02 (23.36)

Contd...

Table 46 (Concluded)

Treat-ments	No. of vines/ plant	Fruit weight (g)	Fruit diameter (cm)	Flesh thickness (cm)	TSS (%)	Market-able fruit/ plant	Marketable fruit yield/ plant (kg)	Marketable fruit yield/ ha (q)	Incidence of wilt (%)*
T_{10}	4.80	807.93	12.40	2.11	11.45	3.29	3.29	230.65	15.38 (22.93)
T_{11}	4.13	671.60	10.45	1.72	10.55	2.17	2.17	173.35	10.00 (18.04)
T_{12}	4.00	660.07	10.61	1.59	10.03	2.15	2.15	172.12	13.50 (21.38)
T_{13}	3.80	665.20	10.93	1.77	10.39	2.18	2.18	174.18	25.00 (29.76)
T_{14}	3.27	498.60	9.18	1.39	9.33	1.50	1.50	120.09	33.33 (35.25)
SEm±	0.22	35.14	0.37	0.07	0.11	0.18	0.18	13.54	1.99
CD at 5%	0.63	102.16	1.08	0.21	0.31	0.51	0.51	39.36	5.75
CV (%)	9.48	9.21	6.09	7.24	1.81	13.85	13.85	13.76	14.30

*Angular transformed value in parentheses.

**Azotobactor* @ 5kg/ha and Phosphorus solubilizing bacteria (PSB) @ 5kg/ha applied as soil treatment.

Treatment details

For Kinnow mandarin crop

Treatment	Details
T_1	FYM @ 100 kg/plant
T_2	Vermicompost @ 30kg/plant
T_3	Neem cake@ 10kg/plant
T_4	FYM @ 100 kg/plant + Biofertilizers*
T_5	Vermicompost @ 30kg/plant +Biofertilizers
T_6	Neem cake@ 10kg/plant + Biofertilizers
T_7	FYM @ 50 kg/plant + Vermicompost @ 15kg/plant
T_8	FYM @ 50 kg/plant + Neem cake@ 5kg/plant
T_9	Vermicompost @ 15kg/plant + Neem cake@ 5kg/plant
T_{10}	FYM @ 50 kg/plant + Vermicompost @ 15kg/plant +Biofertilizers
T_{11}	FYM @ 50kg/plant + Neem cake@ 5kg/plant + Biofertilizers
T_{12}	Vermicompost @ 15kg/plant + Neem cake@ 5kg/plant +Biofertilizers
T_{13}	Inorganic control
T_{14}	Absolute control

Experimental Design: Randomized Block Design
Replications: Three (Two plant / replication)
Varity used: Hybrid of citrus 'King' (*Citrus nobilis*) × 'Willow Leaf' (*Citrus* × *deliciosa*)

The experiment was conducted on 13 year old orchard of Kinnow mandarin at research farm of ICAR-CIAH, Bikaner. The plants were receiving the recommended dose of FYM along with the N, P and K fertilizers till the year 2013. In the month of February 2016, the doses of different organic treatments were deployed from 1 to 12 treatments while in treatment 13, recommended doses of N, P and K were applied and in treatment No. 14 no fertilizers and organic treatments were applied and kept as absolute control. The flowering was noticed in the month of March-April and in the last week of April 2016, fruit set was observed. The picking of fruits has been started in the month of December 2016 and complete harvest was done in the month of January 2017. The total fruit yield, fruit quality parameters were recorded in all treatments. Data

Table 47. Effect of different organic treatments on growth, yield and quality of Kinnow.

Treatments		Fruit weight (g)	Juice content (%)	Acidity (%)	TSS (%)	Marketable fruit yield (t/ha)	Plant height (m)
T_1	FYM @ 100 kg/plant	185	48.00	0.75	13.50	18.00	3.00
T_2	Vermicompost @ 30kg/ plant	185	50.00	0.75	13.00	17.00	3.00
T_3	Neem cake@ 10kg/plant	170	48.00	0.80	12.50	17.50	2.75
T_4	FYM @ 100 kg/plant + Biofertilizers*	200	52.00	0.75	13.50	18.00	2.80
T_5	Vermicompost @ 30kg/ plant +Biofertilizers	190	52.00	0.75	13.50	16.00	2.80
T_6	Neem cake@ 10kg/plant + Biofertilizers	175	48.00	0.80	12.50	16.00	2.60
T_7	FYM @ 50 kg/plant + Vermicompost @ 15kg/ plant	225	58.00	0.70	14.00	19.00	3.00
T_8	FYM @ 50 kg/plant + Neem cake@ 5kg/plant	190	58.00	0.70	13.00	18.50	3.00
T_9	Vermicompost @ 15kg/ plant + Neem cake@ 5kg/ plant	190	50.00	0.70	13.00	17.50	2.75
T_{10}	FYM @ 50 kg/plant + Vermicompost @ 15kg/ plant +Biofertilizers	230	58.00	0.70	14.00	19.50	2.70
T_{11}	FYM @ 50kg/plant + Neem cake@ 5kg/plant + Biofertilizers	225	56.00	0.75	13.50	17.25	2.75
T_{12}	Vermicompost @ 15kg/ plant + Neem cake@ 5kg/ plant +Biofertilizers	220	50.00	0.80	13.00	17.00	2.75
T_{13}	Inorganic control	175	50.00	0.80	11.50	17.00	2.85
T_{14}	Absolute control	150	45.00	0.85	11.50	16.00	2.60
CD at 5%		20.52	4.85	NS	1.52	2.56	0.15

*Azotobactor @ 250g/plant and Phosphorus solubilizing bacteria (PSB) @ 250 g/plant applied as soil treatment.

revealed that maximum fruit yield (19.50/ha) was recorded in T10 and which was statistically at par with fruit yield received in T1, T4, T7 and T8 treatments. The minimum fruit yield was recorded in absolute control treatment (16.00t/ha). The maximum juice recovery (58%) was recorded in treatment T7, T8 and T10. The maximum fruit weight (235g) was recorded in T10 and minimum in T14 (150g). The plant height ranged between 2.60 to 3.00 m. Fruit juice acidity has been lowered down in organically treated plants (Table 47).

Site characterization/observations

No.	Properties	Value (0-30cm)
1	Major textural class	Loamy sand
2	Particle size distribution(%) Sand Silt clay	 88.50 06.50 05.00
3	Bulk density	1.35 gcm^{-3}
4	Porosity (%)	48
5	Water holding capacity (%)	6.50
6	pH	8.10
7	EC (dSm^{-1})	0.15
8	CEC	
9	Organic carbon (%)	0.14
10	Available P (kg/ha)	14.50
11	Available K (kg/ha)	205
12	Iron (ppm)	3.80
13	Zinc (ppm)	0.50
14	Copper (ppm)	0.15
15	Manganese (ppm)	2.60

Above data also revealed that inclusion of organic sources of manure have reduced the bulk density, increased the water holding capacity reduced the soil pH, increased the organic carbon and available P & K content of the experimental site.

Progress made till date

Following salient achievements have been made during the year

- In muskmelon, maximum fruit yield (230.65q/ha) was recorded in application of FYM @100q/ha along with vermicompost @25q/has and biofertilizers consortia.
- The Kinnow fruit yield (19.50t/ha) was also maximum in treatment T10 comprising of FYM @50kg + vermicompost @15kg + biofertilizers/plant.
- The total microbial load was higher in bulky organic source in comparison to concentrate organic sources.
- The physico-chemical properties of the experimental sites have been improved in terms of organic carbon, available nutrients, etc.

Field trial was also conducted during summer season of 2016 to know the effect of different organic sources on major diseases of muskmelon (variety 'RM-50') under organic trial at Vegetable Block of our Institute. Fourteen treatments such as FYM@ 200q/ha, vermicompost@ 50 q/ha, neem cake@ 5 q/ha, FYM@ 200q/ha + bio-fertilizer, vermicompost@ 50 q/ha + bio-fertilizer, neem cake@ 5 q/ha+ bio-fertilizer, FYM@ 100q/ha + vermicompost@ 25 q/ha, FYM@ 100q/ha + neem cake@ 2.5 q/ha, vermicompost@ 25 q/ha + neem cake@ 2.5 q/ha, FYM@ 100q/ha + vermicompost@ 25 q/ha+ bio-fertilizer, FYM@ 100q/ha + neem cake@ 2.5 q/ha + bio-fertilizer, vermicompost@ 25 q/ha + neem cake@ 2.5 q/ha+ bio-fertilizer, inorganic control and Absolute control were taken with 03 replications. Wilt disease was appeared and incidence was observed with ranging from 7.14 to 33.33% during cropping season. Minimum wilt incidence (7.14%) was found in neem cake@ 5 q/ha+ bio-fertilizer (Azatobacter @ 5 kg/ha and PSB @ 5 kg/ha) which was the most effective treatment while maximum incidence (33.33%) of wilt was recorded in control in muskmelon.

9. Borers Management in Arid and Semi-arid Horticulture Crops under Consortium Research Platform (CRP) on Borers in Network Mode

Name of PI	:	Dr. S. M. Haldhar
Name of Co-PI	:	Dr. R. Bhargava Dr. R. S. Singh Dr. Hare Krishna Dr. A. K. Singh
Funding Agency	:	ICAR Scheme

The seasonal incidence of fruit borers, *Aubeus himalayanus, Meridarchis scyrodes, Dudua aprobola*, *Curculio c-album*, *Arenipses sabella* and *Batrachedra amydraula* recorded in the arid and semi-arid horticultural crops. During the study, the average percent incidence of stone weevil, *A. himalayanus* was observed between 13.67 to 64.67 in fallen fruits and 12.33 to 59.67 on fruits of ber at CIAH, Bikaner. The seasonal incidence of fruit borer, *M. scyrodes* was observed maximum in the second fortnight of December (59.00%) in ber crop at CHES, Godhra. The incidence of fruit borers, *M. Scyrodes*, *D. aprobola* and *Curculio c-album* in jamun was recorded from month of May to August, 2016 at CHES, Godhra. The seasonal incidence of lesser date moth, *B. amydraula* was observed to be maximum in the first fortnight of August (38.67%) and minimum in the second fortnight of May (3.67%). The seasonal incidence of greater date moth was recorded from June to September, 2016 (Table 48 & Fig. 38).

Host Plant Resistance (HPR) study in Jamun against fruit borers, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick): Significant differences were found in per cent fruit borer, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick) infestation among the tested genotypes during 2016-17. GJ-26, GJ-27 (Katha Jamun), GJ-19, GJ-17 and GJ-15 were found to resistant; GJ-3, GJ-6, GJ-7, GJ-9, GJ-13, GJ-16, GJ-18, GJ-20, GJ-23, GJ-24 and GJ-25 moderately resistant; GJ-4, GJ-8, GJ-10, GJ-12, GJ-14, GJ-21 and GJ-22 were susceptible and GJ-1 and GJ-GJ-11 highly susceptible genotypes. The per cent fruit infestation of fruit borer, *M. scyrodes* was highest in genotype GJ-1 (64.97%)) followed by GJ-11 (61.90%). The minimum per cent fruit infestation of fruit borer, *M. scyrodes* was observed in GJ-27 (Katha Jamun) (8.10%) followed by GJ-17 (9.90%). The per cent infestation of *D. aprobola* was highest in GJ-1 (76.10 %) and lowest in GJ-27 (Katha Jamun) (10.63 %) followed by GJ-26 (10.97 %). The per cent fruit infestation of fruit borer, *M. scyrodes* and *D. aprobola* were significantly lower in resistant germplasm and higher in susceptible genotypes (Table 49).

Table 48. Per cent seasonal incidence of fruit borers in different arid and semi-arid horticulture crops during 2016-17.

Months	Ber			Jamun			Date Palm	
	CIAH, Bikaner		CHES, Godhra	CHES, Godhra			CIAH, Bikaner	
	A. himalayanus (Fallen fruits)	*A. himalayanus* (On fruits)	*M. scyrodes*	*M. scyrodes*	*D. aprobola*	*C. c-album*	*B. amydraula*	*A. sabella*
May-I	-	-	-	8.00 (16.23)	12.00 (20.13)	-	-	-
May-II	-	-	-	18.33 (25.24)	21.00 (27.20)	8.67 (16.88)	3.67 (10.95)	-
June-I	-	-	-	30.33 (33.36)	32.00 (34.40)	19.33 (25.98)	7.00 (15.23)	4.00 (11.28)
June-II	-	-	-	40.00 (39.20)	41.33 (39.94)	30.67 (33.54)	13.33 (21.37)	7.67 (15.71)
July-I	-	-	-	50.00 (44.98)	53.33 (46.90)	34.33 (35.81)	24.00 (29.25)	13.33 (21.32)

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Table 48 (Concluded)

Months	Ber			Jamun			Date Palm	
	CIAH, Bikaner		CHES, Godhra	CHES, Godhra			CIAH, Bikaner	
	A. himalayanus (Fallen fruits)	*A. himalayanus* (On fruits)	*M. scyrodes*	*M. scyrodes*	*D. aprobola*	*C. c-album*	*B. amydraula*	*A. sabella*
July-II	-	-	-	55.00 (47.86)	67.00 (55.05)	39.33 (38.78)	27.67 (31.62)	18.00 (24.97)
Aug-I	-	-	-	41.00 (39.78)	52.00 (46.13)	28.33 (32.06)	38.67 (38.38)	27.00 (31.22)
Aug-II	-	-	-	27.67 (31.60)	28.67 (32.24)	16.00 (23.52)	31.33 (33.98)	22.67 (28.39)
Sept-I	-	-	-	-	-	-	21.33 (27.45)	15.67 (23.28)
Sept-II	-	-	-	-	-	-	-	9.33 (17.62)
Oct-I	22.33 (28.15)	14.00 (21.93)		-		-	-	-
Oct-II	26.00 (30.63)	19.00 (25.76)	18.00 (25.03)	-	-	-	-	-
Nov-I	36.00 (36.85)	29.33 (32.74)	25.00 (29.97)	-	-	-	-	-
Nov-II	54.67 (47.66)	47.00 (43.26)	36.67 (37.21)	-	-	-	-	-
Dec-I	64.67 (53.53)	59.67 (50.57)	51.00 (45.56)	-	-	-	-	-
Dec-II	57.00 (49.02)	52.00 (46.13)	59.00 (50.17)	-	-	-	-	-
Jan-I	44.33 (41.72)	40.67 (39.58)	52.00 (46.13)	-	-	-	-	-
Jan-II	39.33 (38.81)	30.00 (33.15)	35.00 (36.24)	-	-	-	-	-
Feb-I	25.00 (29.95)	22.33 (28.14)	21.67 (27.71)	-	-	-	-	-
Feb-II	13.67 (21.65)	12.33 (20.49)	-	-	-	-	-	-
SEm±	1.35	1.42	1.46	1.82	2.48	2.14	1.68	1.76
LSD (P = 0.05)	4.04	4.25	4.46	5.58	7.59	6.66	5.16	5.38

*Values in parenthesis are angular-transformed

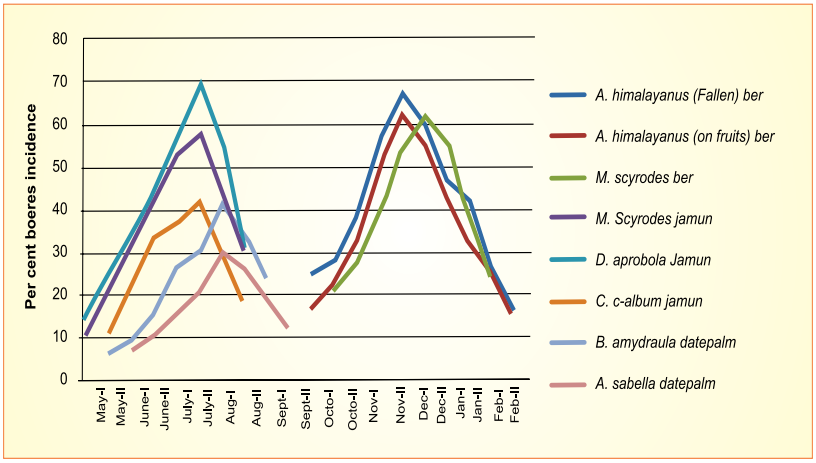

Fig. 38. Per cent seasonal incidence of fruit borers in different arid and semi-arid horticulture crops

Table 49. Per cent fruit infestation of fruit borer, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick) on different genotypes of Jamun during 2016-17.

S. No.	Genotypes	Per cent fruit infestation		Resistance category
		Meridarchis scyrodes Meyrick	*Dudua aprobola* (Meyrick)	
	GJ-1	64.97 (53.71)	76.10 (61.01)	HS
	GJ-2	20.63 (26.97)	20.93 (27.20)	MR
	GJ-3	44.53 (41.84)	44.93 (42.07)	S
	GJ-4	47.20 (43.38)	51.20 (45.67)	S
	GJ-6	37.13 (37.52)	39.03 (38.63)	MR
	GJ-7	27.93 (31.88)	29.43 (32.80)	MR
	GJ-8	24.30 (29.48)	25.87 (30.46)	MR
	GJ-9	44.97 (42.09)	43.23 (41.07)	S
	GJ-10	53.07 (46.74)	53.90 (47.23)	S
	GJ-11	61.90 (51.86)	73.50 (59.17)	HS
	GJ-12	55.93 (48.40)	57.53 (49.34)	S
	GJ-13	22.67 (28.37)	21.13 (27.34)	MR
	GJ-14	42.83 (40.86)	44.10 (41.59)	S
	GJ-15	12.00 (20.23)	13.00 (21.12)	R
	GJ-16	19.73 (26.34)	20.40 (26.79)	MR
	GJ-17	9.90 (18.27)	12.10 (20.29)	R
	GJ-18	28.87 (32.46)	31.70 (34.25)	MR
	GJ-19	15.63 (23.26)	18.20 (25.20)	R
	GJ-20	37.53 (37.76)	39.80 (39.10)	MR
	GJ-21	47.53 (43.57)	49.90 (44.92)	S
	GJ-22	51.07 (45.59)	54.93 (47.82)	S
	GJ-23	35.03 (36.24)	39.30 (38.79)	MR

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Table 49 (Concluded)

S. No.	Genotypes	Per cent fruit infestation		Resistance category
		Meridarchis scyrodes Meyrick	*Dudua aprobola* (Meyrick)	
	GJ-24	20.90 (27.10)	23.33 (28.87)	MR
	GJ-25	19.27 (25.98)	22.17 (28.06)	MR
	GJ-26	9.87 (18.25)	10.97 (19.32)	R
	GJ-27 (Katha Jamun)	8.10 (16.51)	10.63 (18.99)	R
SEm±		1.18	1.59	
LSD (P = 0.05)		3.36	4.52	

*Values in parenthesis are angular-transformed

R- resistant, MR- moderately resistant, S- susceptible and HS- Highly susceptible

Tannins, phenols, total alkaloid and flavonoid contents were significantly higher in resistant genotypes and lower in susceptible genotypes. Tannins, phenols, total alkaloids and flavonoid contents had significant negative correlations with per cent fruit infestation of fruit borer, *M. scyrodes* and *D. aprobola*. The fruit length (0.55 & 0.55), fruit width (0.35 & 0.33), pulp thickness (0.58 & 0.57) and pulp: stone ratio (0.51 & 0.54) showed significant positive correlations with per cent fruit infestation of fruit borer, *M. scyrodes* and *D. aprobola* (Table 50, 51).

Table 50. Correlation coefficient (r) between per cent infestation of fruit borer, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick) with different allelochemicals fruit traits of jamun genotypes.

	Meridarchis scyrodes Meyrick	*Dudua aprobola* (Meyrick)	Flavonoid content (mg/100g)	Tannins content (mg/100g)	Phenols content (mg/100g)
Dudua aprobola (Meyrick)	0.990**				
Flavonoid content (mg/100g)	-0.789**	-0.790**			
Tannins content (mg/100g)	-0.876**	-0.880**	0.945**		
Phenols content (mg/100g)	-0.761**	-0.765**	0.900**	0.880**	
Total alkaloid content (%)	-0.849**	-0.858**	0.827**	0.887**	0.815**

**Significant at P = 0.01 (two-tailed) * Significant at P = 0.05 (two-tailed)

Table 51. Correlation coefficient (r) between per cent infestation of fruit borer, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick) with different antixenotic fruit traits of jamun genotypes.

	Meridarchis scyrodes Meyrick	*Dudua aprobola* (Meyrick)	Fruit length (cm)	Fruit width (cm)	Pulp thickness (cm)
Dudua aprobola (Meyrick)	0.990**				
Fruit length (cm)	0.547**	0.548**			
Fruit width (cm)	0.352^{NS}	0.330^{NS}	0.366^{NS}		
Pulp thickness (cm)	0.584**	0.572**	0.503**	0.734**	
Pulp:stone ratio	0.514**	0.543**	0.350^{NS}	0.409*	0.517**

**Significant at P = 0.01 (two-tailed) * Significant at P = 0.05 (two-tailed)

10. Production and Demonstration of Tissue Culture Raised Plants under Three Locations and Collection and Maintenance of Elite Germplasm of Date Palm

Name of PI	:	Dr. Dhurendra Singh
Funding Agency	:	ICAR Scheme

Evaluation of tissue culture raised plants supplied by coordinating centers under field conditions

Selection and preparation of field for tissue culture plants and plantation

Two hectares land has been identified for field evaluation of tissue culture plants. Necessary field preparation and layout work has been completed. Several planting requirements of FYM, fertilizers, pesticides and chemicals have been arranged. 25 tissue culture plants of date palm of elite local genotype produced under project at AAU, Anand have been procured and planted on 27.07.2013. One hundred and sixty culture plants of date palm of elite local genotype produced under project at AAU, Anand were planted on 28.08.2014 and 133 plants were planted on 09.09.2014. Remaining 27 plants kept in green house for further growth and development and will be planted in the month of March 2015. These plants were irrigated regularly. Two applications of chloropyrophos were given during September and October 2014 to protect the plants from termite attack. Twenty five plants planted during July 2013 were protected from wild boar by fixing thorny biomass of *Ziziphus* species surrounding these plants. The plants were protected from wild animals by fixing wire mesh fencing.

During fourth year of project period, 160 plants of Barhee variety were procured from AAU, Anand during November 2015. The plants have been kept under greenhouse for further hardening. The growth of plants has attained 25-30cm with 100% survival. Encouraging results were obtained with respect to morphological growth and development of 03 years date palm tissue culture plants of Anand local elite genotype (Red colour type) planted in the field The success rate of establishment was 100 per cent with the first lot of planting and height of plants reached to almost triple to the initial plants height. Number of leaves per plant were also increased from 6-7 to 26-34 per plant. Canopy size of the plants was increased to three times to that of initial canopy. Further no pests and diseases were noticed in any of the plant. In 33 plants, flowering taken place during the month of February and March, 2017.

The following observations were recorded on these plants.

The observation recoded with respect to:

- Percentage of field establishment of tissue culture plants
- Plant height
- Number of opened leaves per plant
- Canopy size of plants
- Incidence of pests and diseases

It appears from the table 52 that encouraging results were obtained with respect to morphological growth and development of one year date palm TC plants elite local genotype. The success rate of establishment was 100 per cent and height of plants reached to almost double to the initial plants. Number of leaves per plant were also increased from 6-7 to 22-28 per plant at 4th year growth of the plants. Canopy size of the plants was increased to four times to that of initial canopy. Further, attack of termite and rodents noticed in some plants

Initiation of spathe

In another lot of 133, tissue cultured plants of local elite type of date palm were planted during September, 2014. Two date palm plants were adversely affected by root rot and some of the plants were also affected by rabbit and ants. To manage the problem of rabbit and ants, chloropyrophos @ 2ml/L of water was on used for drenching. The plants are growing well and regular management practices of watering, weeding and hoeing are being done. This year flowering was recorded in 23 plants (Table 53).

Table 52. Observation of 25 plants planted in field during July 2013.

Parameters	During planting (July 2013)	December 2013	June 2014	December 2014	December 2015	December 201616
Establishment success	-	100%	100%	100%	100%	100%
Average Plant Height (cm)	45	64	74	90	186	196
No. of leaves per plant	6-7	8-10	9-14	12-18	22-28	26-34
Canopy size (cm x cm)	55x60	70x74	110x116	156x170	212x218	243-339
Incidence of pest	Nil	Nil	Nil	Nil	Nil	Termite
Incidence of disease	Nil	Nil	Nil	Nil	Nil	Nil

Fig. 39. Fruiting of Elite Genotype during 2016

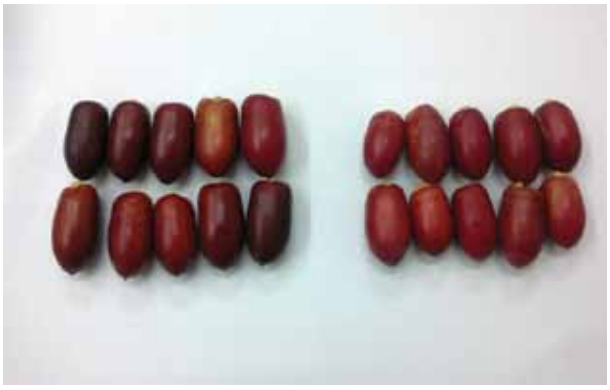

Fig. 40. Metaxennia effect about 21 % with selected male of CIAH on fruit size of date palm Anand local genotype

Table 53. Observation of 133 plants planted in field.

	During planting (September, 2014)	December, 2014	December, 2015	December, 2016c. 2016
Establishment success		98.45%	98.45%	90
Average Plant Height (cm)	30	45	76	84
No. of leaves per plant	4-5	6-7	11-16	13-17
Canopy size (cm xcm)	45x47	60x58	94-98	174x167
Incidence of pest	Nil	Ants and Rabbit attack	Ants and Rabbit attack	Ants, Rabbit and termite attack
Incidence of disease	Nil	Root rot in 02 plants	Nil	Nil

Growth and development of tissue culture plants of Barhee variety under greenhouse

160 plants of Barhee variety were procured from AAU, Anand at secondary hardening stage during the month of November 2015. The plants kept under greenhouse for further hardening and growth and development of plants. During the month of January the plants were infected by *Graphiola* leaf spot *(Graphiola phoenicis)* with the symptoms of small spots on both sides of leaves and yellow spore masses on underneath of leaves. For its management, the leaves of infected plants were pruned out and plants were sprayed weekly with copper oxychloride and bavastin fungicides alternatively. Five plants affected severely. In about 120 plants 3 to 5 pinnate leaves have emerged.

Secondary Hardening of Tissue Culture Plants of Date Palm

Twenty tissue culture imported plants of date palm cv. Barhee deposited by private companies at primary hardening stage to CIAH, Bikaner for evaluation of date palm plants at field level as per directives of Deputy Commissioner (QC), Department of Agriculture and Co-operation, Ministry of Agriculture, Govt.of India. The primary hardened plants at tarpedo stage were transferred from torpedo container to big pots of 30 x 30 cm size. The pots were filled with potting mixtures of sand and sheep manure in the ratio of 3:1. The pots were kept in high-tech hardening unit. Initially under environmental regimes of 30-33°C and relative humidity ranging 60-80 per cent for three month. Thereafter these plants were transferred to hardening chamber having temperature 34-40°C and 40-60 % RH. The well hardened plants was successfully planted in field for further evaluation. No insect pest and disease was recorded during secondary hardening process.

Godhra

11. Development of Morphological Descriptors and DUS Test Guidelines for Jamun

Name of PI	:	Dr Sanjay Singh
Funding Agency	:	PPV&FRA, New Delhi

Morphological descriptors and DUS test guide lines for jamun have been developed and submitted to the Authority.

12. Validation of DUS Descriptors for Chironji and Tamarind

Name of PI	:	Dr. Sanjay Singh
Funding Agency	:	PPV&FRA, New Delhi

Tamarind: Total 10 genotypes/ cultivars were studied**.** All cultivars were having semi- tall character. CHEST-7, CHEST-8, CHEST-9, CHEST-10, CHEST-12, CHEST-14 had semi spreading type growth habit, while CHEST-11, CHEST-13, was of drooping type growth pattern. The genotypes CHEST-15 and CHEST-16 showed spreading growth pattern.

Chironji: Detailed characters like vegetative and fruiting attributes were recorded to develop the DUS descriptor (Table 54). Total 10 genotypes were studied. It was observed that CHESC-11, CHESC-12 and CHESC-13 CHESC-16, CHESC-17 and CHESC-18 were found to semi tall type, while CHESC-14, CHESC-15, CHESC-19 and CHESC-20 were found tall type. Foliage was dense and leaf was elliptical lanceolate. Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined in all genotypes.

Table 54. Characteristics of tree and leaves of different chironji genotypes

Characters	Tree height	Tree form	Branch	Foliage	Leaf
CHESC-11	Semi-tall	Semi-spreading	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-12	Semi-tall	spreading	Angled	Dense	Leaves thickly coriaceous, elliptical, obtuse, reticulately veined,
CHESC-13	Semi-tall	Semi-spreading	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-14	Tall	Up right	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-15	Tall	Up right	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-16	Semi-tall	Up right	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-17	Semi-tall	Semi-spreading	Angled	Dense	Leaves thickly coriaceous, elliptical, obtuse, reticulately veined,
CHESC-18	Semi-tall	Spreading	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-19	Tall	Up right	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,
CHESC-20	Tall	Up right	Angled	Dense	Leaves thickly coriaceous, broadly oblong, obtuse, reticulately veined,

8. PUBLICATIONS

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Radio Talk

Sanjay Singh

Delivered radio talk at Godhra Radio Station on the topic importance of environment on 23.12.16.

Delivered radio talk at Godhra Radio Station, Godhra on the topic of water harvesting techniques on 11.07.16.

A.K. Singh

Delivered a talk on the topic *Hamare ash pas ke aushdhiya paudho ko jane* 1stOctober, 2016, AIR, Godhra.

Others

Agronomical improve Package of Practices of kachri production was presented during ZARC meeting (*Kharif* Season) on 5 -6 April, 2016. These were appreciated and accepted for POP of the Zone-1C, Bikaner and they have been included and published in book of POP (Hindi) on "Improved Agricultural Practices of Major *Kharif* Crops"-2016, Bikaner Zone- 1C, as published by the Joint Director Agriculture (Extension), Bikaner Zone, pp. 119 - 122.

9. RESEARCH PROJECTS

Code	Title of project	Investigators name PI & Co-PI	Revised name of PI & Co-PI (From 07.02.2017)
CIAH: 1	**Introduction, collection, characterization, conservation and evaluation of germplasm of arid and semi-arid fruit and vegetable crops.**		
(a)	*Ber* (*Ziziphus* spp.)	Dr. Hare Krishna	Dr. Hare Krishna Dr. Kamlesh Kumar Dr. S.M. Haldhar
(b)	Pomegranate (*Punica granatum* L.)	Dr. Ramkesh Meena Dr.S.K. Maheshwari Dr. D. S. Mishra	No change
(c)	Date palm (*Phoenix dactylifera* L.)	Dr. R. S. Singh Dr. R. Bhargava Dr. B. D. Sharma	Dr. R. S. Singh Dr. R. Bhargava Dr. B. D. Sharma Dr. Ramkesh Meena
(d)	*Aonla* (*Emblica officinalis* Gaertn)	Dr. A. K. Singh Dr. P. P. Singh Dr. D. S. Mishra	No change
(e)	*Bael* (*Aegle marmelos* Correa.)	Dr. R. S. Singh Dr. A. K. Singh Dr. Sanjay Singh Mr. Jagan Singh Gora	Dr. R. S. Singh Dr. A. K. Singh Dr. Sanjay Singh Mr. Jagan Singh Gora Dr. Ramkesh Meena
(f)	Wood apple (*Feronia limonia*) and custard apple (*Annona squomosa)*	Dr. Vikas Yadav Dr. A. K. Singh	No change
(g)	Jamun, tamarind, mahua, chiraunji, karonda, phalsa, khirni and manila tamarind.	Dr. Sanjay Singh Dr. A. K. Singh Dr. R. Bhargava Dr. V. V. Appa Rao Dr. D. S. Mishra	No change
(h)	Indigenous and exotic underutilized fruit crops (Lasora, ker, pilu, karonda, phalsa, cactus pear, fig, mulberry and dragon fruit).	Dr. Hare Krishna Dr. R. S. Singh Dr.Dhurendra Singh	Dr. D. K. Samadia Dr. Dhurendra Singh Dr. Kamlesh Kumar Dr. S.M. Haldhar
(i)	Cucurbitaceous vegetable crops: Bottle gourd, round gourd, snap melon and kachri and Improvement in vegetable crops.	Dr. D. K. Samadia	Dr. D. K. Samadia Dr. Ajay Kr. Verma Dr. S. M. Haldhar

Code	Title of project	Investigators name PI & Co-PI	Revised name of PI & Co-PI (From 07.02.2017)
(j)	Cucurbitaceous crops: Muskmelon, watermelon, sponge gourd and longmelon.	Dr. B. R. Choudhary Dr. R. Bhargava Dr.S.K. Maheshwari Dr. S. M. Haldhar	Dr. B. R. Choudhary Dr. S. K. Maheshwari Dr. S. M. Haldhar
CIAH: 2	**Improvement of arid and semi arid fruit and vegetable crops including biotechnological interventions.**		
(a)	Genetic improvement of ridge gourd (*Luffa acutangula*) under arid environment.	Dr. B. R. Choudhary Dr. S. K. Maheshwari Dr. S. M. Haldhar	No change
(b)	Breeding for abiotic stress tolerance in solanaceous crops.	Dr. P. P. Singh	Dr. P. P. Singh Dr. Ajay Kr. Verma
(c)	Development of aonla varieties against frost resistance.	Dr. P. P. Singh Dr. R. Bhargava Dr. R. S. Singh	Dr. R. Bhargava Dr. P. P. Singh Dr. Mukesh kumar
(d)	Biochemical and biotechnological interventions :		
(i)	Standardization and commercialization of micro-propagation techniques of horticultural crops under arid agro eco-system: Date palm	Dr. Dhurendra Singh	Dr. Dhurendra Singh Dr. Kamlesh Kumar Dr. Ajay Kr. Verma
(ii)	Development of phyto-chemical markers in arid horticultural crops for varietal identification and assessment of phylogenetic relationship.	Dr. R. Bhargava Dr. B. D. Sharma Dr. D. Singh	No change
(iii)	Physiological and biochemical investigations in arid horticultural crops under abiotic stresses.	Dr. R. Bhargava Dr. R. S. Singh Dr. B. D. Sharma	To be completed during 2017
(iv)	Alleviation of climatic constraints on growth of vegetable crops under hot arid regions with an understanding on its seed physiology.	Dr. Mukesh Kumar Dr. R. Bhargava	No change
CIAH: 3	**Standardization of arid and semi-arid fruits and vegetables production technology.**		
(a)	Evaluation of fruit based diversified cropping models for arid region.	Dr. Hare Krishna Dr. R. Bhargava Dr. S. R. Meena Dr. M. K. Jatav	Dr. M. K. Jatav Dr. Ajay Kr. Verma
(b)	Standardization of integrated nutrient management in arid horticultural crops.	Dr. B. D. Sharma Dr. R. Bhargava Dr. R. S. Singh Dr. S. K. Maheshwari	No change
(c)	Intensification of research on tissue cultured date palm in hot arid region.	Dr. B. D. Sharma Dr. R. S. Singh Dr. R. Bhargava Dr. Ramkesh Meena	No change
(d)	Standardization of production technology of *bael* under rainfed semi-arid conditions of western India.	Dr. A. K. Singh Dr. Sanjay Singh Dr. V. V. Appa Rao	--
(e)	Studies on compatibility and adaptability of citrus rootstock under hot arid environment of Rajasthan.	Mr. Jagan Singh Gora Dr. B. D. Sharma	--

Code	Title of project	Investigators name PI & Co-PI	Revised name of PI & Co-PI (From 07.02.2017)
(f)	Studies on flowering regulation, cracking management and root stock adaptability in pomegranate under hot arid environment of Rajasthan.	Dr. Ramkesh Meena Mr. JaganSingh Gora Dr. M. K. Jatav	--
(g)	Standardization of production technology of mango and sweet orange.	Dr. Sanjay Singh Dr. A. K. Singh Dr. V. V. Appa Rao	---
(h)	Nutrient management in chironji, custard apple, jamun and tamarind.	Dr. V. V. Appa Rao Dr. Sanjay Singh Dr. A. K. Singh	--
(i)	Nutrients management in vegetables (mateera, kachri, snap melon and cluster bean,) of hot arid region of Rajasthan.	Dr. M. K. Jatav Dr. B. D. Sharma Dr. S. R. Meena Dr. D. K. Samadia	Dr. M. K. Jatav Dr. B. D. Sharma Dr. D. K. Samadia
(j)	Value addition in semi-arid fruit crops.	Dr. D. S. Mishra Dr. Sanjay Singh Dr. V.V. Appa Rao	Extension is proposed
(k)	Exploitation of arid fruits and vegetables for value addition and commercialization.	Dr. Vijay R. Reddy Dr. R. S. Singh Dr. S. R. Meena Dr. Ramkesh Meena Dr. Mukesh Kumar	No change
(l)	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 Dr. M. K. Jatav	Dr. S. R. Meena Dr. R. S. Singh Dr. D. K. Samadia Dr. D.K.Sarolia
(m)	A study on rural wisdom and resources of arid horticultural importance.	Dr. S. R. Meena Dr. B. D. Sharma Dr. S.K. Maheshwari	Dr. S. R. Meena Dr. S. K. Maheshwari Dr. Vijay R. Reddy,
CIAH: 4	**Plant health management studies in arid and semi-arid fruit and vegetable crops.**		
(a)	Biology and management strategies for major insect pests of fruit crops in hot–arid region with special reference to ber, bael, date palm and lasora.	Dr. S. M. Haldhar Dr. R. Bhargava Dr. R. S. Singh Dr. Hare Krishna	Dr. S. M. Haldhar Dr. R. S. Singh Dr. Hare Krishna
(b)	Management of different diseases of arid horticultural crops through botanicals and inorganic salts under hot arid conditions of Rajasthan.	Dr. S. K. Maheshwari Dr. Hare Krishna Dr. B. R. Choudhary	No change
	Concluded Projects		
CIAH-4(b)	Survey of insect-pests, their natural enemies and pest management strategies for cucurbits in arid region of Rajasthan.	Dr. S. M. Haldhar Dr. B. R. Choudhary Dr. R. Bhargava	

Code	Title of project	Investigators name PI & Co-PI	Revised name of PI & Co-PI (From 07.02.2017)
Externally funded projects			
EF 1	DUS centre (watermelon and muskmelon).	Dr. B. R. Choudhary	No change
EF 2	DUS centre for *ber* (*Ziziphus* sp.).	Dr. Hare Krishna Dr. R. Bhargava	No change
EF 3	DUS centre for date palm horticultural crop.	Dr. R. S. Singh Dr. R. Bhargava	No change
EF 4	Validation of DUS descriptor for *bael*.	Dr. A. K. Singh	No change
EF 5	Characterization of *aonla* varieties for developing DUS testing guidelines.	Dr. A. K. Singh (Co-Nodal Centre: CHES, Godhra)	No change
EF 6	Development of morphological descriptor and DUS testing guidelines for jamun.	Dr. Sanjay Singh (Co-Nodal Centre: CHES, Godhra)	No change
EF 7	Validation of DUS descriptors for chironji and tamarind	Dr. Sanjay Singh (Nodal Centre: CHES, Godhra)	No change
EF 8	Production and demonstration of tissue culture raised plants under three locations and collection and maintenance of elite germplasm of date palm.	Dr. Dhurendra Singh	No change
EF 9	Borers management in arid and semi-arid horticulture crops under consortium research platform (CRP) on borers in network mode.	Dr. S. M. Haldhar Dr. R. Bhargava Dr. R. S. Singh Dr. Hare Krishna Dr. A. K. Singh	No change
EF 10	Network project on organic farming in horticultural crops.	Dr. B. D. Sharma Dr. R. Bhargava Dr. S. K. maheshwari Dr. B. R. Choudhary	No change
EF 11	Network project on micro-nutrient management in horticultural crops for enhancing yield and quality.	Dr. B. D. Sharma Dr. R. Bhargava Dr. B. R. Choudhary	No change
EF 12	Consortium Research Platform (CRP) on Agro-biodiversity.	Dr. R. S. Singh Dr. Hare Krishna Dr. A. K. Singh	No change
New Research Projects started during 2016-17			
1.	Intensification of production technology in guava, jamun and mulberry under hot arid conditions.	Dr. D. K. Sarolia Dr. Dhurendra Singh Dr. Vijay R. Reddy	No change
2.	Introduction, collection, characterization, conservation and evaluation of guava, lime and pomegranate under rainfed semi-arid conditions of western India.	Dr. D. S. Mishra Dr. Sanjay Singh Dr. A. K. Singh Dr. Vikas Yadav	No change

Code	Title of project	Investigators name PI & Co-PI	Revised name of PI & Co-PI (From 07.02.2017)
3.	Introduction, collection, characterization, conservation and evaluation of vegetable crops (dolichosbean, clusterbean and cowpea) under rainfed semi-arid conditions of western India	Mr. Gangadhara, K. Dr. V. V. Appa Rao Dr. L. P. Yadav	No change
4.	Biochemical mechanism of abiotic stress tolerance in arid horticultural crops.	Dr. Mukesh Kumar Dr. R. Bhargava Dr. S. M. Haldhar	No change
5.	Introduction, collection, characterization, conservation and evaluation of germplasm of drumstick, spine gourd, ivy gourd, tomato, pumpkin and bottle gourd.	Dr. L. P. Yadav Dr. V. V. Appa Rao Mr. Gangadhara, K.	No change
Flagship Project			
1.	Development of khejri based cropping models under rainfed conditions.	Dr. D. K. Samadia Dr. B. D. Sharma Dr. S. R. Meena	No change

10. RAC, IRC, IMC

RAC

Chairman
Dr. S. L. Mehta
Ex-Vice Chancellor
MPUA&T, Udaipur

Members
Dr. B. B. Vashishtha
Ex-Director
NRC on Seed Spices, Ajmer

Dr. Y. N. Reddy
Ex-Principal Scientist & Head
IIHR, Bengaluru

Dr. S. Lingappa
Ex-Director of Research
UAS, Dharwad

Dr. A. R. Mishra
Principal Scientist
Director of Water Management
Bhubaneswar

Director
ICAR- CIAH, Bikaner

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

Member Secretary
Dr. B. D. Sharma
Head, Division of Crop Production
ICAR-CIAH, Bikaner

RAC (w.e.f. 23.01.2017)

Chairman
Dr. T. A. More
Former-Vice Chancellor
MPKV, Rahuri-413722, MS

Members
Dr. P. S. Naik
Former Director
ICAR-IIVR, Varanasi (U.P.)

Dr. Ashwani Kumar
Ex-Director, ICAR-IIWM
Chandrasekharpur, Bhubneswar-751023

Dr. M. Anandaraj
Ex-Director, ICAR-IISR, Calicut-673012

Dr. D. S. Khurdia
Former Head, Division of Post Harvest Technology
ICAR-IARI, Pusa, New Delhi-110 012

Director
ICAR-CIAH, Bikaner

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

Member Secretary
Dr. Dhurendra Singh
Head, Division of Crop Improvement
ICAR-CIAH, Bikaner

The meeting of RAC was held on 2-3 September, 2016.

Institute Research Committee (IRC)

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

Members
All Scientists of the Institute

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

IRC meeting was held on 10-11 August, 2016.

Institute Manageemnt Committee

Chairman: Director, ICAR-CIAH, Bikaner

S. No.	Name of Members	Term	
1	ADG (H-1), ICAR, New Delhi	28.8.2014	27.8.2017
2.	Director (Horticulture) Government of Rajasthan, Jaipur (Rajasthan)	27.7.2015	26.7.2018
3.	Director of Horticulture Gujarat State, Krishi Bhavan, Sector No.10-A, Gandhinagar (Gujarat)	27.7.2015	26.7.2018
4.	Director of Research Swami Keswanand Rajasthan Agricultural University Bikaner	27.7.2015	26.7.2018
5.	Shri Sher Singh Nehra, Chirawa, Jhunjhunu	17.9.2013	16.9.2016
6.	Shri Nihal Singh, Chirawa, Jhunjhunu	17.9.2013	16.9.2016
7.	Finance & Accounts Officer ICAR-Central Arid Zone Research Institute, Jodhpur	27.7.2015	26.7.2018
8.	Dr. Sanjay Singh P. S. & I/c Head, CHES, Vejalpur, Godhra	28.8.2014	27.8.2017
9.	Dr. R. Bhargava, Principal Scientist, ICAR-CIAH, Bikaner	28.8.2014	27.8.2017
10.	Dr. Kishan Kant, Principal Scientist, ICAR-NRCSS, Ajmer	28.8.2014	27.8.2017
11.	Dr. N. D. Yadav, P. S. & Head, ICAR-CAZRI, RS, Bikaner	28.8.2014	27.8.2017
12	Administrative Officer & Member Secretary	Ex-officio whole time	

IMC meeting was held on 19 May, 2016.

11. MEETINGS, CONFERENCES, LECTURES, ETC.

Meetings

Dr. P. L. Saroj

- Participated in the 25th Annual Group Meeting of AICRP on Palms at ICAR-CPCRI, Kasaragod (Kerala) as Guest of Honour on 19.5.2016 and delivered key note address.
- Participated in Annual Group Meeting AICRP on Fruits at ICAR- Indian Institute of Horticulture Research, Bangalore (Karnataka) from 4-7-January, 2017.
- Participated in Annual Group Meeting AICRP on Soil Salinity at SKRAU, Bikaner on19-20 January, 2017.
- Participated in Annual Group Meeting AICRP on Arid Zone Fruits at ICAR-CIAH, Bikaner on 5-7 March, 2017.
- Participated in Scientific Advisory Board on International Noni Research Foundation on 3-12-2016 at ICAR-IISR, Lucknow.
- Attended the Review Meeting chaired by the Hon'ble Union Minister for Agriculture, Cooperation & Family Welfare convened at College of Agriculture, Bijapur on 23.6.2016.
- Participated in Review Meeting, chaired by Hon'ble Minister of Agriculture and Farmers Welfare, Govt. of India, New Delhi at SKRAU, Bikaner on 18.2.2017.
- Attended Vice-Chancellors and Directors Conference at New Delhi from 14-17 February, 2017.
- Participated in Review Meeting of AICRPs Chaired by Dr. P.L. Gautam and in Sub-group Meeting Chaired by Dr. G.L. Kaul on 17th February, 2017 at NBPGR, New Delhi.
- Acted as Member during Assessment of Principal Scientist under Career Advancement Scheme in the discipline of Soil Science at ASRB, New Delhi on 23.01.2017.
- Acted as Member during Assessment of Principal Scientist under Career Advancement Scheme in the discipline of Plant Pathology at ASRB, New Delhi on 01.02.2017.

Dr. B. D. Sharma

- Meeting with OSD, President Secretariats, President Bhawan, New Delhi on 11-12th April 2016 regarding the date palm plant received from Government of Palestine.
- Meeting with Ambassador, Palestine Republic, on 15-04-2016 regarding the releasing of date palm plants from Delhi Air port at New Delhi.
- Attended the Institute Foundation Day on 23-04-2016 at ICAR-CIAH, Bikaner.
- Attended Kisan Mela at SKRAU, Bikaner on 30-04-2016 organized by KVK, regarding awareness of Bima Fasal Yojna.
- Attended Zonal Review Meeting of KVKs of Rajasthan and Gujarat states from 3-5th May 2016 at AAU, Anand.

- Attended Bael Day at CHES, Godhra on 5th May 2016.
- Attended Western Zone financial review meeting at CIFE, Mumbai on 6th May 2016.
- Chaired IMC meeting of the ICAR-CIAH, Bikaner 0n 19th May 2016 (F/N).
- Conducted AIEEA UG -2016 examination at Bikaner centre on 21st May 2016.
- Chaired the PMC meeting at ICAR-CIAH, Bikaner on 19th May 2016 (A/N).
- Celebrated Swachh Bharat Pakhwada on 30th May 2016.
- Attended a special meeting at SIAM, Jaipur Chaired by Smt. Neel Kamal Darbari, Principal Secretary (Agril./Horti.), Government of Rajasthan, Jaipur on 8th June 2016.
- Attended Date palm exhibition on 10th June 2016 at DPRS, Mundra, Gujarat.
- Attended as member to review the case of appointment on the post of AP (Hort.) at SKRAU, Bikaner on 13-06-2016.
- Attended CAS meeting on 17th June 2016 at ICAR-CIAH, Bikaner.
- Attended International Yoga day on 21-06-2016 at CIAH, Bikaner.
- Chaired OL meeting on 24th June 2016 at CIAH, Bikaner.
- Attended DAC-CRIDA-GOR interface meeting at Pant Krishi Bhawan, Jaipur on 4th July 2016
- Organized Agricultural Education Day programme on 22.7.2016 for students/teachers at CIAH, Bikaner.
- Attended a Plantation programme organized by Rajasthan Patrika at Sareh Nathaniyan village, Bikaner on 22.8.2016.
- Chaired PMEC meeting on 06.8.2016 at CIAH, Bikaner.
- Chaired IRC meeting of the Institute held on 10-11th August, 2016.
- Attended meeting as member of Committee for implementation Official languages on 27.12.16 and 28.3.2017 during the year.
- Attended Jai Kisan - Jai Vigyan programme on 23.12.2016 organized at Khichiya village, Bikaner and at BL Gurukul Learning Institute, Sithal on 26.12.2016.
- Research Advisory Meeting of the ICAR-CIAH, Bikaner on 2nd and 3rd September 2016 under the Chairmanship of Dr. S. L. Mehta, Former Vice Chancellor, MPUAT, Udaipur.
- Seminar on "Recent Trends in Agricultural Research Capacity, Investment and Outputs in India on 17-08-2016 at NASC Complex, New Delhi.
- Attended Regional Committee meeting at CAZRI, Jodhpur on 13-14 September 2016.
- Participated and Display of Institutes exhibition in Magra Net work project Field day programme of CSWRI, held at Kotara village,Bikaner on 4.11.2016.
- Attended Expert Consultation Meeting on 30 & 31st January 2017 at ICAR-NIASM, Baramati (MS).

Dr. R. S. Singh

- Attended meeting of Institutes Variety Identification Committee as Member Secretary on12.8. 2016 at CIAH, Bikaner.
- Worked as Chairman, Staff Welfare Committee related works during the year.
- Attended meeting as member of Committee for implementation Official languages on 24.6.16, 27.12.2016 and 28.3.2017 during the year.
- Attended Global Rajasthan Agro-Meet 2016 as expert of Horticulture with team of scientist at JECC, Jaipur organized by Govt of Rajasthan and FICCI on 11.11.2016.
- Attended Library Advisory committee meeting of the Institute on 28.12.2016 at CIAH, Bikaner.
- Attended IMC meeting of ICAR-CAZRI as Member of Committee nominated by ICAR on 30.12.2016 at CAZRI, Jodhpur.

Dr. S. K. Maheshwari

- Attended as Member Secretary (Dr. S. K. Maheshwari)- IRC Meeting held on 10-11th August, 2016.
- Attended PMEC (Project Monitoring and Evaluation Committee) meeting of the Institute as 'Invitee Member' on 19-05-2016 for approval of status reports for preparation of new research projects.
- Nominated as 'Invitee Member' of Variety Identification Committee which was held on 12th August, 2016.
- Attended as 'Subject Expert' regarding disease management of fruit and vegetable crops under session of Jajam Chaupal- (Horticulture) in 'Global Rajasthan Agri-Meet-2016' at Jaipur on 11th November, 2016.
- Served as 'Member' of Institute Technology Management Committee (ITMC) which was held on 27-12-2016.

Dr. D. S. Mishra

- Attended a meeting with Govt. Officials of Parbhani District, Maharashtra under a programme 'Engagement of Parbhani District Administration with ICAR Institutes for enhancing betterment of farmer's of Parbhani District with the guidance of ICAR Institutions expertise during August 03-05, 2016.

Conference/Semimar/Symposium/ Workshop/etc.

Dr. P. L. Saroj

- Participated in 7th Indian Horticulture Congress, organized by Horticulture Society of India from 14-17 November, 2016 at IARI, New Delhi.
- Participated in National Seminar on "Plantation based cropping system for improving livelihood security" at ICAR-CPCRI, Kasaragod (Kerala) on 23.7.2016.
- Participated in 11th National Symposium on "Noni and Medicinal Plants for Health and Livelihood" at ICAR-IISR, Lucknow from 3-4th December, 2016.
- Participated in National Seminar on "Enhancing Productivity of Fruit Crops-Mitigating Major Challenges" on 8th January, 2017 at IIHR, Bengalore (Karnataka).
- Participated in "Western Regional Agriculture Fare at SKRAU, Bikaner from 18-20 February, 2017

Dr. Sanjay Singh

- Participated in the global conference on perspective of future challenges and options in agriculture organised by ASM foundation at Jalgaon from 28th to 30th May, 2016.
- Participated in the International conference on agriculture, horticulture and plant sciences on 25-6-2016 and 26-6-2016 at New Delhi.
- Participated in National workshop on technological changes and innovations in pomegranate production and utilization for enhancing farmers income on 26th September at JAU, Junagarh.
- Participated in the Annual Group Workers Meeting of AICRP on Arid fruits from 5-3-2017 to 7-3-2017 at CIAH, Bikaner, Rajasthan.

Dr. B. D. Sharma

- Attended 7th Indian Horticultural Congress-2016 held during 15-18th November 2016.
- Attended the National Workshop on Pomegranate technological production and utilization for enhancing farmers income by AU, Jodhpur on 10-12-2016
- Organized XXI Group Workers Meet of AICRP on Arid Zone Fruits at ICAR-CIAH, Bikaner during 5-7th March 2017 (Organizing Secretary)

Dr. Dhurendra Singh

- Participated in annual review meeting of Network project on "Production & Demonstration of tissue culture raised plants under three locations & collection & maintenance of elite germplasm of date palm" at ICAR-CIAH, Bikaner on 07.03.2017

- Attended Brain storming session on oil palm tissue culture on 20.09.2016 ICAR-IIOPR, Pedavegi, AP.
- Attended ICAR-AICR on AZF 21th Research Workers Group Meeting-2016 held at ICAR-CIAH, Bikaner during 5-7th March. 2017.
- Attended National Seminar on National Education Policy-2016: Issues, Challenges and Suggestions, organised by MGS University, Bikaner on 17.10.2016.
- Attended 7th Indian Horticulture Congress 2016 and an International meet Doubling Farmers Income through Horticulture organized by Horticulture Society of India at IARI, New Delhi during Nov. 15-18, 2016.
- Attended National Seminar on Environmental Managhement and Technology 8-9th March, 2017 organised by MGSU, Bikaner.
- Attended Brain storming session on the germplasm introduction and exchange on 19.11.2016 organised by Hort. Sci. Division ICAR and NBPGR, New Delhi.
- Attended National Agricultural convention on opportunities in agriprenurship for agricultural students organized br AIASA at RAJUVAS, Bikaner on 7.10.2016.
- Attended workshop on wild life conservation organized by District Department of Forest and Wildlife Conservation at SKRAU Bikaner on 08.07.2017.

Dr. R. S. Singh

- Attended a Plantation programme organized by Rajasthan Patrika at Sareh Nathaniyan village, Bikaner on 22.7.2016.
- Attended as convener for Scientists -farmers interaction meet and workshop held at CAZRI, RRS, Bikaner on 12.7.2016.
- Attended Global Rajasthan Agro-Meet 2016 as expert of Horticulture with team of scientist at JECC, Jaipur organized by Govt of Rajasthan and FICCI, on 11.11.2016.

Dr. D.K. Samadia

- Attended and poster presentation in the Ist International Agro-biodiversity Congress, Organized by Indian Society of Plant Genetic Resources & Biodiversity International. November 6–9, 2016 New Delhi, India.
- Attended XXI Research workers group meeting of ICAR-AICRP on AZF and act as Rapporteur in technical session - Improvement of Arid Zone Fruits. Organized by CIAH, Bikaner, Rajasthan. 5–7th March 2017.

Dr. A. K. Singh

- Participated in Global Conference on perspective of Future Challenges and Options in Agriculture held at Jain Hills, Jalgoan from 28th may to 31st May, 2016, p. 71-72.
- Participated in national workshop on technological Changes and Innovation in Pomegranate Production and Utilization for Enhancing Farmers' Income held 26/09/2016 at JAU, Junagarh, Gujarat.
- Participated in Noni Search, Eleventh National Symposium on Noni and Medicinal Plants for Health and Livelihood Security held at IISR, Lucknow, 3rd & 4th December, 2016.
- Participated in Brain Storming Session-cum Interaction Meet on Engineering Interventions for Production and processing of Horticultural Crops at CIAE, Bhopal on 24th and 25th October, 2016.
- Participated in 7th Indian Horticulture Congress on Doubling Farmers Income through Horticulture (An International Meet) held at IARI, New Delhi from 15th to 18th November, 2016.
- Participate in Retreat –cum Dialogue on Foundation of Golden India: Empowering Farmers held between11to 14th June, 2016 at Gyan Sarovar, Mount Abu, Rajasthan.

Dr. Hare Krishna

- Attended and represented the Institute at the workshop '*Higher Education ka Hub-Bikaner*' organized by RAJUVAS, Bikaner and Rajasthan Patrika on June 18, 2016.

M. K. Jatav

- Attended IJTA 3 International Conference on Agriculture, Horticulture & Plant Sciences at New Delhi, India during 25th to 26th June 2016 organized by Academic Research Journals (India).
- Attended the International conference on integrating climate, crop, ecology -the emerging areas of agriculture, horticulture, livestock, fishery, forestry, biodiversity and policy issues On 5th June, 2016 Organized by "Krishi Sanskrit" at Jawaharlal Nehru University, New Delhi
- Attended National seminar on Climate Resilient Saline Agriculture: Sustainable Livelihood Security during 21-23rd January is being held at SKRAU, Bikaner, organized by Indian Society of Soil Salinity and water Quality, Karnal and ICAR-CSSRI, karnal,

Dr. B. R. choudhary

- Participated '34th AICRP Group Meeting on Vegetable Crops' held at IARI, New Delhi from 10-13 May, 2016.
- Attended Farmer Scientist Interaction Workshop on 12th July, 2016 organized by ICAR- CAZRI RRS, Bikaner.
- Participated in Zonal Research Extension Advisory Committee meeting for *Rabi* 2016-17 organized by ARS, Bikaner on 6-7th Sept., 2016.
- Attended SAC meeting of KVK, Abusar (Jhunjhunu) held on 16th Sept., 2016.
- Attended SAC meeting of KVK, Padampur (Sri Ganganagar) held on 22nd Sept., 2016.
- Participated in International Meet on Doubling Farmers Income through Horticulture held during 7th Indian Horticulture Congress-2016 at New Delhi from 15-18th Nov., 2016.
- Attended 7th Indian Horticulture Congress-2016 held at New Delhi from 15-18th Nov., 2016.
- Participated in different activities during Jai Kisan-Jai Vigyan week celebrated by the institute from 23-29th December, 2016.
- Participated in National interaction programme between 'Scientists, Progressive Farmers of different districts of Rajasthan and Farmer Scientists of 6 North-Western States' organized by RAJUVAS, Bikaner on 9-10th March, 2017.
- Exhibited the technologies developed by the institute in Global Rajasthan Agritech Meet (GRAM) held at Jaipur during 9-11th Nov., 2016.
- Exhibited the technologies developed by the institute in Arogya Fair held at Bikaner during 13-16th December, 2016.
- Participated in Western Regional Agriculture Fair held at SKRAU, Bikaner from 18-20th February, 2017 and displayed the technologies developed by the institute.

Dr. S. R. Meena

- Attended the "Global Rajasthan Agritech Meet (GRAM) -2016" organized by Government of Rajasthan at Jaipur from 09.11.16 to 11.11.16 and contributed a lot during the technical interactions held with farmers/clients through "*Chopal* programmes" held during the same.
- Attended and contributed in Workshop/ 21st Research Workers Group Meet on AICRP-AZF held at ICAR-CIAH from 05.03.17 to 07.03.17.
- Attended the *Rajasthan Food Protech Meet* held by ICC (Indian Chamber of Commerce) at Hotel Marriot, Jaipur on 19.01.17.

Dr. D. K. Sarolia

- Participated in Global Rajasthan Agritech Meet (GRAM) at Jaipur on 11th Nov., 2016.

Dr. D. S. Mishra

- Participated in the National workshop on "Technological changes and innovation in pomegranate production and utilization for

enhancing farmers' income jointly organised by Jain irrigation and CHAI at JAU, Junagarh, Gujarat on Sept., 26, 2016.

Dr. Ramkesh Meena

- Attended Pomegranate Research worker meet on 23-24th August 2016 at Pune and delivered the lecture on "Status of Pomegranate Cultivation in Hot Arid Ecosystem of Rajasthan"
- Participated Indo-Israel work plan seminar on 27-28th September, 2016 Bassi (Rajasthan) delivered the lecture on "Problem & Prospect of pomegranate cultivation in Rajasthan"
- Attended and delivered evaluation report of Pomegranate & Bael in Workshop on 21st Research Workers Group Meet on AICRP-AZF held at ICAR-CIAH from 05.03.17 to 07.03.17.
- Attended National workshop on pomegranate on 10th December, 2016 at Agriculture University Mandoor, Jodhpur (Rajasthan).

Dr. S. M. Haldhar

- Attended tephritid seminar on 'Understanding tephritids in toto: taxonomy, ecology, quarantine and management' organized by ICAR-IIHR, Bengaluru during 27th May, 2016.
- Attended Symposium of Tephritid workers of Asia, Australia and Oceania (TAAO) organized by Universiti Putra Malaysia, Malaysia during 15 to 18 August, 2016.
- Attended International Conference on Entomology organized by Punjabi University, Patiala during 03 to 05, December 2016.
- Attended Interaction programme between Scientists and Progressive Farmers organized by RAJUVA, Bikaner during 09 to 10, March, 2017.

Dr. Vikas Yadav

- Participated and present poster in international seminar on recent trends and experimental approaches in science, technology and nature, December 23-24, 2016 at IISR, Lucknow, UP, India.)
- Participated in ICAR-All India Coordinated Research Project on Arid Zone on 5-7 march, 2017 at CIAH, Bikaner.
- Participated in the Institute Research Committee (IRC) Meeting on 10-11August, 2016 at CIAH, Bikaner.

Dr. Vijay Rakesh Reddy S.

- Participated in Annual Research Workers Group meet of AICRP on Arid Zone fruits held during 5-7th Feb. 2017 at ICAR-CIAH, Bikaner, Rajasthan.
- Participated in 'Hindi Workshop' on 17-03-2017 held at National Research Center for Camel, Bikaner, Rajasthan.
- Participated in National Seminar 'Zero Hunger Challenges-Food Security for all' held during 4-5th January 2017 at Govt. College for Women (A), Guntur, AP.

Dr. Kamlesh Kumar

- Participated in 21st Group Workers Meeting of All Indian Coordinated Research Project on Arid Zone Fruits from 5-7 March, 2016 at ICAR-CIAH, Bikaner

Dr. Ajay Kumar Verma

- Participated in National Agricultural Convention on Opportunities in Agripreneurship for Agricultural Students (OAAS) organized by RAJUVAS and AIASA, Rajastha on 7 October, 2016.
- Participated in 21st Group Meeting of All Indian Coordinated Research Project on Arid Zone Fruits on 5-7 March, 2017 at ICAR-CIAH, Bikaner

Lecture

Dr. Sanjay Singh

- Deliver lecture on Under utilized fruits, mango and sweet orange on 26/07/2016, 28/07/2016, 30/07/2016, 01/08/2016, 02/08/2016,17/01/2017, 18/01/2017,

19/01/2017, 20/01/2017, 21/01/2017, 23/01/2017, 25/01/2017, 15/02/2017, 16/02/2017, 18/02/2017, 20/02/2017, 21/02/2017, 22/02/2017 and 23/02/2017 at Taluka Garvada, Jhalod, D. Bariya, Dhanpur, Sanjeli, Fatepura, Dahod, Garvada, Jhalod, D. Bariya, Limkheda, Fatepura, Dhanpura, Dahod, Garvada, Fatepura, Limkheda, Dhanpur, Deogarh Baria, Sanjeli respectively.

Dr. Dhurendra Singh

- Presented paper on status of date palm tissue culture at ICAR-CIAH, Bikaner Brain storming session on oil palm tissue culture om 20.09.2016 ICAR-IIOPR, Pedavegi, AP.
- Presented Germplasm issues related to Arid horticultural crops in Brain storming session on the germplasm introduction and exchange on 19.11.2016 organised by Hort. Sci. Division ICAR and NBPGR, New Delhi.
- Presented 4 years progress of project at CIAH in Annual Review Meeting of date palm network project on "Production & Demonstration of tissue culture raised plants under three locations & collection & maintenance of elite germplasm of date palm" on 7th March, 2017 organised at ICAR-CIAH, Bikaner.
- Presented a paper on Vocational Opportunities For Graduates In Plant and Biological Sciences National Seminar On National Education Policy-2016: Issues, Challenges and Suggestions, organised by MGS University, Bikaner on 17.10.2016.
- Presented a paper on Green house based multitier hi-tech propagation- A methodology for mitigating environmental stresses in arid zone in National Seminar on Environmental Managhement and Technology 8-9 March, 2017 organised by MGSU, Bikaner.
- Presented a lead paper on Bio-entreprenurship opportunities for agricultural graduates in National Agricultural convention on opportunities in agriprenurship for agricultural students organized br AIASA at RAJUVAS, Bikaner on 7.10.2016.
- Delivered lecture on key element of wildlife conservation in arid region workshop on wild life conservation organized by District Department of Forest and Wildlife Conservation at SKRAU Bikaner 08.07.2017.
- Lecture on importance of horticulture in Integrated farming system in farmers training on Integrated farming system in arid zone organised at Equine Production Centre-ICAR-NRC on Equine production, Bikaner under ATMA on 10.02.2016.
- Lecture on Crop improvement in horticultural crops of arid zone in farmers-scientist interface workshop organized by ARS, SKRAU, Bikaner under ATMA on 16.02.2016.
- Lecture on Importance of bio-compost in horticulture crops in Farmer meeting on 02.10 2016 organised by Mahamaya Jaivik Khad Bhandar at Sri Dungargarh, Bikaner.
- Lecture on Hi-tech propagation of arid fruit crops in Global Agritech Fair organised by Govt. of Rajasthan at Jaipur on 11.11.2016.

Dr. R. S. Singh

- Importance of Fruits production in Agriculture Education Day programme on 22.7.2016 at ICAR- CIAH, Bikaner.
- Cultivation of Fruit crops in arid region in Jai Kisan - Jai Vigyan programme on 23.12.2016 organized at Khichiya village, Bikaner and at BL Gurukul Learning Institute, Sithal on 26.12.2016.
- Improved Fruits Cultivation techniques in Farmers-Scientist Interaction workshop programme at ICAR- CAZRI, RRS, Bikaner on 12.7.2016
- Fruit crops as fodder for Livestock in Short course training programme held at SKRAU, Bikaner on 07.12.2016.
- Horticultural crops of Arid region in training programme held at ARS, SKRAU, Bikaner on 15. 2. 2016.

Dr. D. K. Samadia

- Good management practices for healthy production under protected vegetable cultivation. In: Framers-scientist training programme - Integrated pest management (IPM) in arid horticulture crops, Organized by CIAH, Bikaner from February 15–16, 2016.
- Delivered scientific training lecture and orientation regarding research programme "Genetic resource, research on arid vegetables, seed production and flagship project on khejri" as professional training to Mr. Ajay Kumar Verma and Mr. Kamlesh Kumar, CIAH: Bikaner on 02/05/2016.
- Delivered lecture "Arid zone vegetable culture for nutrition and doubling farm income. In: Jay Kisan - Jai Vigyan programme of CIAH organized at Mohata Gurukul, Sinthal on 27/12/2016.
- Delivered lecture "Kachri crop and seed production technology" to Framers group from Ambuja Foundation, Nagour. On-campus training organized by CIAH, Bikaner on 08/02/2017.
- Delivered field talk and method demonstrations "Arid zone vegetable culture and seed production. In: off-campus framer training programme: Improved package of practice of kachri and snap melon cultivation with their seed production technologies, at village Sarahrupayat and Khinchiya. Organized by CIAH, Bikaner on 31/01/2017 to 01/02/2017.
- Delivered field talk and method demonstrations "Arid zone vegetable culture and seed production. In: Off-campus framer training programme: Improved package of practice of kachri and snap melon cultivation, at village Bachhasar and Kolasar. Organized by CIAH, Bikaner on 03/02/2017.

Dr. A. K. Singh

- Delivered invited lecture on Role of bael plantation in semi-arid Horticulture and demonstrated the various preparations of bael to NGO officials at Sadguru Foundation, Dahod on 11th May, 2016.
- Delivered invited lecture on bael during Retreat –cum- Dialogue on Foundation of Golden India: Empowering Farmers held between 11 to 14 June, 2016 at Gyan Sarovar, Mount Abu, Rajasthan.

Dr. V. V. Apparao

- Delivered lecture in 25 Days training I on "Gardener" under Agriculture skill council of India, Govt of India at ICAR, KVK, Panchamahals on 25 Feb., 2017 and 24 March, 2017 on garden components.
- Deliver lecture on Preparation of Media for nursery, pot and soil less culture.
- Practical in Preparation of Media for nursery, pot and soil less culture.
- Lectures delivered to farmers of ATMA group on Soil Testing and fertilizer recommendation- 25.07.2016, 28.07.2016, 29.07.2016 and 02.08.2016.

Dr. Hare Krishna

- Delivered lecture on '*Agricultural Research Management*' on 13-07-16 during a short course organized by SKRAU, Bikaner.
- Delivered lecture on topic anar utpadan ki naveen taknike during Farmer-Scientist interaction workshop on 07.07.16 organized at CAZRI-RRS, Bikaner.
- Delivered lecture on '*Knowledge dissemination system in horticulture using ICT*' on 15-11-16 during a winter school organized by SKRAU, Bikaner.
- Delivered a talk on 'Planning for on-site testing in *Ber*' during the 11th review meeting of DUS Centers organized by PPV&FRA, New Delhi at IGKV, Raipur on 28.02.2017.

Dr. S. K. Maheshwari

- Dr. S. K. Maheshwari, Sr. Scientist delivered a lecture on "Disease management strategies of vegetable crops" in 01 days off-campus farmers training programme on 30-09-2016 at Saraikunjia village of Bikaner district.
- Delivered a lecture on 'Integrated disease

management in arid fruit crops' on 16-02-2017 during 02 days Farmers-Scientists Interface Training at our Institute.

M. K. Jatav

- Lecture was delivered on Soil health care, its testing and soil health card importance for farmers in off campus farmers training programme on Improved package of practice of *kachari* and snap melon cultivation with their seed production technologies" at Sarahrupayat village of Bikaner district on 31/01/2017.
- Lecture was delivered on Nutrient management of *kachri* and snap melon cultivation farmers in Off campus farmers training programme on Improved package of practice of *kachari* and snap melon cultivation with their seed production technologies" at Sarahrupayat village of Bikaner district on 01/02/2017.
- Lecture was delivered on Nutrient management of *kachri* and snap melon cultivation farmers in Off campus farmers training programme on Improved package of practice of *kachari* and snap melon cultivation with their seed production technologies" at Kolasar village of Bikaner district on 03/02/2017.
- Lecture was delivered on Nutrient management of *kachri* and snap melon cultivation farmers in on campus farmers training programme on Improved package of practice of *kachari* and snap melon cultivation with their seed production technologies" at ICAR-CIAH, Bikaner district on 08/02/2017.
- Lecture was delivered on Nutrient management of arid horticulture crops in two days Farmers-Scientists Interface Training on "Integrated pest management (IPM) in arid horticulture crops" at ICAR-CIAH, Bikaner during 15th to 16th February, 2017.

Dr. D. K. Sarolia

- Delivered lectures on Genetic resource management in less known arid fruits and Genetic diversity in Khejri (Prosopis cineraria (L.) Druce) in Thar Desert. In Winter School on Exploitation of Underutilized Fruits of Arid and Semi Arid Region (4 Oct., 2016), Directorate of Research, RCA, MPUAT, Udaipur.
- Delivered lectures on Good nursery activities for healthy saplings production in Farmers-scientists interface training on integrated pest management in arid horticulture crops at CIAH, Bikaner from 15-16 Feb., 2017.

Dr. B. R. Choudhary

- Delivered lecture and replied the questions of farmers during Global Rajasthan Agritech Meet (GRAM) on 11 Nov., 2016 at Jaipur.
- Delivered a lecture 'Vegetable cultivation in arid regions' on 16-02-2017 during District Level Horticulture Seminar organized by Directorate of Horticulture, Bikaner from 16-17 February, 2017.

Dr. D. S. Mishra

- Delivered a lecture on "Future fruit crops for semi-arid conditions of Western India" on 13.10.2016 in a winter school on "Exploitation of Underutilized Fruits of Semi Arid Region" at MPUAT, Udaipur.
- Delivered lecture in 25 days training programme on "Gardener" under ASCI (Agricultural Skill Council of India), Govt of India at ICAR KVK, Panchmahals on Feb25, 2017 and March 24, 2017 on Garden components.

Dr. S. M. Haldhar

- Lecture delivered to farmers on Insect-pests management of kachri and snapmelon crops in two days training on "Improved package of practices of kachri & snapmelon cultivation with their seed production technologies" at Sarahrupayat village of Bikaner dated 31.01.2017.
- Lecture delivered to farmers on Insect-pests management of kachri and snapmelon crops in one day training on "Improved package of practices of kachri & snapmelon cultivation" at Bachhasar village of Bikaner dated 03.02.2017.
- Expert for farmers on 'pests management in fruit and vegetable crops' in three days farmers fair GRAM, Jaipur dated 11.11.17.

- Lecture delivered to farmers on Insect-pests management of arid fruit and vegetable crops in two days training on "Integrated pest management (IPM) in arid horticulture crops" at ICAR-CIAH, Bikaner dated 15.02.2017.
- Oral presentation Host plant resistance (HPR) study on snapmelon (*Cucumis melo* var. *momordica*) against melon fruit fly (*Bactrocera cucurbitae* (Coquillett)) in arid region Rajasthan Tephritid seminar on 'Understanding tephritids in toto: taxonomy, ecology, quarantine and management' organised by Universiti Putra Malaysia, Malaysia during 15-18, August, 2016.
- Oral presentation Host Plant Resistance (HPR) study in Jamun (*Syzygium cumini*) against fruit borers, *Meridarchis scyrodes* Meyrick and *Dudua aprobola* (Meyrick) in semi-arid region. International Conference on Entomology organized by Punjabi University, Patiala during 03 to 05, December 2016.

Dr. Vikas Yadav

- Two Lectures were delivered in 25 days training programme on "Gardener" under ASCI (Agriculture Skill Council of India).
- Lecture was delivered on selection of annuals, shrubs, tree for garden on 25-03-2017.
- Lecture was delivered to the farmers of ATMA, on cultivation of custard apple on 17.01.2017.
- Lecture was delivered to the farmers of ATMA, on propagation of custard apple on 18.01.2017.
- Lecture was delivered to the farmers of ATMA on production technology of custard apple on 19.01.2017.
- Lecture was delivered to the farmers of ATMA, on value added product of custard apple fruits on 24.01.2017.

Interacted and delivered five lectures/talks to the farmers of Dahod district during ATMA training programmes on

Date	Topic	Taluka	No. of farmers' attended
26/07/2016	Production technology of acid lime	Garvada	30
27/07/2016	New improved varieties of mango	Jhalod	30
29/07/2016	Production technology of guava	Limkheda	30
30/07/2016	New technologies of mango cultivation	Dhanpur	30
01/08/2016	Cultivation of *Citrus* fruits	Sanjeli	30
17/01/2017	Technologies of guava production	Dahod	30
18/01/2017	Technologies of pomegranate production	Garvada	30
19/01/2017	Technologies of pomegranate production	Jhalod	30
20/01/2017	Technologies of acid lime production	D. Bariya	30
21/01/2017	Technologies of guava production	Limkheda	30
24/01/2017	Technologies of guava production	Sanjeli	30
25/01/2017	Technologies of acid lime production	Dhanpura	30
15/02/2017	Drip irrigation and fertigation for quality fruit production	Dahod	30
16/02/2017	Guava production technologies	Garvada	30
17/02/2017	Production technology of *Citrus* fruits	Jhalod	30
18/02/2017	Production technology of guava	Fatepura	30
20/02/2017	Production technology of pomegranate	Limkheda	30
21/02/2017	Production technology of guava	Dhanpur	30

- Lecture was delivered to the farmers of ATMA, on cultivation of underutilized fruits on 25.01.2017
- Lecture was delivered to the farmers of ATMA, on cultivation of custard apple fruits on 15.02.2017.
- Lecture was delivered to the farmers of ATMA on intercropping in custard apple orchard on16.02.2017.
- Lecture was delivered to the farmers of ATMA, on cultivation of custard apple fruits on 17.02.2017.
- Lecture was delivered to the farmers of ATMA, on cultivation of wood apple on 18.02.2017.
- Lecture was delivered to the farmers of ATMA, on proper management of custard apple fruits on 20.02.2017.
- Lecture was delivered to the farmers of ATMA, physiological disorder in custard apple fruits on 21.02.2017.
- Lecture was delivered to the farmers of ATMA, post harvest management of custard apple on 23.02.2017.

Dr. Lalu Prasad Yadav

- Lecture was delivered to the thirty farmers of ATMA, Dahod on kitchen gardening on 17.01.2017.
- Lecture was delivered to the thirty farmers of ATMA, zalod on scientific production technology of drumstick (Thar Harsha) on 19.01.2017.
- Lecture was delivered to the thirty farmers of ATMA, Fatehpura on scientific production technology of solanaceous vegetable crops on 23.01.2017.
- Lecture was delivered to the thirty farmers of ATMA, Sanjeli on nutritional and medicinal importance of drumstick on 24.01.2017.
- Visit to thirty farmers of ATMA, Ratlam to experimental block II and III of CHES, Vejalpur on 07.03.2017.
- Lecture was delivered on 25 days training on gardening under Agriculture skill council of India at KVK, Vejalpur on "Establish of physical infrastructure- shade house, mist chamber, irrigation system on 23.03.2017.
- Lecture was delivered on 25 days training on gardening under Agriculture skill council of India at KVK, Vejalpur on "Practical shade house, mist chamber, irrigation system on 23.03.2017.
- Actively participated in Bael Day celebration programme for the farmers of Gujarat for creation awareness among the farmers regarding Bael on 02/04/2016 at CHES,Vejalpur.

Dr. Gangadhara K.

- Many lectures were given to ATMA farmers of Dahod and Godhra district (from 17/01/2017 to 25/01/2017) to motivate them to adoption of new technology. Different lectures as fallows below:
  - Production technology of beans on 17/1/2017. Integrated farming system on 18/1/2017. Production technology of tomato, brinjal and chilli on 19/1/2017. Production technology of on 20/1/2017. Management of brinjal shoot and fruit borer on 21/1/2017, Insect pest management in beans on 23/1/2017, Vegetable nursery management on 24/1/2017.
  - Integrated farming system on 25/1/2017. Importance and scope of polytunnel in vegetable crops-To the students of rural science at ASCI training programme conducted by KVK, Vejalpur on 22/03/2017.

Impoartant Events

Celebration of Week/day

Celebration of Foundation Day of the Institute: Foundation Day of the Institute was celebrated on 23.04.16 at the Institute.

Celebration of Agriculture Education Day: On 22.07.2016 and 03.12.2016 the Agriculture *Education Day* was celebrated in the Institute in which > 100 students and teachers from different

school of Bikaner participated. Technological film of the Institute for the technical knowledge of arid horticultural technologies was presented. The students and other participants were visited to the Museum of the Institute to acquaint them with latest technologies displayed in the museum.

Organization of Communal Harmony Campaign and the Fund Raising Week: During the reported period the Communal Harmony Campaign and the Fund Raising Week" (Under NFCH, New Delhi.) was carried out in the Institute from 19-25 November, 2016.

The Institute organized/celebrated the *Jai Kisan Jai Vigyan Week* from 23.12.2016 to 29.12.2016.

Vegetable Seed Sale Day: To promote arid zone vegetable culture and development of seed chain, vegetable seed sale day was organized on 09/02/2017 at ICAR-CIAH, Bikaner. The institute varieties seed sale activities were performed smoothly on the announced day, and sale was continued for a week period as spring-summer season crops. About one thousand farmers were benefited with seeds of institute varieties of kachri AHK–119, snap melon AHS–82, mateera Thar Manak, cluster bean Thar Bhadavi and other vegetable seeds. Crop variety seeds required for 0.25 ha sowing area was given to each farmer for covering large number of farmers came from the state of Rajasthan (17 districts), Punjab and Haryana. Technical know-how and literature was given for systemic crop and seed production, and to promote vegetable culture under resource constraints hot arid agro-climate.

12. DISTINGUISHED VISITORS

Bikaner

- Dr. A. K. Gehlot, Hon'ble VC, RAJUVAS, Bikaner on 23.4.2016.
- Dr. O. P. Yadav, Director ICAR-CAZRI, Jodhpur on 25.04.2016.
- Dr. S. K. Malhotra, Agricultural Production Commissioner, Govt. of India, Min. of Agric. & FW, New Delhi on 30.04.2016.
- Sh. Sua Lal, IAS, Commissioner, Bikaner on 30.04.2016.
- Dr. M. J. Kaledhankar, Project Coordinator, AIRCP on Salt Affected Soils and Use of Saline water, ICAR, CSSRI, Karnal, Haryana on 09.08.2016.
- Dr. Sushil Kumar, Ex-Director, NDRI, Karnal on 20.08.2016.
- Dr. S. L. Mehta, Former Vice Chancellor (MPUAT, Udaipur), Ex-DDG (Education.), ICAR, New Delhi on 2- 3 September 2016.
- Dr. B. B. Vashishtha, Former Director, ICAR-NRCSS, Ajmer on 2-3 September, 2016.
- Dr. H. P. Vyas, Ex-Vice Chancellor, Bikaner Tech, University, Bikaner on 14.09.2016.
- Sh. Amrish Kumar, Director, Agriculture, Government of Rajasthan, Jaipur on 6.8.2016
- Sh. Vipin Kumar Pandey, IPS, IG of Police, Bikaner Range on 25.10.2016.
- Dr. S. K. Chakravarty, Director, ICAR-CPRI Shimla on 18.12.2016.
- Dr. V. K. Dua, PC (Potato), CPRI, Shimla, on 18.12.2016.
- Dr. B. R. Chhipa, Hon'ble Vice Chancellor, SKRAU, Bikaner 29.12.2016.
- Dr. V. N. Sharda, Member, ASRB, New Delhi on 20.01.2017.
- Dr. Gurbachan Singh, Chairman, ASRB, New Delhi 21.01.2017.
- FAEQ, H. H. Hamza, Palestine Embassy, New Delhi on 25.01.2017.
- Jamal Mohd. Abujavvar, Jerico, Palestine on 25.01.2017.
- Sh. Nazih, M. A. Eshdaya, Jerico, Palestine on 25.01.2017.
- Dr. A. K. Singh, Deputy Director General (Agril. Extn. & Hort. Science), ICAR, New Delhi on 05.03.2017.
- Dr. W. S. Dhillon, Asstt. Director General (Hort. Science-I), ICAR, KAB-II, Pusa New Delhi on 05.03.2017.
- Dr. Prakash Patil, Project Coordinator (Tropical Fruits), Indian Institute of Horticultural Research, Bengaluru on 05.03.2017.
- Dr. Gopal Lal, Director, ICAR-NRCSS on 05-03-2017.
- Dr. Balraj Singh, Vince Chancellor, Agriculture University, Jodhpur on 05-03-2017.
- Dr. S. Rajan, Director, ICAR-CISH, Lucknow on 05-03-2017.

CHES, Godhra

- Dr. P. M. Vaghasia, Joint Director and Head, Agricultural Technology Management Agency (A.T.M.A.), Govt. of Gujarat, Visited the farm on dated 25.03.2017.
- Dr. S. K. Singh, Director, ATARI Zone-VI Visited the farm on dated 02.02.2017.

13. RAJBHASHA

हिन्दी चेतना सप्ताह 2016

भाकृअनुप–केन्द्रीय शुष्क बागवानी संस्थान बीकानेर, में दिनांक 14 से 21 सितम्बर 2016 के मध्य मनाया गया। उद्घाटन के अवसर पर प्रख्यात वैज्ञानिक और इंजीनियर और बीकानेर तकनीकी विश्वविद्यालय के पूर्व कुलपति डॉ. एच. पी. व्यास मुख्य अतिथि थे। उन्होंने कहा कि हिन्दी को किसी एक विशेष दिवस पर याद करने के बजाय प्रतिदिन आदत बनाएं। हिन्दी में विज्ञान की शिक्षा सरलता से दी जा सकती है अतः सभी को इस प्रकार के प्रयास करने चाहिए। हिन्दी भाषा की वैज्ञानिकता को सिद्ध करते हुए उन्होंने कहा कि यह भाषा पूर्ण रूप से वैज्ञानिक और मानव जीवन पर आधारित है। उन्होंने संस्थान के वैज्ञानिकों से कहा कि हिन्दी में शोध साहित्य का सृजन कर आप हिंदी की सेवा कर सकते हैं। संस्थान के प्रभारी निदेशक डॉ. धुरेन्द्र सिंह ने कहा कि हिंदी का प्रयोग बढ़ाने के लिए भारत सरकार के प्रेरणा और प्रोत्साहन कार्यक्रम पर बल दिया जाना चाहिए। उन्होंने कहा कि कल्पना हिन्दी में और क्रियान्वयन अंग्रेजी में नहीं चल सकता है। जब कल्पना हिंदी में है तो उसका क्रियान्वयन भी हिंदी में ही किया जाना चाहिए। वयोवृद्ध किसान श्री दामोदर शर्मा और स्टूडियो एबीसीडी, मुम्बई के श्री सखा मित्र अश्विनी ने भी अपने विचार व्यक्त किये। उन्होंने कहा कि हिंदी भाषा के 240 शब्द ऑक्सफोर्ड शब्दकोश में ज्यों के त्यों समाहित किये गये हैं। हिन्दी चेतना सप्ताह आयोजन समिति के सदस्य डॉ. दिलीप कुमार समादिया ने अतिथियों का स्वागत किया।

समापन अवसर पर डूंगर महाविद्यालय, बीकानेर के हिंदी विभाग की अध्यक्ष डॉ. शालिनी मूलचंदानी मुख्य अतिथि थीं। उन्होंने कहा कि हिन्दी अपने आप में एक सुदृढ़ भाषा है, इसे अनुवाद की भाषा बनाकर प्रयोग नहीं करना चाहिए। निरन्तर अभ्यास से हिंदी का प्रयोग बढ़ाया जा सकता है। उन्होंने इस बात पर चिंता व्यक्त करते हुए कहा कि हिंदी को हीनता की भाषा न समझें। हिंदी में भी उपार्जन के समुचित अवसर हैं। केवल दिवस मनाकर अपने कार्य की इति श्री न समझें। हिंदी में दूसरी भाषाओं के शब्दों को अपनाने की शक्ति है तो, यह दूसरी भाषा को अपने शब्द देने का सामर्थ्य भी रखती है। अतः हिंदी को किसी भी रूप में कमतर न आंके। आधुनिक दौर में हिंदी का प्रचार–प्रसार मन में उत्साह भर देता है। संस्थान के कार्यकारी निदेशक डॉ. ब्रजेश दत्त शर्मा ने कहा कि हिंदी का प्रयोग बढ़ाने के लिए भारत सरकार के प्रेरणा और प्रोत्साहन कार्यक्रम पर बल दिया जाना चाहिए। उन्होंने कहा कि हिन्दी सजग और सरल भाषा है। अपनी भाषा में कार्य करने में हिचक नहीं करनी चाहिए। इससे डरें नहीं यह हम सब की मातृभाषा है। हमें हिंदी में कार्य करने का माहौल तैयार करने की आवश्यकता है।

चेतना सप्ताह के दौरान आयोजित की गयी विभिन्न प्रतियोगिताओं में विजयी प्रतिभागियों को पुरस्कार प्रदान किए। विभिन्न प्रतियोगिताओं में प्रथम स्थान पर डॉ. शिवराम मीना, डॉ. बालूराम चौधरी, श्री संजय पाटिल, श्री रामदीन, डॉ. दीपक कुमार सरोलिया और श्री भोज राज खत्री, द्वितीय स्थान पर डॉ. रामकेश मीना, श्री छुट्टन लाल मीना, डॉ. मुकेश कुमार, डॉ. विजय राकेश रेड्डी और डॉ. श्रवण हलधर रहे और तृतीय स्थान पर श्री स्वरूप चंद राठौड़, डॉ. अजय कुमार वर्मा। डॉ. एस. के. महेश्वरी ओर डॉ. हरे कृष्ण को विशेष पुरस्कार से सम्मानित किया गया।

हिन्दी कार्यशाला आयोजन

इस अवधि के दौरान प्रथम तिमाही की कार्यशाला का आयोजन दिनांक 24 जून 2016, दूसरी 27 सितम्बर, 2016 को किया गया। इसमें ''हिन्दी वाईस सॉफ्टवेयर'' की जानकारी देते हुए उस पर कार्य करने करने के तरीके बताये गये। तीसरी कार्यशाला का आयोजन दिनांक 27 दिसम्बर, 2016 को किया गया। इसमें साइबर क्राइम एक्सपर्ट श्री उम्मेद मील ने साइबर क्राईम पर व्याख्यान दिया। चौथी कार्यशाला का आयोजन दिनांक 30 मार्च, 2017 को किया गया।

राजभाषा कार्यान्वयन समिति की बैठक

इस अवधि के दौरान संस्थान राजभाषा कार्यान्वयन समिति की तिमाही के आधार पर आयोजित की जाने वाली बैठकों में पहली बैठक का आयोजन दिनांक 24 जून 2016 को, दूसरी दिनांक 27 सितम्बर, 2016 को तीसरी बैठक का आयोजन दिनांक 27 दिसम्बर 2016 तथा चौथी बैठक दिनांक 28 मार्च, 2017 को की गयी।

संस्थान से वर्ष 2016 के दौरान हिन्दी में प्रकाशित

1. वार्षिक प्रतिवेदन 2015–16 (संस्थान), 2. वार्षिक प्रतिवेदन 2015–16 (अखिल भारतीय शुष्क क्षेत्र फल समन्वित अनुसंधान परियोजना 'एक्रिप'), 3. केशुबासं समाचार (छःमाही), हिन्दी बुलेटिन (1. मतीरा, 2. शुष्क क्षेत्र में कद्दुवर्गीय सब्जियों के प्रमुख कीट एवं उनका प्रबंधन, 3. काचरी)

हिन्दी कार्यशाला में सम्बोधित करते हुए संस्थान के निदेशक प्रोफेसर पी.एल.सरोज

हिन्दी चेतना सप्ताह में सम्बोधित करते हुए अतिथि और समापन समारोह में पुरस्कार प्राप्त करते हुए अधिकारी

गोधरा गुजरात

राजभाषा कार्यन्वयन समिति

राजभाषा कार्यन्वयन समिति की तिमाही बैठकों का आयोजन क्रमशः दिनांक 30.06.2016, 20.09.2016, 31.12.2016 एवं 23.03.2017 को किया गया। जिसमें केन्द्र की राजभाषा की प्रगति की समीक्षा की गई एवं कार्यान्वयन में आ रही कठिनाईयों को दूर करने के लिए विचार विमर्श करके हिन्दी की प्रगति को सुनिश्चित करने के लिए कदम उठाये।

हिन्दी कार्यशाला

केन्द्र में कार्यरत अधिकारियों को हिन्दी में कार्य करने की प्रेरणा के लिए राजभाषा विभाग के निर्देशानुसार दिनांक 20.09.2016 को "देश की एकता और अखंडता में राजभाषा हिन्दी का योगदान" विषय पर आयोजित की गयी।

हिन्दी सप्ताह का आयोजन

केन्द्रीय बागवानी परीक्षण केन्द्र, वेजलपुर (गोधरा) में दिनांक 14.09.16 से 19.09.16 तक हिन्दी सप्ताह मनाने का आयोजन किया गया था। हिन्दी सप्ताह दौरान यह निर्णय लिया गया की सभी कर्मचारी एवं अधिकरियों अपना महत्तम कार्य हिंदी में ही करने का प्रयास करे।

हिन्दी दिवस

दिनांक 14.09.2016 को हिन्दी कार्यान्वयन में वक्ता अथवा व्याख्याता की प्रभावी भूमिका के गूढ़ विषय पर आयोजित हिन्दी दिवस पर कार्यक्रम की शुरूआत में श्री मकवाणा ने बताया कि निम्न लिखित बिंदु पर ज्यादा ध्यान देना अति आवश्यक है (1) व्याख्यान देने की शैली (2) विषय वस्तु का समुचित ज्ञान (3) स्पष्टता (4) अंतिम पड़ाव (5) समय सीमा का ध्यान (6) आंगिक अभिव्यक्ति (7) व्याख्यान का प्रारंभ, मध्य और चरम।

नगर राजभाषा समिति की बैठक

दिनांक 22.09.2016 दूर संचार भवन गोधरा में आयोजित बैठक में भाग लिया।

किसान प्रशिक्षण

केन्द्र द्वारा समय–समय पर किसान प्रशिक्षणों आयोजित किए जाते है। इन किसान प्रशिक्षणों में केवल हिन्दी भाषा का ही प्रयोग किया जाता है। केन्द्रीय बागवानी परीक्षण केन्द्र वेजलपुर पर आत्मा के सहयोग से दाहोद जिले, गुजरात के पीपलोद और वन्दार गांव से किसानो और महिला किसानो को "ग्रामीण विकास के लिए अर्ध–शुष्क बागवानी "प्रशिक्षण कार्यक्रम का आयोजन किया गया। यह कार्यक्रम संपूर्ण हिन्दी में ही आयोजित किया गया था।

14. PERSONNEL

STAFF POSITION AS ON 31.03.2017

ICAR-CIAH (including CHES)

S. No.	Designation	Sanctioned Posts	Posts filled	Posts vacant
1	Director (RMP)	01	01	00
2	Scientific	35	29	06
3	Technical	42	35	07
4	Administrative	23	17*	07
5	Skilled Support Staff	33	24	09
Total		**134**	**106***	**29**

*Sh. Raj Kumar, FAO has been posted against vacant post of other Institute and it will be reverted back as and when Sh. Raj Kumar vacated the post.

Krishi Vigyan Kendra

Category	Sanctioned Strength	In position	Posts vacant
Programme Coordinator	01	01	00
Administrative	02	01	01
Technical	11	10	01
Supporting	02	02	00
TOTAL	**16**	**14**	**02**

ICAR-CIAH, Bikaner – Headquarter (As on 31.03.2017)

S. No.	Name	Designation/Discipline
	I. RESEARCH MANAGEMENT POSITION	
1.	Dr. P. L. Saroj	Director
	II. SCIENTIFIC	
1.	Dr. B. D. Sharma	Head, Division of Crop Production
2.	Dr. Dhurendra Singh	Head, Division of Crop Improvement
3.	Dr. R. Bhargava	Principal Scientist (Plant Physiology)
4.	Dr. R. S. Singh	Principal Scientist (Horticulture)

S. No.	Name	Designation/Discipline
5.	Dr. D. K. Samadia	Principal Scientist (Horticulture)
6.	Dr. S. K. Maheshwari	Senior Scientist (Plant Pathology)
7.	Dr. Hare Krishna	Senior Scientist (Horticulture)
8.	Dr. M. K. Jatav	Senior Scientist (Soil Science)
9.	Dr. P. P. Singh	Senior Scientist (Vegetable Science)
10.	Dr. B. R. Chaudhary	Senior Scientist (Vegetable Science)
11.	Dr. S. R. Meena	Senior Scientist (Agricultural Extension)
12.	Dr. D. K. Sarolia	Scientist (Vegetable Science)
13.	Dr. S. M. Haldhar	Scientist (Agricultural Entomology)
14.	Dr. Mukesh Kumar Berwal	Scientist (Plant Biochemistry)
15.	Sh. Ramesh Kumar	Scientist (Floriculture)
16.	Dr. Ramkesh Meena	Scientist (Horticulture)
17.	Sh. Jagan Singh Gora	Scientist (Fruit Science)
18.	Dr. Anita Meena	Scientist (Soil Science)
19.	Sh. Roop Chand Balai	Scientist (Soil Science)
20.	Dr. Vijay Rakesh Reddy S.	Scientist (Fruit Science)
21.	Dr. Kamlesh Kumar	Scientist (Fruit Science)
22.	Dr. Ajay Kumar Verma	Scientist (Vegetable Science)
	III. ADMINISTRATIVE	
1.	Sh. Ramdeen	Administrative Officer
2.	Sh. Raj Kumar	Finance & Accounts Officer
3.	Sh. Kuldeep Pandey	Asstt. Admn. Officer
	IV. TECHNICAL	
1.	Dr. U. V. Singh	Sr. Technical Officer - Field
2.	Sh. P. P. Pareek	Sr. Technical Officer - O.L.
3.	Sh. Sanjay Patil	Sr. Technical Officer - Artist-cum-Photography
4.	Sh. C. L. Meena	Sr. Technical Officer - Field
5.	Sh. M. K. Jain	Technical Officer
6.	Sh. B. R. Khatri	Technical Officer

B. CHES, Godhra – Regional Station

S. No.	Name	Designation/Discipline
	I. SCIENTIFIC	
1.	Dr. Sanjay Singh	Principal Scientist & Head
2.	Dr. A. K. Singh	Principal Scientist (Hort.)
3.	Dr. V. V. Appa Rao	Senior Scientist (Soil Science)
4.	Dr. D. S. Mishra	Senior Scientist (Hort.)

S. No.	Name	Designation/Discipline
5.	Dr. Vikas Yadav	Scientist (Fruit Science)
6.	Dr. Lalu Prasad Yadav	Scientist (Vegetable Science)
7.	Sh. Gangadhara K.	Scientist (Vegetable Science)
	II. ADMINISTRATIVE	
1.	Sh. Rajesh Daiya	Asstt. Admn. Officer
	III. TECHNICAL	
1.	Sh. Nihal Singh	Chief Technical Officer - Field
2.	Sh. G. U. Trivedi	Sr. Technical Officer - Library
3.	Sh. M. N. Makwana	Sr. Technical Officer - O.L.
4.	Sh. A. V. Dhobi	Sr. Technical Officer - Civil
6	Sh. R. B. Baria	Technical Officer - Field
7	Sh. K. K. Vankar	Technical Officer - Field
8	Sh. R. D. Rathva	Technical Officer - Lab
9	Sh. G. R. Baria	Technical Officer - Field
10	Sh. D. C. Joshi	Technical Officer - Field
11	Sh. K. V. Parmar	Technical Officer - Lab
12	Sh. C. S. Chamar	Technical Officer - Field

KVK, Vejalpur

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

NEW ENTRANTS

1. Dr. P. L. Saroj, Director joined the Institute on 03.10.2016.
2. Dr. Kamlesh Kumar, Scientist (Fruit Sci.) joined on 11.04.2016.
3. Sh. Ajay Kumar Verma, Scientist (Veg. Sci.) joined on 11.04.2016.
4. Dr. Daya Shankar Mishra, Sr. Scientist (Fruit Sci.) joined on 02.03.2016.

PROMOTION

SCIENTIFIC

Sr. No.	Name/Designation	Grade to which promoted and pay scale	Date of Promotion
1.	Dr. A. K. Singh Senior Scientist (Hort. - Fruit Sci.)	Principal Scientist 37400-67000 + RGP 10000/-	20.11.2014
2.	Dr. Shiv Ram Meena, Senior Scientist (Agril. Extension)	PB-4 / Rs 37400-67000 + RGP 9000/-	14.09.2012
3.	Dr. Ramkesh Meena Scientist (Horticulture - Fruit Science)	PB-3 / Rs 15600-39100 + RGP 7000/-	06.06.2012

ADMINISTRATIVE

--Nil--

TECHNICAL ASSESSMENT

S. No.	Name & Designation	Functional Group	Assessment period	Recommendation of the Assessment Committee	Date of effect	Present place of posting
1.	Sh. Jadav Jaypalsinh Kalyansinh (SMS) Sr. Technical Officer Grade pay Rs. 5400/-	Field/Farm Technician	26.05.2009 to 25.05.2014	Promoted as Asstt. Chief Technical Officer PB-3 + GP Rs.6600/-	26.05.2014	KVK-Panchmahal, CHES, Vejalpur, Godhra
2.	Sh. Balbir Singh Khadda (SMS) Sr. Technical Officer Grade pay Rs. 5400/-	Field/Farm Technician	28.05.2009 to 27.05.2014	Promoted as Asstt. Chief Technical Officer PB-3 + GP Rs.6600/-	28.05.2014	KVK-Panchmahal, CHES, Vejalpur, Godhra
3.	Sh. Ajay Kumar Rai (SMS) Sr. Technical Officer Grade pay Rs. 5400/-	Field/Farm Technician	01.06.2009 to 31.05.2014	Promoted as Asstt. Chief Technical Officer PB-3 + GP Rs.6600/-	01.06.2014	KVK-Panchmahal, CHES, Vejalpur, Godhra
4.	Dr. Raj Kumar (SMS) Sr. Technical Officer Grade pay Rs.5400/-	Field/Farm Technician	04.06.2009 to 03.06.2014	Promoted as Asstt. Chief Technical Officer PB-3 + GP Rs.6600/-	04.06.2014	KVK-Panchmahal, CHES, Vejalpur, Godhra
5.	Dr. Shakti Khajuria (SMS) Sr. Technical Officer Grade pay Rs. 5400/-	Field/Farm Technician	27.07.2009 to 26.07.2014	Promoted as Asstt. Chief Technical Officer PB-3 + GP Rs.6600/-	27.07.2014	KVK-Panchmahal, CHES, Vejalpur, Godhra

Skilled support staff

--Nil--

MODIFIED Assured Career Progression Scheme (MACPS)

--Nil--

JOINING ON TRANSFER

Sl. No.	Name/Designation	Date of joining
1.	Dr. Mukesh Kumar Berwal, Scientist	23.05.2016
2.	Dr. Anita Meena, Scientist	16.03.2017
3.	Sh. Roop Chand Balai, Scientist	31.03.2017

RELIEVING ON PROMOTION/TRANSFER

1. Sh. Gangadhara K., Scientist (Vegetable Scientist) relived from the Institute on 30.04.16 on transfer to CHES, Godhra.

SUPERANNUATION/RETIREMENT

1. Sh. B. J. Patel, Technical Officer - Artist & Photograpy retired on superannuation from the Council's service in the afternoon of 30.09.2016.
2. Sh. K. R. Vagela, Skilled Supporting Staff retired on superannuation from the Council's service in the afternoon of 31.01.2017.
3. Sh. Shiv Dayal, Skilled Supporting Staff retired on superannuation from the Council's service in the afternoon of 28.02.2017.

RESIGNATION

1. Dr. Pinaki Acharyya, Senior Scientist (Vegetable Science) resigned from Council's services w.e.f. 30.06.2016 (A.N.).

15. BUDGET

Head	Plan Expenditure			Non-Plan Expenditure		
	Bikaner	Godhra	Total	Bikaner	Godhra	Total
A. Grant in aid-Salary						
a. Salary	0	0	0	48682698	37693587	86376285
b. Wages	0	0	0	0	18297152	18297152
Total (A)	0	0	0	48682698	55990739	104673437
B. Grant in aid- Capital						
a. Equipment	1704418	234200	1938618	120848	151025	271873
b. Works	2904358	12400000	15304358	0		0
c. Library	51151	4995	56146	0		0
d. Furniture and Fixture	0	0	0	98362	98225	196587
Total (B)	4659927	12639195	17299122	219210	249250	468460
C. Grant in aid-General						
a. O.T.A						
b. T.A	499285	499668	998953	247147	148873	396020
c. H.R.D	286035	65601	351636	0	0	0
Total (C)	785320	565269	1350589	247147	148873	396020
D. Contigency						
Res. & Operation	3021585	765010	3786595	4342717	1078126	5420843
Administrative Exp.	7750617	1096641	8847258	4169901	1659430	5829331
Misc. Exp. (PDTC + TSP)	1501512	1996968	3498480	1117901	125991	1243892
Total (D)	12273714	3858619	16132333	9630519	2863547	12494066
E. Others						
a. Pension	0	0	0	1189721	6318767	7508488
b. P-loans	0	0	0	106500	396000	502500
Total (E)	0	0	0	1296221	6714767	8010988
Grand Total (A+B+C+D+E)	17718961	17063083	34782044	60075795	65967176	126042971

Revenue Receipt 2016-17

Head	CIAH	CHES	KVK- RFS	Seed Project	Amount
i) Sale of Farm Produce	188152	833630	44030	1003610	2069422
ii) Sale of Condemned Item	19174	0	0		19174
iii) Electric Charges	95616	2098			97714
iv) Water Charges	5553	0			5553
v) Sale of Tender Form	165050	2000	0		167050
vi) Interest on P Loan	433439	28938	0		462377
vii) Liscense Fee	60173	18785	0		78958
viii) Other - Misc. Receipt	1903333	24718	0		1928051
ix) Guest House	105550	0	0		105550
x) Interest earned on short term deposits	2027803	0	0	60586	2088389
xi) Recoveries of Loans and Advances	261165	556670	0	0	817835
Total : Other Receipts	5265008	1466839	44030	1064196	7840073

16. METEOROLOGICAL DATA

METEOROLOGICAL DATA FOR THE YEAR 2016-17 (BIKANER)

S. No.	Month	Temp (°C)		RH%		Rainfall	Wind speed	Sunshine	Evaporation
		Max.	Min.	I	II	(mm)	(km/hr)	Hrs.	Mean (mm)
1	April, 2016	40.73	26.17	39.83	16.63	0.00	4.42	7.90	11.13
2	May, 2016	43.54	30.16	55.74	27.45	0.00	7.51	9.25	13.57
3	June, 2016	38.19	28.58	66.33	29.67	79.00	9.83	8.13	10.86
4	July, 2016	38.16	28.56	73.39	50.06	90.60	7.66	8.47	8.54
5	August, 2016	36.91	26.24	73.87	46.13	134.80	3.97	8.07	7.97
6	September, 2016	22.90	14.71	39.29	20.14	0.00	2.94	4.94	4.30
7	October, 2016	34.11	16.15	56.32	28.74	23.20	3.23	9.03	7.34
8	November, 2016	24.51	9.42	73.17	40.07	0.00	1.14	8.29	5.67
9	December, 2016	22.75	5.67	70.39	36.29	0.00	1.19	7.57	3.88
10	January, 2017	21.4	6.6	91.3	56.2	2.2	4.1	5.4	2.1
11	February, 2017	28.3	9.3	74.4	24.6	0.0	4.7	9.4	5.0
12	March, 2017	33.7	15.6	60.3	21.0	0.8	5.6	8.3	7.2

METEOROLOGICAL DATA FOR THE YEAR 2016-17 (CHES, GODHRA, GUJARAT)

S. No.	Month	Temp (°C)		RH%		Rainfall	Rainy Days
		Max.	Min.	I	II	(mm)	--
1	April, 2016	37.40	21.60	78.95		--	--
2	May, 2016	39.74	27.42	77.98		--	03
3	June, 2016	28.33	27.33	71.75		22.40	13
4	July, 2016	30.92	24.94	87.40		442.42	14
5	August, 2016	29.94	22.94	95.49		347.26	02
6	September, 2016	23.70	20.93	86.07		36.52	04
7	October, 2016	23.14	21.13	78.06		83.04	--
8	November, 2016	30.93	12.47	70.51		--	--
9	December, 2016	29.93	10.49	70.19		--	--
10	January, 2017	29.25	08.67	70.04		--	--
11	February, 2017	30.32	10.67	69.81		--	--
12	March, 2017	36.41	15.69	71.08		--	--

Research farm ICAR-CIAH, Bikaner

Seed production of cluster bean

Khejri-Variety Thar Shobha

National field repository of ber

Evaluation of heat tolerant bottle gourd

भाकृअनुप
ICAR

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

स्वच्छ भारत
एक कदम स्वच्छता की ओर