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Annual Report
2020

ICAR-Central Institute for Arid Horticulture
Beechwal, Bikaner- 334 006 (Rajasthan)

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Preface

It gives me immense pleasure in bringing out the Annual Report 2020 of the ICAR-Central Institute for Arid Horticulture, Bikaner. Owing to their strength such as vast area, ample solar radiation, low incidence of diseases and pests; arid and semi-arid regions are bestowed with potential to become the horticultural bowl of India provided adequate technologies are developed. Ever since its inception on 1st April 1993, ICAR-Central Institute for Arid Horticulture, Bikaner is dedicated to serve the farmers and stake holders of arid and semi-arid region by developing technologies, introduction of crop genotypes from iso-climatic conditions, package and practices of arid horticultural crops under adverse climatic condition with limited resources, handling and value addition technologies of the horticultural produce, development of quality planting materials for the farmers, *etc.*

The present report highlights glimpses of 4 mega research projects and 8 externally funded projects including research accomplishment, significant advisory services provided, dissemination of knowledge acquired, human resource development, linkages cultivated/nurtured with various ICAR institutes, SAUs, line departments and other research organizations of India. For the same, my appreciation to all the members of the Institute Research Committee (IRC) who have discussed all the activities at length and come out with well laid out plan of action within a definite time frame. I also thank technical personnel, administrative, finance and other staff of the Institute who have put their lot of efforts to take policies and programmes of the Institute forward.

I take this opportunity to place on record my sincere thanks and deep sense of gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for his constant support in executing the mandate of the Institute. I also express my gratitude to Dr. A. K. Singh, Deputy Director General (Horticultural Science) and ADG (Hort.-I) for their ciritcal remarks and valuable suggestions.

This Annual Report is the culmination of dedicated and sustained efforts by our scientists and other staff of the institute. I wish to express my sincere appreciation to Dr. B. D. Sharma, Dr. D. Singh, Dr. B.R. Choudhary, Dr. Ramesh Kumar and Dr. Chet Ram for their sincere and whole-hearted support in bringing out the Annual Report (2020). The technical support in terms of computerization/Hindi Translation by Sh. Bhoj Raj Khatri, Sh. P. P. Pareek and Sh. Sanjay Patil is also appreciated.

May 2021, Bikaner

(P. L. Saroj)

CONTENTS

1. EXECUTIVE SUMMARY

PLANT GENETIC RESOURCES AND CROP IMPROVEMENT

The diverse germplasm of various arid fruit and vegetable crops were collected, conserved and evaluated at the field gene bank of ICAR-CIAH, Bikaner, Rajasthan and its regional station CHES, Godhra, Gujarat during the year 2020. In bael, variety Thar Srishti was identified which has highly centric seed cavity (locule arrangement), attractive pulp and appealing fruit colour with no off flavour. It is suitable for both table and processing purpose. Thar Srishti is prolific bearer, become ready in 300 days after fruit setting and recorded yield 91.50 kg/plant on 9th year. The average fruit weight is 1.55 kg, pulp TSS 36.85 ºBrix, mucilage TSS 51.50 ºBrix, acidity 0.35% and rich in fine fibres. It is free from gummosis under semi-arid conditions of western India.

During reporting period, survey was conducted in Kachchh region of Gujarat and collected seeds of 14 elite type's date palm germplasm and multiplied through seeds. In Manila tamarind, one genotype (CHESM-30) from Dakore, Gujarat was collected. One genotype of *ker* having heavy fruit load and bunch bearing was collected from Nagaur and successfully established in the field gene bank. The IC number for thornless *ker* 'AHCD-1' (IC-0634593) was obtained from ICAR-NBPGR, New Delhi.

The IC numbers of five promising pomegranate selections (CIAH PG-1:633374, CIAH PG-3:633375, CIAH PG-4:633376, CIAH PG-5:633377 and CIAH PG-9:633378) have been obtained from ICAR-NBPGR, New Delhi. These selections can be utilized as breeding lines for development of varieties for table, anardana and rootstock purposes. Two superior germplasm of acid lime namely CIAH acid lime-3 and CIAH acid lime-11 were identified for higher yield and quality under hot arid condition of Rajasthan. CIAH acid lime-3 has semi vigorous plant. The fruits are oblong shape, medium size, pleasing flavour and greenish colour, fruit weight 45.30 g. Fruits have 7.60 °Brix TSS and 6.12% acidity. The fruit yield on third year is 10.60 kg per plant. CIAH acid lime-11 has highly vigorous plant and produce fruits almost round the year. Fruits are oblong shape, medium size, pleasing flavour, light greenish colour and fruit weight 40.05 g. Fruits have 7.30 °Brix TSS and 5.58% acidity. The fruit yield on third year is 14.28 kg/plant. It is very less affected by citrus canker, which is very serious problem under hot arid condition of Rajasthan. In acid lime, 34 genotypes including varieties are conserved in field gene bank under semi-arid condition. Twenty seven genotypes/varieties of acid lime were evaluated on the basis of growth, yield and quality attributes.

Pomegranate germplasm were evaluated for growth, fruit quality and aril attributes under hot arid condition. Maximum number of fruits per plant was obtained in Saharanpur (40.50) followed by Jalore Seedless (38.25), Mridula (35.67) and Jodhpur Red (35.33). Number of cracked fruits per plant was varied significantly among different germplasm and recorded maximum (20.00) in Saharanpur followed by Mridula (10.50). Very less number of cracked fruits per plant was observed in some of the sour type deciduous germplasm like Gul-e-Shah (1.33), Gul-e-Shah Red (1.33), Gul-e-Shah Rose Pink (1.00), *etc*. Maximum fruit weight was recorded in Jalore Seedless (255.21 g) followed by G-137 (254.19 g) and Jodhpur collection (250.37 g) while minimum fruit weight was recorded in Yercaud Local (85.12 g).

Ten sweet orange cultivars budded on Rough lemon rootstock were evaluated for growth, yield and fruit quality attributes under hot arid region of Rajasthan. Maximum average number of fruits per plant was recorded (130.40) in Satgudi followed by Hamlin (118.60) as compared to lowest (10.80) in Washington Navel variety. Fruit yield was recorded maximum (25.04 kg/plant) in Satgudi followed by Hamlin (22.22 kg/plant) as compared to lowest (1.81 kg/plant) in Washington Navel variety. Satgudi was found significantly superior as compared to other

cultivars of sweet orange varieties in overall yield and fruit quality attributes under arid region climatic conditions.

The Fremont mandarin plants budded on Rough lemon, Karna Khatta, Pectinifera and Troyer rootstocks were evaluated under hot arid condition. The maximum number of fruits per plant, fruit weight and fruit yield per plant (241.25, 145.98 g and 35.22 kg) were recorded in Karna Khatta followed by Rough lemon (210.30, 140.10 g and 29.46 kg) as against minimum recorded in Troyer citrange (150.76, 125.74 g and 18.96 kg), respectively. Ripening index was found highest (14.97) in Pectinifera followed by Karna Khatta (12.02) and minimum (11.32) in Rough lemon.

The Daisy mandarin plants budded on Karna Khatta, Rangpur lime, Sour orange, Troyer citrange, Pectinifera and Rough lemon rootstocks were evaluated under hot arid condition. The maximum number of fruits and yield per plant (98.18 and 22.11 kg) was found on Rough lemon followed by Pectinifera (91.51 and 21.10 kg) while minimum found on Troyer citrange (42.28 and 8.89 kg), respectively. Fruit weight was found maximum on Karna Khatta (238.47 g) followed by Sour orange (235.50 g) while minimum found on Troyer citrange (210.18 g). Ripening index was found highest (17.44) in Pectinifera followed by Troyer citrange (16.29) and minimum (12.55) in Karna Khatta.

The date palm germplasm (38) were evaluated for morphological, physical and quality characters under hot arid condition. The maximum number of fruit setted per strand at pea stage (40) in Khadrawy and minimum was recorded in Javantri (16). The maximum fruit set (90.90%) was recorded in Zahidi followed by Nagal (76.90%) while minimum number of fruit setting was recorded in Gulchati (19.2%), respectively. The maximum bunch weight was recorded in Hayani (8.2 kg) followed by Khalas (6.6 kg) and minimum was recorded in Punjab Red (1.3 kg). Response of date palm cultivar to pollen sources, pollen quality, quantity and suitability were studied under hot arid ecosystem. In male palms, the number of days from spathe emergence to opening was varied from 29.4 to 37.6 days. Maximum spathe length (50.4 cm), width (17.2 cm), number of spathe per plant (27.4), number of strands (172.6), weight of pollen per spathe (23.8 g) and pollen yield per plant (667 g) were recorded in male M1. In female palms, spathe emergence to opening period was ranged from 16 to 29 days. The maximum spathe length and width was observed in variety Barhee (39.6 x 8.8 cm), but number of buds per strand (34.40) and length of strands (36.20 cm) were observed in Halawy, Khalash, Barhee and Medjool varieties.

Aonla varieties were studied for their morphomatrix, yield and qualitative attributes of fruits. Genotypes (CHESA-1 to CHESA-12) were studied for their growth, flowering and fruiting characters. Fruit weight was varied between 27.25-38.20 g, being maximum in Banarasi (37.20 g) followed by NA-7 (31.50 g) and it was measured minimum in BSR-1 (12.08 g).

Among bael germplasm evaluated under semi-arid condition, wide genetic diversity was noticed in their morphological, quantitative and qualitative fruit characters. Genotypes exhibited wide range of variability in terms of yield/plant (54.24-115.75 kg), fruit weight (0.60-2.60 kg), pulp weight (0.38-2.19 kg), TSS in pulp (30.20-42.50 °Brix), acidity (0.31-0.57%), vitamin C (12.09-24.80 mg/100 g). The genotypes, CHESB-11, CHESB-16, CHESB-27, CHESB-29, CHESB-31, CHESB-42, CHESB-48 CHESB-59, CHESB-60, CHESB-62, CHESB-69, CHESB-71, CHESB-73, CHESB-77 and CHESB-78 were found superior for morphological, quantitative and qualitative characters among the genotypes.

In jamun, fifteen promising genotypes were evaluated for growth, flowering, fruiting and fruit quality attributes. Maximum panicle length was recorded in CHESJ-30, closely followed by CHES-32 and CHESJ-35. Peak period of ripening was recorded in the month of May-June in all the genotypes. Fruit yield, pulp and TSS found highest in CHESJ-30. In tamarind, twenty four promising genotypes were evaluated for growth, flowering, fruiting and fruit quality attributes. On the basis of fruit yield and quality attributes, CHEST-10 was found promising. It has upright growth habit, thick trunk and drooping branches. It recorded 75.00 kg fruit per plant. Peak period of ripening time was last week of March. It recorded

52.20% pulp and 70.30 °Brix TSS during ripening.

In Manila tamarind germplasm, peak period of flowering was noted in January-February in all genotypes. Earliest flowering took place in CHESM-4, while it was noted at the last in CHESM-12. Maximum panicle length, fruit weight 30.00 g with 73.00% pulp was recorded in CHESM-4, while, highest TSS was recorded in CHESM-12 (25.10 °Brix).

One red fleshed guava cv. Lalbahadur was collected from AAU, Anand. Fifty five guava accessions are being conserved at field gene bank. Fourty five genotypes of guava which includes 22 red fleshed and 23 white fleshed genotypes were evaluated for growth, yield and biochemical attributes. Two red fleshed (CHESG-15 & Hyb 4/3) and one white fleshed (CHESG-38) genotypes were found promising on the basis of fruit yield and quality parameters. Hybrid seedlings of 10 cross combinations in guava were planted in the field and four cross combinations out of 10 showed precocious flowering and fruit setting. One year old plants of CHESG-15 x Thai guava are in fruiting. Five promising genotypes of guava (CHESG-12, CHESG-14, CHESG-27, CHESG-31 & CHESG-32) were selected on the basis of fruit size, weight, yield and quality parameters. In evaluation of F_1 hybrids of guava, the cross of Bhavnagar local x SP had significantly shorter plant height and spread in comparison to other crosses. The cross MPUAT-2 x CHESG-15 had tallest plant stature while CHESG-31 x Purple, CHESG-31 x TP, Lalit x CHESG-28, Thai x CHESG-30 and Thai x SP were showed moderately tall trees. However, Thai x SP had the maximum spread while Bhavnagar local x SP produced least spread. Four hybrids (Thai x CHESG-30, Thai x SP, SP x CHESG-28 and Bhavnagar local x SP) flowered earlier than other six crosses with highest percentage of flowering.

In wood apple, fifty eight germplasm are being conserved and evaluated at field gene bank under semi-arid ecosystem of western India. Among the genotypes, CHESW-6, CHESW-10, CHESW-22, CHESW-25 and CHESW-27 were found superior for fruit yield and quality attributes. The maximum fruit weight was recorded in Thar Gaurav (452.53 g) followed by CHESW-6 (388.10 g) while it was found minimum in CHESW-7 (168.57 g). The highest yield per plant was noted in CHESW-6 (162.00 kg) followed by CHESW-4 (129.27 kg), CHESW-10 (123.96 kg) and CHESW-15 (115.43 kg). The highest fruit pulp TSS (19.80 °Brix) was recorded in genotype CHESW-6. In custard apple, seventy four germplasm were conserved in field gene bank and evaluated under rainfed conditions of hot semi-arid ecosystem. The gemplasm CHESCA-4, CHESCA-13, CHESCA-23 and CHESCA-27 were found superior in respect of fruit quality and yield characters.

Six germplasm of *Jhaar karela* (*Momordica balsamina*) and two of spine gourd (*Momordica dioica*) were collected from different locations of Nagaur and Sikar districts of Rajasthan. Obtained IC number of four germplasm of muskmelon *viz*., AHMM/BR-1 (IC-634955), AHMM/BR-49 (IC-634956), AHMM/BR-52 (IC-634957), AHMM/BR-53 (IC-634958) and one of watermelon *i.e.* YF 5-2-7 (IC-0633085) from ICAR-NBPGR, New Delhi. YF 5-2-7 germplasm of watermelon was registered with ICAR-NBPGR, New Delhi under INGR 20117 for saffron coloured flesh with high carotenoid content and non-lobed (entire) leaves. Active breeding lines of muskmelon (40), watermelon (30), ridge gourd (20), sponge gourd (16) and long melon (05) are being conserved under *ex-situ* condition.

During the reporting period, regular monitoring of arid vegetable genetic resources (500 lines) which mainly consisted of desert melons (125 lines), non-dessert melons (161 lines), gourds (60 lines), cluster bean and beans (35 lines) was done for their safe conservation in gene bank facilities. In addition, germplasm of *khejri*, sahjan, aloe-vera, ivy gourd, *phog* and other perennial crop-plants were maintained in field repository. Under maintenance, okra, pumpkin, cucumber and cluster bean was taken for seed enhancement. Trait-specific genetic material in the form of potential lines/value added genotypes/varieties (>20) in particular to native cucurbits, beans and cluster bean, *palak*, sahjan were supplied for utilization in breeding for abiotic stresses tolerant genes or commercial seed production.

Cowpea line AHCP-1-4-1 and AHCP-2-

3 were studied for performance during rainy season, and recorded pod yield potential of 132-174 and 124-168 q/ha, respectively. Similarly, 17 diverse clusterbeen genotypes were evaluated for vegetable significance parameters including dehydration. The seed production of snapmelon (AHS-82: 60.5 kg), *kachri* (AHK-119: 30 kg), sponge gourd (Thar Tapish), bottle gourd (Thar Samridhi), cluster bean (Thar Bhadavi: 105 kg), *palak* (Thar Hariparna: 10 kg), Indian bean (Thar Kartiki and Thar Maghi: 3 kg), brinjal (Thar Rachit: 2.7 kg) and other arid vegetable crop varieties was done under revolving funds of ICAR seed programme.

A total of 49 genotypes of drumstick, 28 genotypes of ivy gourd, 25 genotypes of spine gourd, 7 genotypes of bottle gourd, 3 genotypes of tomato and one variety of pumpkin were maintained and multiplied under semi-arid condition. The tomato variety Thar Annant was developed through induced mutation followed by selection of desired phenotypic traits in the induced populations. It is having high flesh thickness (0.85 cm), deep red fruit colour rich in lycopene content (7.9 mg/100 g) with medium acidity (0.42%) under semi-arid condition. The superior phenotype of cross between LS- 4 x LS3-2 was advanced to F_8 for homogeneity. The fruits are round in shape, with 22.8 cm length and 750 g weight. Each plant produced about 12.91 kg fruits. The fruits are characterized with high TSS (8.1-8.7 °Brix), with creamy white flesh colour. Heavy yielding drumstick genotype (CHES D-40) with medium plant height 2.74 m, 248 pods, parrot green colour, pod weight 218 g, pod length 45-48 cm, 9-10 seed per pod and TSS 9.50 °Brix was evaluated under dryland semi-arid conditions. A promising genotype of ivy gourd (CHES IG 2) evaluated having high yield potential with the maximum fruit weight (29.30 g) as compared to other genotypes with identical appearance in form of attractive dark green shining colour with discontinuous strips, round oblong fruit shape without neck under the dryland semi-arid conditions. A unique genotype of ivy gourd (CHES IG-10) having heart shape leaf, small size lush green colour, pear shape fruit with sparse white stripes, high yield potential and tolerant to drought was identified under the hot semi arid conditions. Three promising lines of spine gourd namely CHES SG1 (IC:632328), CHES SG11 (IC:632329) and CHES SG15 (IC:632330) were evaluated for their specific traits including yield potential, colour, appearance, shape of fruit.

In evaluation of brinjal germplasm under hot arid environment, a promising brinjal genotype CIAH-22 (AHB-03) was identified, evaluated and designated as CIAH-22-6-1 with further purification during spring-summer and rainy season. The plants were moderate in growth and thorny in nature including stem, leaf and fruit calyx. It took 56-62 days from transplanting for first marketable fruit harvest. It is moderate bearer (16-27 fruits) and marketable yield potential is 2.85-3.72 kg/plant/season. Tender fruits at marketable stages are oblong, bluish-purple in colour, 7.56-8.33 cm in length, 7.19-7.48 cm in diameter and 120-155 g in weight. The plants exhibited good growth and continuous harvesting of quality fruits with temperature range of 42-46 °C during May-June months.

Among watermelon breeding lines developed, AHW/BR-40 continued to perform best and produced 260 q/ha marketable fruit yield with high TSS (12.10%). YF 5-2-7 having saffron flesh produced maximum carotenoid content (8.57 µg/g FW) followed by Durgapura Kesar (6.41 µg/ g FW). In muskmelon, AHMM/BR-47 (IC-0624305) found promising with respect to days to first fruit harvesting (80-85 DAS) which produced 3-4 marketable fruits/ plant weighing 600-750 g. The fruit TSS, rind thickness and flesh thickness varied from 11.0-11.6%, 0.3-0.4 cm and 3.0-3.4 cm, respectively. The width of seed cavity is small 4.0-5.1 cm and flesh colour is salmon orange. The rind is netted with clear sutures.

Thirty four genotypes of moringa were evaluated for their antioxidants and nutrient content in leaves and pods. A wide variation was observed in the content of antioxidants and nutrients. The highest total phenolic content was recorded in CHES D-40 pod, pulp and leaf among all moringa germplasm. The maximum total phenolic content in bark was assessed in CHES D-42. The highest vitamin C in leaves and pods were recorded in CHES D-40. The germplasm CHES D-40 recorded with highest nitrogen, potassium, calcium, sulphur, iron and

copper in dry leaves powder. Likewise, the phosphorus and copper in CHES D-42, zinc in CHES D-45 and magnesium in CHES D-50 leaves were recorded. The protein content was analyzed in moringa germplasm leaves with the maximum in CHES D-40.

In dolichos bean germplasm evaluated under semi-arid conditions, the genotypes CHESIB-07, CHESIB-31, CHESIB-40 and CHESIB-50 were found promising for their different horticultural traits. In CHESIB-50, pods are very attractive green in colour. A total of 600-700 pods per plant were obtained with an average yield of 6-7 kg/plant of fresh green pods. In CHESIB-07, pods are very attractive and dark pink in colour. It produced 800-1200 pods per plant with an average yield of 8-9 kg/plant of fresh pink pods. It is having field tolerance to dolichos bean yellow mosaic virus disease. In CHESIB-31, pods are attractive and light greenish white in colour. It produced 700-900 pods per plant with an average yield of 6.5-7.0 kg/plant of fresh pods. The germplasm CHESIB-40 had light pink pods with average yield of 7.0 to 8.5 kg/plant of fresh green pods. It is having field tolerance to dolichos bean yellow mosaic virus disease.

In order to cluster bean genotypes evaluated under semi-arid condition, the genotypes CHESCB-25 and CHESCB-24 were found superior with respect to fresh number of pods and pod yield. In genotype CHESCB-25, total number of fresh pods per plant varied from 280 to 320 with an average yield of 1.2 kg/plant while in genotype CHESCB-24, total number of fresh pods per plant varied from 300 to 320 with an average yield of 1 kg/plant.

CROP MANAGEMENT AND AGRO-TECHNIQUES

In ber canopy management, four ber varieties (Gola, Thai ber, Goma Kirti & Thar Sevika) were trained on Y shape, espalier, telephone and modified centre leader training system. Maximum fruit yield was recorded in variety Thai ber (29.13 kg/plant & 16.20 t/ha) followed by Goma Kirti and minimum in Thar Sevika (12.88 kg/plant & 20.97 t/ha). Among the training systems, Y shape system was recorded highest fruit yield (26.14 kg/plant & 20.97 t/ha) over other systems. In different planting densities in Thai ber, higher density of 6 x 3 m was found better with fruit retention (70.8%) and yield (43.30 q/ha) over other spacings. The minimum fruit retention was observed in 3 x 3 m spacing over other spacings probably due to intermingling of branches and damage caused by birds and rodents.

In bael fruit drops and sun scald management, minimum fruit drop (94.27%) and sun scald (19.00%) and the highest fruit retention (5.15%) were recorded with grass mulch + NAA (15 ppm) + course cotton cloth followed by grass mulch + NAA (15 ppm) + ascorbic acid (96.00, 27.34 and 4.00%) and grass mulch + Zn SO_4 (1000 ppm) + coarse cotton cloths (96.50, 26.00 and 3.18), respectively. The fruit drop and sunscald were recorded maximum in control (98.62% and 47.20%) while fruit retention was also recorded minimum (1.97%) in control.

In canopy management of bael cv. Goma Yashi, the maximum number of shoots (3.65) was recorded with 3 m plant height + 25% annual growth extension (AGE). Average yield was recorded highest with 3 m plant height + 25% AGE (68.59 kg/plant) followed by 2.5 m plant height + 25% AGE (65.50 kg/plant), whereas the lowest yield was observed with 2.5 m height + 75% AGE among the different combination of plant height and pruning intensity. Fruit size and TSS were recorded maximum in 3 m plant height + 25% AGE.

In flower regulation of pomegranate, maximum fruits yield per plant were observed in *mrig bahar* (9.00 kg) followed by *hasta bahar* (8.97 kg) as compared to minimum recorded in control (3.28 kg). Fruit cracking was varied significantly among different flower regulations treatments. The minimum fruit cracking was observed in *hasta bahar* (10.05%) followed by *mrig* + *hasta bahar* (12.25) while maximum in control (27.50%).

Different rootstocks were significantly influenced compatibility index of sweet orange cv. Mosambi and Satgudi under hot arid climatic condition. In Mosambi, highest scion rootstock (SR) ratio was recorded on Karna Khatta (0.95) rootstock followed by Volkameriana (0.92) and minimum on sour orange (0.80) rootstock. In Satgudi, the highest SR ratio was recorded on Rough lemon (0.95)

rootstock followed by Macrophylla (0.91) as compared to minimum on Rangpur lime (0.74) rootstock. Compatibility index of lemon cv. Pant lemon was significantly influenced by different rootstocks under hot arid climatic condition. The highest SR ratio was recorded on Rangpur lime (0.92) rootstock followed by Rough lemon (0.89) and minimum on Karna Khatta (0.80) rootstock.

In bael, plant growth and yield were influenced by mulches, manure, biofertilizer and fertilizer. Among different combination, plant height (3.91 m) was recorded maximum in standard dose of NPK followed by grass mulch + FYM + neem cake + 50% recommended dose of NPK + *Azotobactor* + VAM culture and grass mulch + FYM + 25% recommended dose of NPK + *Azotobactor* + PSB culture. The plant spread (3.87 m), stem girth (30.65) and number of fruit retention (5.23 fruits/plant) was also recorded maximum with grass mulch + FYM + neem cake + 50% recommended dose of NPK + *Azotobactor* + VAM culture under rainfed semi-arid conditions.

High density planting (400 plants/ha) in bael cv. Goma Yashi was standardized under rainfed semi-arid condition. The yield per plant was recorded 0.57 kg (2nd year) to 59.27 kg (10th year) and yield was recorded 2.28 q/ha (2nd year) to 237.28 (10th year). Gross income was obtained Rs. 2280.00 (2nd year) and Rs. 237080.00 (10th year). Net profit of Rs. 187080.00 was computed at the rate of Rs. 10/kg and purely under rainfed conditions of western India. In standardization of time of patch budding in Manila tamarind, maximum success (82.00%) was recorded in March closely followed by April and May. Maximum length of sprout, girth of sprout was also recorded when patch budding was done in the month of March.

In pruning studies of mango cv. Kesar, the maximum fruit yield (42.10 kg/plant), TSS (20.20 °Brix) was recorded in 3.60 m plant height + 25% annual growth extension. Fruit yield was recorded maximum in control (26.40 kg/plant). In rootstock studies in sweet orange cv. Sathgudi under semi-arid condition, maximum plant growth and rootstock girth was recorded in Rangpur lime closely followed by Rough lemon. Highest fruit yield, TSS and juice content was recorded in Rangpur lime.

The propagation studies on phalsa at CHES, Vejalpur resulted with highest percentage of success (52.10%) with 2000 ppm IBA followed by 1000 ppm, 500 ppm and 150 ppm concentrations of IBA. Other parameters like length of sprout, number of leaves per plant and girth of sprout was also noted highest in 2000 ppm IBA.

In *ker* propagation studies, maximum success was obtained only in semi hardwood stem cuttings during September month with clay + vermiculite + clay media. The average sprout percentage on semi hardwood stem cuttings was observed 41.13% while well rooted success cuttings recorded 45.95%. After one year, average plant height and number of success sprouts were noted 47.40 cm and 3.60, respectively.

While evaluation of fruit based diversified cropping models for arid region, higher plant height of aonla was found in sole aonla (5.0 m) followed by aonla + ber (4.3 m) whereas minimum plant height of aonla was recorded in aonla + karonda (3.3 m) followed by aonla + moringa (3.6). The yield of aonla was varied considerably in different cropping model systems and highest was recorded in aonla-*khejri* (73.90 kg/plant) followed by aonla-ber (70.2 kg/plant) and aonla + karonda (68.6 kg/plant). The yield of bael was recorded 16.41 kg/tree, while a single fruit weighed around 1.62 kg with maximum and minimum fruit weights recorded to be 3.96 and 0.4 kg, respectively. The yield of karonda was recorded 13.32 kg/plant planted in between aonla plants.

In protected cultivation of watermelon under hot arid conditions, the crop raised under tunnel (20th December with polythene covering) attained the harvestable maturity on 8th March in comparison to open field sowing (second week of February), which came in harvesting during first week of May which was 61 days later than the tunnel. Tunnel facilitated the early harvest of crop which earn higher market price in off-season than the normal season. The sowing on 10th January with polythene covering recorded the maximum fruit yield (256.32 q/ha) followed by sowing on the same date with non-woven covering (232.64 q/ha) and the minimum was recorded in sowing under open condition

(156.78 q/ha).

The protected cultivation of tomato (AHSL-1) under hot arid conditions performed differently under varying environments (open drip, open mini-sprinkler and shade net) during spring-summer season. The fruit yield was ranged from 1.89 to 3.68 kg/plant under varying environments. The highest fruit yield was recorded under open mini-sprinkler followed by shade net and the lowest was recorded under open drip environment. Based on performance studies, the genotype has the potential for cultivation under hot arid environment with further improvement.

Under protected cultivation, the genotype AHB-03 (CIAH-22) of brinjal was evaluated with varying environments (open drip, open mini-sprinkler and shade net) during spring-summer season. The genotype has the ability to tolerate high temperature as there was continuous fruiting during hot summer months (temperature up to 46 °C). The fruit yield per plant was ranged from 2.18 to 3.72 kg under varying environments. The highest fruit yield per plant was recorded under open mini-sprinkler followed by shade net and the lowest was recorded under open drip environment. The genotype mathania type slection-1 of chilli was also evaluated under different environmental conditions during spring-summer season. The genotype had light green fruits with typical fruit shape. The immature fruits at marketable stage were 16.25 cm in length and 1.52 cm in diameter.

In evaluation of onion varieties under hot arid conditions, the highest bulb yield was obtained from variety Bhima Red (44.85 t/ha) followed by Bhima Kiran (41.47 t/ha) and Bhima Shakti (41.00 t/ha), whereas the lowest was obtained from Bhima Shubhra (19.14 t/ha). No incidence of any pest and disease was observed to any of the variety under field conditions. It is concluded that onion has vast potential for cultivation with good yield and quality under hot arid conditions.

The production practices of *phog* were standardized. Seedlings of CIAH Selection-1 took faster growth and shrubs well-shaped in 4-5 year. The May pruning and November lopping were recommended for the higher bio-mass production. Commercial harvest starts after 6-7 year of planting and fresh yield of total produce is 14.85 kg/plant/year. Plants gained quick growth, huge flowering and seed formation in May month, and this is the period for bio-mass harvest through light pruning (2.65 kg fodder and 2.88 kg fuel-wood yield). Plants re-sprouted from June and lopping for fodder (3.16 kg/plant) is done in November.

INTEGRATED WATER AND NUTRIENT MANAGEMENT

Leaf sampling survey was carried out in custard apple, chironji and Jamun. The nutrients were estimated and norms for Diagnosis Recommendation Integrated System (DRIS) were calculated and categorised into deficient, low, optimum, high and toxic according to standard deviation. The nutrient concentrations in the range with mean $\pm$ 4/3 SD are optimum, < (mean -8/3 SD) are deficient, (mean -8/3 SD) to (mean -4/3 SD) are low, (mean +4/3 SD) to (mean +8/3 SD) are high and > (mean +8/3 SD) are toxic. These can be used for calculating DRIS indices in the corresponding fruit crops for efficient diagnosis of required element and nutrient management.

In nutrient management in *kachri*, yield was significantly influenced by application of organic and inorganic sources of nutrients. Yield of *kachri* under different treatments i.e. control, 100% recommended dose (I), 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 44.62, 86.63, 98.12, 104.12, 91.90 and 88.39 q/ha, respectively.

In management of saline water with amendments in kachri, the application of saline water with amendments increased yield of *kachri* as compared to control. The data revealed that the highest yield of kachri was observed with the treatment of gypsum 4 t/ha + $4EC_{IW}$ (dSm^{-1}) (50.00 q/ha) followed by vermicompost 10 t/ha + $4EC_{IW}$ (dSm^{-1}) (45.83 q/ha) and FYM 15 t/ha + $4EC_{IW}$ (dSm^{-1}) (42.66 q/ha) and 36.66 q/ha yield in control. In management of saline water with amendments in snapmelon, the highest yield was observed under the treatment of IW 4EC (dSm^{-1}) + FYM 15 t/ha was (185 q/ha) followed by irrigation water 4EC (dSm^{-1}) + vermicompost 10 t/ha (170.60 q/ha), IW 4EC (dSm^{-1}) + gypsum 4 t/ha (168.86 q/ha) and 136.77 q/ha yield of snapmelon in control treatment.

In tissue cultured date palm evaluation under hot arid environment, the effect of pit size was recorded only on the growth performance

while it had no effect on emergence of spathe. In all cultivars (Khuneizi, Khalas, Barhee and Medjool), the impact of spacing i.e. 6 x 6 m and 8 x 8 m was not observed. The survival, plant height and spread were not significantly influenced by both the spacings. It was observed that in 6 m spacing side difference between canopy was 1.5-2.0 m while in 8 m spacing difference between canopy was 3.25-4.0 m in different cultivars.

In standardization of irrigation scheduling in date palm, the results revealed that 100 and 75% of ETc resulted in the maximum plant height (350 cm) and spread (2.00 x 180 cm) in cultivar Barhee. In Khalas cultivar, maximum spathe per plant (5) was recorded in 1.00 ETc irrigation level and minimum (2) in 50% ETc irrigation level. The maximum moisture (5.50%) was recorded at 45 cm depth after 8 h of irrigation.

PHYSIOLOGICAL, BIOCHEMICAL AND BIO-TECHNOLOGICAL INTERVENTIONS

For DNA fingerprinting of watermelon cultivars, sixteen ScoT (Start codon Targeted polymorphism) and 25 CBDP (CAAT Box-Derived Polymorphism) markers were used for profiling on genomic DNA. Consequently, eleven ScoT and 16 CBDP markers produced varietal specific bands and differentiated each cultivar. To identify the Respiratory Burst Oxidase Homologs (RBOH) genes in watermelon, the BLASTp search was performed against the genomic database of watermelon using *Arabidopsis* RBOH protein as a query. As a result, nine putative RBOH genes were identified in watermelon. Based on the species belong and their chromosomal position, the RBOH genes were named as ClaRBOH genes and nomenclatured as ClaRBOH01 to ClaRBOH09, respectively.

For assessing the sequence conservation among the ClaRBOH genes, multiple sequence alignment (MSA) analysis was carried out using amino acid sequences of ClaRBOH proteins. Among the ClaRBOH proteins, the MSA analysis revealed the significant peptide sequence similarities and conserved domains. The phylogenetic tree constructed with deduced amino acid sequences of ClaRBOH genes classified them into 4 major groups. The ClaRBOH genes showed close proximity with bottle gourd RBOH genes. To validate the tissue-specific expressivity governed by ClaRBOH genes, the RNAseq data sets pertaining to different tissues and environmental conditions (osmotic and salt stress) were analysed using SRA Blast tool of NCBI. During the *in silico* gene expression analysis, the ClaRBOH genes clustered the tissues and conditions into 6 major groups and ClaRBOH genes itself clustered into two major groups. The ClaRBOH06 and ClaRBOH08 were found most up-regulated in their expression comparatively.

The effect of concurrent abiotic stresses (drough, low & high tempreature) was studied on tannin, proline, malondialdehyde (MDA), chlorophyll, soluble protein content and specific activities of superoxide dismutase (SOD), peroxidase (POD) and catalase enzymes in *khejri* (*Prosopis cineraria*) leaves (wild and Thar Shobha). The significant differences were observed in all the metabolites/enzymes studied in response to different concurrent stresses and the trend of these compounds/enzymes. The expression pattern of antioxidant enzymes like SOD, peroxidase and catalase was also studies in *khejri* leaves under concurrent abiotic stresses and observed a significant different in all the enzymes under different conditions in both genotypes. SOD responded very well under both heat and cold stresses and maximum activity was observed during May-June and December-January. While, peroxidase and catalase behaved differently under concurrent abiotic stresses. The peroxidase activity was more responsive to heat stress (May-June) than cold stress and maximum activity was observed during May-June. The catalase enzyme found more responsive towards cold stress and maximum activity was observed during December-January. Under heat stress the catalase activity was slightly higher than mansoon season but lower than March April. The expression pattern of these enzymes under concurrent abiotic stresses might be one of the defense components in *khejri* plant which make it tolerant towards multiple abiotic stresses.

In nutraceutical profiling of ber germplasm, maximum TSS was observed in the cultivar Tikdi (28.1 °Brix) with lowest in Seb

(10.52 °Brix). The titratable acidity (%) was found maximum in the cultivar Kathaphal (1.09%) with lowest acidity in cv. Mundia (0.16%). Ascorbic acid content was found maximum in the ber cv. Thar Malti (54.12 mg/100 g FW) while minimum was registered in cv. Thai ber (16.40 mg/100 g FW). Total phenolic content was noted highest in cv. Thar Malti (523.99 mg GAE/100 FW) and lowest in cv. Thai ber (190.22 mg GAE/100 FW). Total flavonoids were found maximum in the cv. Thar Malti (37.51 mg/100 g FW) and minimum in cv. Narma (6.5 mg/100 g FW). Study of total antioxidant activity (TAA) by CUPRAC and PMA methods exhibited highest values for Thar Malti (1077.54 and 518.24 mg AAE/100 g FW), respectively. However, the *Z. rotundifolia* species possessed greater acidity (3.38%), TSS (31.80 °Brix), phenols (811 mg GAE/100 FW) and total antioxidant activity (PMA) (543.25 mg AAE/ 100 FW) as compared to *Z. mauritiana* species.

PLANT PROTECTION

A trial was conducted for management of wilt caused by *Fusarium acuminatum* in muskmelon (*Cucumis melo* L.) variety 'RM-50' through botanicals and inorganic salts under field conditions. Among different treatments, carbendazim (0.1%) was found the most efficient treatment against *Fusarium* wilt with minimum per cent disease index of 17.38% and 57.87 per cent disease reduction followed by neem leaf extract 10% with per cent disease index of 24.12% and 41.54% disease reduction. Next best treatments were tumba fruit extract (10%) and aak leaf extract (10%) with per cent disease index of 26.45% and 29.13% as well as 35.89% and 29.39% disease reduction, respectively. It was also revealed that neem leaf extract, tumba fruit extract and aak leaf extract (10% each) were statistically at par with each other. Least effective inorganic salts were borax (500 ppm) and salicylic acid (500 ppm) having 38.74% and 39.86% PDI as well as 6.11% and 3.39 per cent disease reduction, respectively. These two salts were also statistically at par with each other. Maximum disease index (41.26%) was found in case of control.

Date palm is infected by many important diseases. Out of which, *Alternaria* leaf spot caused by *Alternaria alternata* (Fr.) Keissler is moderate to severe in date palm growing areas under arid region. Severity of this disease was found from 0.0 to 22.30% in some date palm germplasm/varieties (Khalas, Zahidi, Chip-chap, Halawy, Medini and Medzool). Symptoms were observed as small light/dark gray to black circular spots. Later on, these spots were increased in size and become irregular and black to straw colored and coalesced. The diseased leaves were turned light yellow and defoliated under severe conditions.

In characterization of *Rhizobium* sp. from cluster bean, twenty *Rhizobium* isolates were isolated from collected root nodules. All twenty isolates were acid producers and fast growers. Ability of the isolates to grow at different acidic pH range such as 3.5, 4.5, 5.5, 6.5 and alkaline pH 7.5, 8.5 and 9.5 were studied. No isolates could grow at pH 9.5 and 3.5. Three isolates could grow at pH 4.5 and 7 isolates at pH 5.5. Six isolates were showing growth at 2% NaCl and all isolates were able to grow at 1% NaCl. No isolate could grow above 2% NaCl salt concentration. Ability of isolates to grow at different temperature (10, 28 and 37 °C) was determined. No isolate was able to grow at 10 °C, sixteen isolates could grow at 37 °C and all isolates could grow at 28 °C. CLB11, CLB16 strains of Rhizobium spp. isolated from cluster bean could grow well at higher temperature of 37 °C, alkaline pH of 8.5 and higher salt concentration of 2% NaCl.

In characterization of *Rhizobium* sp. from cowpea, twenty *Rhizobium* isolates were isolated from root nodules. All twenty isolates were acid producers and fast growers. All twenty isolates could grow at pH 6.5, 7.5 8.5. No isolates could grow at pH 9.5, 4.5 and 3.5. 5 isolates could grow at pH 5.5. Five isolates were showing growth at 2% NaCl and all isolates were able to grow at only 1% NaCl. No isolate could grow above 2% NaCl salt concentration. No isolate was able to grow at 10 °C, eighteen isolates could grow at 37 °C and all isolates could grow at 28 °C. CWP05, CWP04, CWP08, CW11 strains of *Rhizobium* spp. isolated from cowpea could grow well at higher temperature 37 °C, alkaline pH of 8.5 and higher salt concentration 2% NaCl.

In potato, under hot arid climatic

conditions, leaf miner and aphid were observed causing very negligible damage. Brown spot of potato was observed with per cent disease incidence of 1-20% varying from variety to variety. Spot on potato was appeared during last week of February with per cent disease incidence of 1-12%. Characterization of brown spot of causing *Alternaria alternata* was also done. *Alternaria alternata* is reported for first time in Rajasthan on potato.

POST-HARVEST MANAGEMENT AND VALUE ADDITION

The aonla varieties were characterized for different value added products. The varieties NA-6, NA-7, NA-10, Banarasi, Laxmi-52 were found suitable of murabba and candy making, whereas BSR-1, BSR-2, Kanchan for pickle; Anand-1, Anand-2 and Chakaiya for powder. Among the varieties, NA-7, Banarasi and Goma Aishwarya are highly suitable for juice extraction.

The fortified extruded products using dried ripe *khejri* pods (*khokha*) was developed. An attempt was made to supplement the traditional ingredient rice flour with dried *khokha* powder alongwith maize flour. In addition to the varying proportions of the *khokha* powder supplementation, the other variable factors include temperature of the extruder and the screw speed which are being optimized for getting the best acceptable product. The design used was Response Surface Methodology (RSM).

Aonla candy was biofortified using karonda extract. The treatment of impregnation with karonda extract had significant effect on the quality and acceptability of the aonla candy. The anthocyanin pigmentation increased with increasing percentage of the karonda extract. There was no significant difference among the treatments in terms of product recovery. The titratable acidity was highest in the control candy as compared to other treatments as well as fresh aonla fruit. The ascorbic acid content (mg/100 g) was highest in fresh aonla fruits as compared to the candy; however, among various treatments candy impregnated with 2% karonda extract exhibited highest ascorbic acid content.

A storage study in mulberry fruits was conducted. Storability of the mulberry fruits both red type (Thar Lohit) and green type (Thar Harit) was worked out by storing them at two different temperatures, i.e. ambient conditions (32 ± 2 °C and 30 ± 2% RH) and refrigerated storage (4 ± 2 °C and 30 ± 2% RH). Fruits stored under ambient conditions could last for only 3 days compared to those stored under refrigerated conditions which lasted up to 8 days. Among the two cultivars, Thar Harit exhibited a greater physiological loss in weight (PLW) as compared to Thar Lohit at both the storage conditions. There was no significant variation in the total soluble solids (TSS) of both the cultivars during the entire storage period.

In standardization of drying method for cluster bean, tender pods were harvested at 10-12 days after setting. Pods were washed with clean water, blanched at 90 °C for five minutes, immediately immersed in cold water to prevent overcooking. Thereafter, pods kept in perforated stainless steel trays and dried at room temperature for 48 h. Trays were covered with perforated plastic net to protect from rodents, birds and other foreign material. Average dried product recovery was 19.77% of fresh weight. Blanching time was standardized for cluster bean green pods. Pods were blanched for 3, 4, 5, 6 and 7 minute in boiling water (90 °C). Blanching of green pods for five minutes was found ideal for retaining colour, texture and sufficient reconstitution capacity in dried product. Rapid moisture loss was observed in blanched pods as compared to unblanched (control) pods. In blanched pods 80% moisture loss was achieved within 68 h while unblanched pods took 180 h for same quantum of moisture loss.

The protocol was standardized for making bael candy. Raw fruits of variety NB-9 were sliced into size of 4 x 2 cm (L x W). Seeds and fruit rind were separated. Slices were blanched in boiling water for 15 minutes then dipped in 60 °Brix sugar syrup for 24 h. Then slices were removed from the syrup and sugar concentration was enhanced to 70 °Brix and again slices dipped in syrup. This process was repeated for 3 times till the stability of syrup Brix. After removal from syrup, the slices washed with hot water (50 °C) to remove

adhered sugar from surface. Slices were dried in cabinet dehydrator for 8 h at 50 °C temperature. Removed from the dehydrator and kept for 3 h at room temperature for conditioning. Candy got 8.60 score out of 9 point Hedonic scale during sensory evaluation.

TECHNOLOGICAL IMPACT ASSESSMENT

During the reported period, a survey was conducted and the preliminary information including secondary data/information about the adoption, area and production under improved variety of date palm from different districts of Rajasthan were collected. The total area and production under date palm cultivation in Rajasthan was found 1,345 ha and 16432 t, respectively. The data under improved variety of pomegranate from different districts of Rajasthan were collected to understand the trend in adoption, area and production of pomegranate hot arid region of Rajasthan. The total area and production under pomegranate cultivation in Rajasthan was 14,619 ha and 25,640 t, respectively. During the survey the preliminary information about the present status with respect to trend in adoption, area and production of ber in different districts of Rajasthan were also collected and documented. The total area and production under ber cultivation in Rajasthan was found 3,290 ha and 34,225 t, respectively.

The impact assessment on adoption of improved variety of *kachri* (AHK-119) and snapmelon (AHS-82) was carried out. The data revealed that maximum area under improved variety of *kachri* (AHK-119) was found in Bikaner district followed by Nagaur, Jodhpur, Sikar and Pali. The area and production of AHK-119 increased tremendously during 2007 to 2020. The area under the improved variety (AHK-119) was 2,057 ha and production was 18,300 t in 2007 which increased to 7,123 ha and 60,030 t in the year of 2020, respectively in hot arid region of India. The gross return from improved variety AHK-119 of *kachri* alone was Rs. 28.19 crores in 2007 which increased to more than Rs. 86 crores in the year 2020. The impact assessment of improved variety AHS-82 of snapmelon was carried out. The area under variety AHS-82 was found 969 ha and production was 14,340 t in 2007 which estimated to increase 4,340 ha and 58,090 t, respectively in the year 2020. The gross return of variety AHS-82 alone was Rs. 11.76 crores in 2007 which increased to more than Rs. 50 crores in the year 2020.

2. INTRODUCTION

The SWOT analysis of arid ecosystem reveals that it has ample strengths, such as plenty of sunshine, vast land, human labour, biodiversity harbouring important genes, low humidity and low incedence of pests and diseases, *etc*. for the production of quality arid fruits and vegetables. In addition to this, the arid ecosystem also has opportunities to improve the horticultural scenario which can lead to overall development of socio-economic and nutritional security of the inhabitants. This can be achieved if adequate technologies are made available for sustainable agricultural production in this region.

In view of this, the National Research Centre for Arid Horticulture came into existence on 1st April 1993. This was later upgraded to Central Institute for Arid Horticulture on 27th September 2000 and CHES, Godhra (earlier Regional Station of IIHR, 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

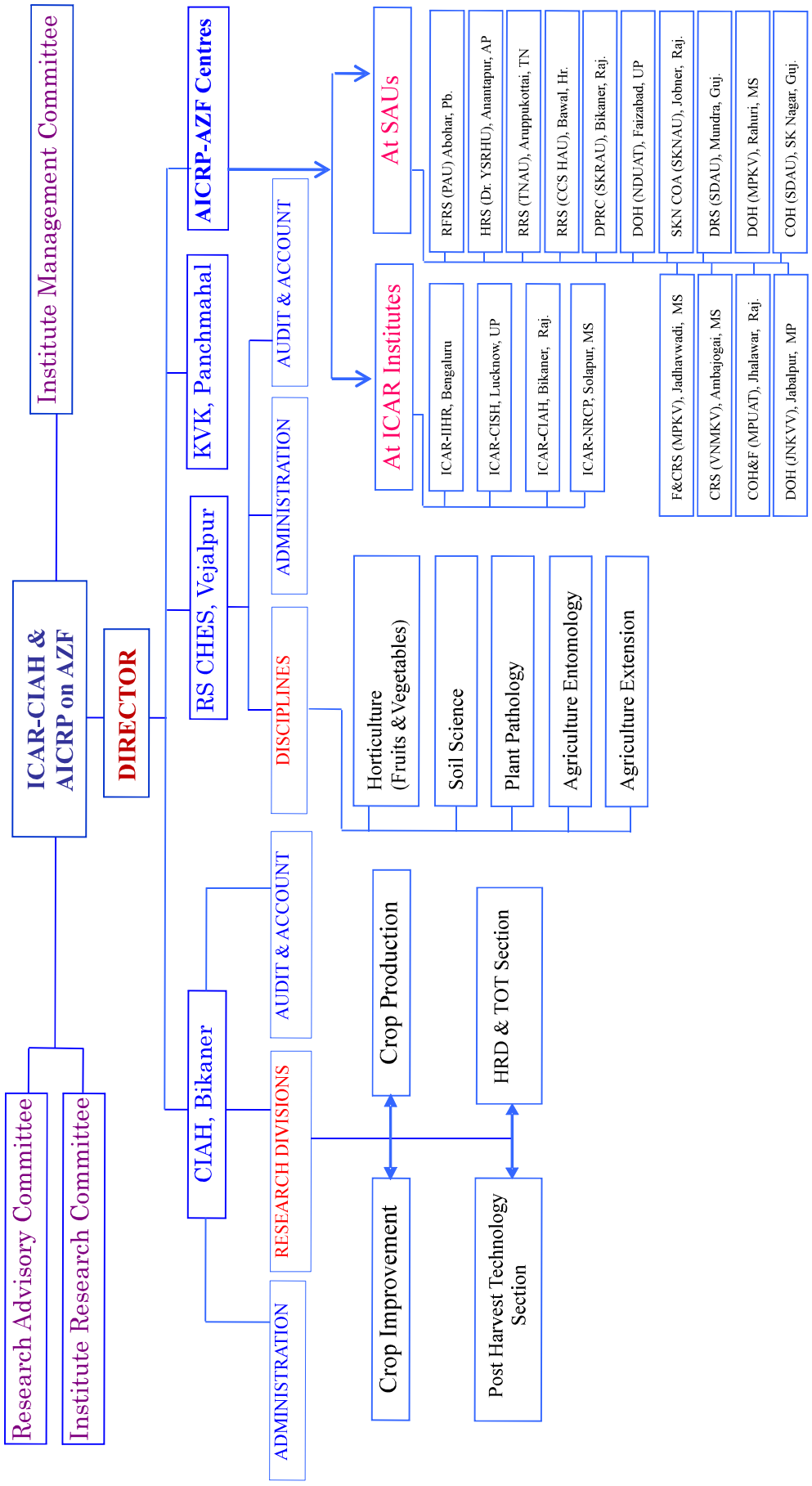
- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of horticultural crops of arid and semi-arid regions.
- Repository of genetic resources and scientific information on horticultural crops of arid and semi arid region.
- Transfer of technology, capacity 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 agro-techniques with respect to efficient use of soil, water and nutrients for increased horticultural productivity involving water harvesting and conservation techniques under rainfed conditions, efficient use of the scarce irrigation water and nutrient management.
- To study the eco-physiological parameters of cropping system models for utilization of high temperature and radiation resources.
- To develop post harvest technology package for extended use of the horticultural produce of arid region.
- To develop integrated pest and disease management technologies for horticultural crops under arid environment.
- To transfer the innovative technologies generated on the above aspects to farmer's field for effective horticultural development and socio-economic upliftment of the farmers
- To carry out the impact assessment of the technologies and constraint analysis.
- To serve as a repository of information related to arid and semi-arid horticulture.
- To collaborate with relevant national and international agencies for achieving the above.

Keeping in view the above mandate and objectives, the research and extension works were carried out during January-December, 2020 and the significant results obtained in different projects are presented hereunder.

ORGANIZATIONAL SETUP



3. RESEARCH ACHIEVEMENTS

GENETIC RESOURCE MANAGEMENT

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

Evaluation of ber (*Ziziphus mauritiana*) genotypes under hot arid region

Ber species (*Ziziphus* spp.) block has been laid out with five species namely *Z. nummularia* - a dwarfing, drought tolerant, early fruit maturity, extensive root system and well adapted, *Z. spina christi* (Christ's thorn jujube) - an evergreen tree distributed in tropical to subtropical area of world, *Z. mauritiana* var. *rotundifolia*- a vigorous growing habit and commonly used rootstock which mainly exist in north-west part of India, *Z. jujube* (Chinese jujube)- mainly distributed in temperate zones where, plants glabrous and shows deciduous behaviour and *Z. mauritiana* Lam. - an improved ber (Fig. 1).

Ziziphus nummularia (Burm.f.) Wight & Arn. | *Z. spina christi* (L.) Desf. | *Z. rotundifolia* Lam. | *Z. jujuba* Mill.

Fig.1. Different species of ber

In ber, thornless bordi (*Z. rotundifolia)* and culinary (*Z. mauritiana)* type were collected during-2018-19 from local Bikaner and Bhilwara area of Rajasthan. They were planted in the field and applied to NBPGR, New Delhi for allotment of IC number.

Performance of Thai ber genotypes collected from different sources *viz*., 24-South Paragana, West Bengal; Godhra, Gujarat; Napasar and Jhajju, Bikaner was evaluated in field condition. Initial observations showed vigrous growth habit in material of west Bengal and precocious bearing in all material except Napasar material. As far as fruit weight and TSS content is concerned, Jhajju site collected material has bigger fruit size (34 g) and higher TSS (9.7 °Brix) content, but more prone to frost reaction over the West Bengal material.

Evaluation and characterization of pomegranate germplasm under hot arid climate

Pomegranate germplasm were evaluated for growth, fruit quality and aril attributes under hot arid condition. In plant growth attributes, observations were recorded on plant height, canopy spread, growth habit and behaviour during December. The fruit and aril attributes were recorded during *ambe bahar*. Significant variations were recorded on plant growth attributes. The maximum plant height (237 cm) and canopy spread (235 cm N-S and 231 cm E-W) was recorded in Uthkal followed by Yercaud with plant height (226 cm) and canopy spread (221 N-S and 225 cm E-W). The minimum plant height (152 cm) and canopy spread (142 N-S and 137 cm E-W) was observed in AHPG-C4. Growth habit varied from dwarf, semi dwarf, semi vigorous, vigorous to very vigorous among different germplasm. The germplasm Uthkal and Yercaud were found very vigorous. Growth behaviour was also varied from evergreen, semi deciduous and deciduous among different germplasm (Table 1).

Fruit quality attributes were recorded on pomegranate germplasm during *ambe bahar* under hot arid condition. Significant variations were recorded in number of fruits per plant,

Table 1. Plant growth characteristics of pomegranate germplasm under hot arid climate

Germplasm	Plant height (cm)	Canopy spread (cm)		Growth habit	Growth behaviour
		N-S	E-W		
Jalore Seedless	182	174	168	Vigorous	Evergreen
Jodhpur Red	205	185	193	Very vigorous	Evergreen
Kajaki Anar	158	152	150	Dwarf	Evergreen
Ganesh	164	168	163	Semi dwarf	Evergreen
Dorsata Malus	189	181	189	Vigorous	Deciduous
Saharanpur	182	185	189	Vigorous	Evergreen
G-137	158	152	143	Dwarf	Evergreen
Kabul	181	182	171	Vigorous	Evergreen
Basein Seedling	172	171	176	Semi vigorous	Evergreen
Banaras collection	183	159	163	Vigorous	Evergreen
Bassin Seedless	174	195	174	Semi vigorous	Deciduous
Alah	198	161	165	Very Vigorous	Deciduous
Kandhari	185	164	158	Vigorous	Deciduous
Bedana Suri	154	158	164	Semi dwarf	Evergreen
GKVK-1	157	152	160	Dwarf	Evergreen
Speen Sacarin	191	178	174	Vigorous	Deciduous
IIHR 12/1	195	195	187	Vigorous	Evergreen
Muskat	187	176	169	Vigorous	Deciduous
Dholka	199	196	201	Vigorous	Evergreen
IIHR 19/10	157	168	173	Dwarf	Evergreen
Jalore Red	205	204	208	Very vigorous	Evergreen
Uthkal	237	235	231	Very vigorous	Deciduous
Kalisirin	213	195	204	Very vigorous	Deciduous
AHPG-C1	198	179	185	Very vigorous	Evergreen
Khog	187	152	148	Vigorous	Semi deciduous
Coimbatore White	186	175	165	Vigorous	Evergreen
Saih Sirin	202	174	170	Vigorous	Deciduous
MR 599	203	203	189	Very vigorous	Deciduous
AHPG-C3	217	205	209	Very vigorous	Deciduous
Yercaud	226	221	225	Very vigorous	Evergreen
Jodhpur coll.	207	197	189	Very vigorous	Evergreen
Bedana Thin Skin	177	185	193	Very vigorous	Evergreen
AHPG-C4	152	142	137	Dwarf	Deciduous
AHPG-C4b	190	196	185	Vigorous	Deciduous
P-23	187	199	206	Vigorous	Evergreen
P-21	201	189	185	Very vigorous	Evergreen
A K Anar	184	149	147	Vigorous	Deciduous
P-26	174	191	187	Semi vigorous	Evergreen
Crenedo de Elecho	190	161	158	Vigorous	Deciduous
Kabul Kohinoor	186	159	151	Vigorous	Deciduous
EC-62812	181	178	179	Vigorous	Semi deciduous
Ruby	182	185	192	Vigorous	Evergreen
Mridula	166	178	181	Semi dwarf	Evergreen
Tujetis EC 4347	195	189	182	Vigorous	Deciduous
Sirin	176	169	165	Semi vigorous	Deciduous
AHPG-H1	212	181	175	Very vigorous	Deciduous
Boseka Link	201	184	179	Very vigorous	Evergreen
Yercaud Local	184	189	193	Vigorous	Deciduous
Tebest	181	181	185	Vigorous	Deciduous

Germplasm	Plant height (cm)	Canopy spread (cm)		Growth habit	Growth behaviour
		N-S	E-W		
Gulsa Red	212	204	196	Very vigorous	Deciduous
Speen Danedar	205	185	171	Very vigorous	Deciduous
AHPG-H2	169	174	169	Semi dwarf	Deciduous
Patna-5	165	159	165	Dwarf	Evergreen
Sur Sukker	199	185	178	Vigorous	Deciduous
Malta	158	158	153	Dwarf	Deciduous
Gul-e-Shah Red	157	162	158	Dwarf	Deciduous
AH-PG-H3	209	185	197	Very vigorous	Deciduous
Gul-e-Shah	201	185	180	Very vigorous	Deciduous
Surat Anar	185	169	160	Vigorous	Deciduous
Gul-e-Shah Rose Pink	194	165	159	Very vigorous	Deciduous
Kurvi	203	188	195	Very vigorous	Evergreen
Bedana Sedana	175	171	168	Semi vigorous	Evergreen
PG-C	167	159	156	Semi dwarf	Evergreen
P-13	194	161	147	Semi vigorous	Evergreen
Agah	171	158	143	Semi vigorous	Deciduous
EC-12613	169	153	160	Semi dwarf	Deciduous
AHPG-H4	174	148	157	Semi vigorous	Deciduous
Achikdana	160	159	148	Dwarf	Deciduous
Surkh Anar	155	152	159	Dwarf	Deciduous
Bhagwa	195	182	176	Vigorous	Semi deciduous
CD (5%)	8.07	9.54	8.29	-	-

number of cracked fruits per plant, fruit weight and size with wide range of rind colour among the germplasm. Maximum number of fruits per plant was obtained in Saharanpur (40.50) followed by Jalore Seedless (38.25), Mridula (35.67) and Jodhpur Red (35.33). Number of cracked fruits per plant varied significantly among different germplasm and recorded maximum (20.00) in Saharanpur followed by Mridula (10.50) and very less number of cracked fruits per plant was observed in some of the sour type deciduous germplasm like Gul-e-Shah (1.33), Gul-e-Shah Red (1.33), Gul-e-Shah Rose Pink (1.00), *etc.* Maximum fruit weight was recorded in Jalore Seedless (255.21 g) followed by G-137 (254.19 g) and Jodhpur collection (250.37 g) while minimum fruit weight was recorded in Yercaud Local (85.12 g). Rind colour varied from light green, yellowish green, light yellow, yellow, light red to red among different germplasm (Table 2 and Fig. 2).

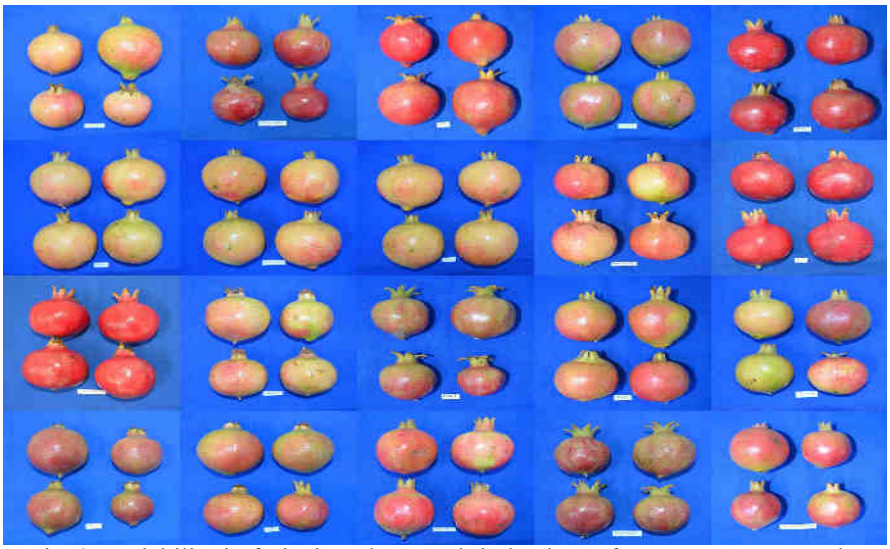


Fig. 2. Variability in fruit size, shape and rind colour of pomegranate germplasm

Table 2. Fruit quality attributes of pomegranate germplasm under hot arid climate

Germplasm	No. of fruits/ plant	No. of cracked fruits/plant	Fruit weight (g)	Fruit size (cm)		Rind colour[1]
				Length	Dia.	
Jalore Seedless	38.25	8.33	255.21	7.85	7.68	LY
Jodhpur Red	35.33	8.50	205.12	7.04	7.00	LY
Kajaki Anar	21.50	6.33	139.62	7.12	5.55	Y
Ganesh	28.67	9.33	202.16	8.12	7.71	LY
Dorsata Malus	14.33	5.50	133.64	5.35	5.75	LR
Saharanpur	40.50	20.00	135.45	6.25	5.33	LY
G-137	20.25	5.67	254.19	7.62	7.41	LG
Kabul	15.67	5.33	120.87	4.97	5.15	LR
Basein Seedling	13.58	3.50	170.40	6.30	5.54	Y
Banaras collection	18.25	4.50	141.69	6.05	5.52	Y
Bassin Seedless	14.33	5.67	175.55	7.58	7.02	LR
Kandhari	14.50	4.67	96.12	4.65	4.50	R
Bedana Suri	20.33	5.50	164.78	6.05	5.98	LG
GKVK-1	18.67	6.00	212.37	7.61	7.20	LG
Speen Sacarin	19.25	4.50	140.35	5.55	5.09	LR
IIHR 12/1	21.33	4.67	172.33	6.25	5.98	LR
Muskat	18.50	6.00	155.42	7.11	7.05	LR
Dholka	20.00	4.50	221.98	7.55	7.18	YG
IIHR 19/10	20.25	3.33	205.64	7.33	7.57	R
Jalore Red	28.35	7.50	220.33	7.51	7.20	LG
Uthkal	18.25	4.50	190.15	6.18	6.28	LY
Kalisirin	15.33	1.50	130.34	5.79	5.67	R
Khog	12.50	2.33	190.05	7.12	6.50	R
Coimbatore White	11.33	4.50	145.73	5.81	5.51	LY
Saih Sirin	16.50	2.33	155.48	6.55	6.05	LY
MR 599	15.65	2.50	90.19	4.15	4.29	R
AHPG-C3	15.20	3.67	181.99	6.62	5.98	R
Yercaud	12.33	4.00	93.74	4.10	4.52	LG
Jodhpur coll.	32.50	4.50	250.37	7.60	7.39	Y
Bedana Thin Skin	20.25	6.33	142.15	7.15	7.18	R
P-23	12.67	1.50	178.95	6.82	6.35	Y
P-21	18.50	2.33	121.85	5.58	4.50	Y
A K Anar	19.67	3.00	137.46	5.10	4.65	R
P-26	15.67	3.50	150.23	5.58	4.23	LR
Crenedo de Elecho	11.33	3.00	112.37	4.33	4.50	R
EC-62812	17.50	1.50	105.74	4.02	4.68	R
Ruby	20.25	4.50	205.47	7.12	6.98	R
Mridula	35.67	10.50	141.98	6.13	6.05	LR
Tujetis EC 4347	25.33	4.50	205.67	7.16	6.59	R
Sirin	13.50	2.50	165.00	6.65	6.31	R
AHPG-H1	18.67	3.50	132.69	5.32	5.11	LR
Yercaud Local	25.33	5.00	85.12	4.05	4.01	LY
Tebest	15.67	3.00	95.15	4.06	4.12	LR
Gul-e-Shah Red	16.00	1.00	205.12	6.95	6.85	R
Speen Danedar	11.67	2.50	114.23	5.15	4.93	LY
AHPG-H2	15.50	1.50	176.18	6.21	6.05	Y
Patna-5	12.00	2.33	150.05	6.12	5.18	LY
Sur Sukker	13.50	2.00	90.33	4.01	4.78	R
Malta	16.33	3.67	125.67	5.67	5.45	R
Gulsa Red	20.67	1.33	175.40	6.18	6.20	R
AH-PG-H3	12.50	2.50	190.08	6.63	6.45	R

Germplasm	No. of fruits/ plant	No. of cracked fruits/plant	Fruit weight (g)	Fruit size (cm)		Rind colour[1]
				Length	Dia.	
Gul-e-Shah	13.33	1.33	180.12	6.35	6.27	R
Gul-e-Shah Rose Pink	15.67	1.00	187.65	6.83	6.15	R
Kurvi	12.00	4.00	137.48	6.25	5.33	LG
Bedana Sedana	24.33	2.50	184.33	7.05	7.18	R
PG-C	15.50	2.33	145.78	5.37	5.66	LR
P-13	20.67	1.50	141.02	5.28	5.08	LR
Agah	18.33	2.67	135.37	4.25	4.37	LG
Bhagwa	26.34	4.78	215.30	7.25	7.10	R
CD (5%)	4.09	0.60	7.85	0.98	0.81	--

([1]Note: Y-Yellow, YG-Yellowish green and LY-Light yellow and LG-Light green, R-Red, LR-Light red)

Matured fruits harvested during July-August were analyzed for different quality attributes. Maximum total soluble solids was recorded in Saih Sirin (15.75 °Brix) followed by G-137 (14.81 °Brix) and Jalore Seedless (14.52 °Brix) while minimum recorded in Sirin (10.23 °Brix). Juice acidity was varied from minimum 0.62% in Jalore Seedless to maximum 3.99% in Tujetis EC 4347. Arils colour was observed to be whitish, whitish pink, light pink, pink, light red to red while seed mellowness varied from soft, medium hard, hard to very hard among different germplasm. During *ambe bahar*, rind and aril colour was observed lighter as compared to *mrig* and *hasta bahar* fruiting (Table 3).

Table 3. Aril characteristics of pomegranate germplasm under hot arid climate

Germplasm	TSS (°Brix)	Acidity (%)	Aril colour	Taste	Seed mellowness
Jalore Seedless	14.52	0.62	Whitish	Sweet	Soft
Jodhpur Red	11.10	0.95	Light pink	Sweet	Very hard
Kajaki Anar	12.53	1.62	Light pink	Sour	Hard
Ganesh	14.22	0.80	Pink	Sweet	Soft
Dorsata Malus	13.66	3.68	Pink	Very sour	Very hard
Saharanpur	12.00	1.26	Whitish	Slightly sweet	Very hard
G-137	14.81	0.75	Whitish	Sweet	Soft
Kabul	11.23	0.89	Light red	Sweet	Very hard
Basein Seedling	10.50	1.02	Whitish	Sweet	Hard
Banaras coll.	12.42	1.32	Whitish	Slightly sweet	Soft
Basein Seedless	13.28	1.18	Light pink	Slightly sour	Very hard
Kandhari	13.06	1.47	Whitish	Sweet	Hard
Bedana Suri	12.05	1.14	Light red	Sweet	Soft
GK VK-1	13.90	1.05	Light red	Sweet	Hard
Speen Sacarin	13.44	2.54	Light red	Very sour	Hard
IIHR 12/1	14.10	3.57	Light red	Very sour	Hard
Muskat	14.35	1.02	Light pink	Sweet	Medium hard
Dholka	14.05	0.91	Whitish pink	Sweet	Hard
IIHR 19/10	14.26	0.87	Light red	Sweet	Soft
Jalore Red	14.31	0.87	Whitish	Sweet	Medium hard
Uthkal	12.70	2.39	Whitish	Sour	Hard
Kalisirin	12.80	3.55	Light red	Very sour	Very hard
Khog	14.05	3.65	Light red	Very sour	Hard
Coimb. White	11.59	1.02	Whitish	Sweet	Hard
Saih Sirin	15.75	2.24	Light pink	Sour	Hard
MR 599	14.07	3.35	Light pink	Very sour	Hard

Germplasm	TSS (°Brix)	Acidity (%)	Aril colour	Taste	Seed mellowness
AHPG-C3	10.65	3.55	Whitish pink	Very sour	Hard
Yercaud	14.05	1.02	Light red	Sweet	Hard
Jodhpur collection	14.15	3.39	Light red	Very sour	Hard
Bedana Thin Skin	14.35	1.02	Light red	Sweet	Hard
P-23	12.05	0.85	Whitish pink	Sweet	Soft
P-21	11.96	0.92	Light pink	Sweet	Very hard
A K Anar	14.18	3.12	Red	Very sour	Very hard
P-26	12.25	0.96	Whitish pink	Sweet	Very hard
Crenedode Elecho	13.35	3.61	Whitish pink	Very sour	Hard
EC-62812	12.04	2.33	Light pink	Sour	Hard
Ruby	14.36	1.03	Pink	Sweet	Soft
Mridula	14.35	0.97	Light red	Very sweet	Soft
Tujetis EC 4347	12.05	3.99	Light red	Very sour	Very hard
Sirin	10.23	2.57	Light pink	Sour	Very hard
AHPG-H1	12.54	2.23	Light red	Sour	Hard
Yercaud Local	12.69	2.03	Whitish	Slightly sour	Hard
Tebest	12.00	3.59	Light red	Very sour	Very hard
Gul e Shah Red	13.36	2.67	Light pink	Sour	Very hard
Speen Danedar	12.58	2.76	Light pink	Sour	Hard
AHPG-H2	14.05	1.42	Whitish	Slightly sweet	Hard
Patna-5	13.33	1.29	Whitish	Sweet	Hard
Sur Sukker	12.10	3.32	Pink	Very sour	Very hard
Malta	13.24	0.79	Pink	Sweet	Hard
Gulsa Red	13.65	3.22	Red	Very sour	Very hard
AH-PG-H3	12.23	2.49	Pink	Sour	Very hard
Gul-e-Shah	13.35	3.62	Light red	Very sour	Very hard
GuleShah R. Pink	13.81	3.38	Light pink	Sour	Very hard
Kurvi	11.25	1.42	Whitish	Slightly sweet	Hard
Bedana Sedana	12.04	2.02	Pink	Slightly sweet	Hard
PG-C	14.31	0.81	Whitish	Sweet	Soft
P-13	13.08	0.89	Whitish	Sweet	Medium hard
Agah	14.25	2.45	Light pink	Very sour	Very hard
Bhagwa	13.27	0.71	Light pink	Sweet	Medium hard
CD (5%)	0.96	0.061	-	-	-

Evaluation of pomegranate germplasm under semi-arid condition

Thirty eight genotypes of pomegranate are being conserved in the field gene bank. Phule Arakta and Jalore Seedless were collected from Bikaner. Pomegranate cv. Yercaud recorded maximum plant height (3.55 m) and stem girth (7.58 cm) while Jyoti recorded maximum canopy spread in both the directions (3.40 & 4.20 m). The minimum plant height (2.20 m), plant spread (2.30 m & 2.40 m) and stem girth (4.15 cm) were recorded in anardana cv. Goma Khatta. Fruiting was observed only in Goma Khatta.

Survey and collection of date palm (*Phoenix dactylifera L.*)

A survey was made in diversity areas of date palm at Kachchh region of Gujarat and collected fruit samples of 14 elite type genotypes *viz*., KKMD-1 to KKMD-14 having distinct fruit characteristics. Seeds were extracted from fruits, washed in running tape water and dried at room temperature. After one week, seeds were sown in root trainer having vermiculite, cocopeat and perlite media in the ratio of 1:1:1 under green house unit. Seedlings were transferred in black polybags filled with clay, soil, FYM 1:2:1 ratio after attaining 10-15 cm height. Seedling plants of these elite types are growing well under green house condition. Thus prepared 79 seedling plants of 14 elite types which are presently ready for field transplantation (Fig. 3).

Fig. 3. Elite date palm seedling genotypes collected from Kachchh region of Gujarat

Evaluation of date palm germplasm under hot arid condition

In date palm field repository, sixty four germplasm are conserved, among them, thirty eight were evaluated for morphological, physical and quality attributing characters. The study exhibited large variation in plant morphological characters like leaf length, leaflet length & width, number of thorns per rachis, inter thorn distance, thorn length, leaf folding angle, *etc.* The maximum leaf length was observed in germplasm Sabiah (353 cm) followed by Braim (352.3 cm) but minimum was found in Hayani (56.67 cm) as well in Bikaner Local (56.00 cm). The maximum leaflet width was recorded in Sewi (3.67 cm) followed by Nagal Hillali (3.66 cm) but leaf folding angles were recorded narrow, medium and wide among germplasm. The number of thorns per rachis was varied between 8-34.3, length 6.07-14.67 cm and inter thorn distance 3.17-10.50 cm (Table 4).

Data were recorded on date of harvesting and yield attributing character (number of bunches per plants, stalk length, bunch length, number of strands and strands length) of date palm germplasm grown in field repository and significant variations were recorded among the germplasm. The early maturing germplasm Dhamas was harvested on 28 June, 2020 followed by Nagal on 1 July, 2020. The number of bunches/plant was recorded maximum (15.0) in Sewi followed by Khuneizi (14.3), while minimum was recorded in Umshok (4.0). Stalk length was ranged between (14.3-80 cm), bunch length (5-39 cm), number of strands/bunch (19.3-58.3) and strands length (22.2-61.0 cm). The maximum numbers of fruits setting/strand at pea stage (40) was recorded in Khadrawy and minimum in Javantri (16). Maximum number of fruits/strand (20.7) at harvest and fruit set (90.9%) was recorded in Zahidi followed by Nagal (76.9) while minimum number of fruit setting was recorded in Gulchati (19.2%). The maximum bunch weight was recorded in Hayani (8.2 kg) followed by Khalas (6.6 kg) and minimum in Punjab Red (1.3 kg) among the germplasm (Table 5 & 6 and Fig. 4).

The significant variation were recorded among the germplasm in physical attributes of fruits *viz.,* fruit weight, length, width, stone weight, pulp weight and pulp stone ratio. Maximum fruit weight (17.00 g) and width (26.0 cm) were observed in Medjool, while minimum (3.3 g) was recorded in germplasm Tayer. Among the germplasm stone weight of fruit was ranged between (0.7-2.1 g), pulp weight (1.5-16.0 g), pulp stone ratio (0.8-11.8), stone length (16.9-27.9 mm), stone width (7.6-11.4 mm) and pulp thickness (2.77-9.17 mm) among the evaluated germplasm. Maximum fruit yield per plant was recorded in Hayani (82 kg) followed by Zahidi, while minimum was recorded in Nagal Hillali (10 kg). Fruit colour was observed yellow, greenish yellow, dark red, red, light red, green brownish yellow, light yellow and orange yellow among the germplasm of date palm. Desirable characters are big size fruit, attractive yellow and dark red colour with early maturity; however, red colour fruit with sweet test is more in demand for table purpose. The some germplasm are observed early maturing, which can be utilized as breeding lines for development of varieties for soft fruits (pind) purpose. The maximum total soluble solid was observed in Medjool (52.6 °Brix) followed by Binte-A-Isha (51.9 °Brix) while minimum was recorded in germplasm Punjab Red (22.8 °Brix) (Table 7 & 8).

Fig. 4. Date palm plants laden with fruit and harvested fruits of different date palm varieties

Table 4. Study of leaf and thorn characteristics of different germplasm of date palm

Varieties/ germplasm	Leaf length (cm)	Leaflet length (cm)	Leaflet width (cm)	No. of thorns/ rachis	Thorn length (cm)	Inter thorn distance (cm)	Leaf folding angle
Halawy	260.0	34.83	2.87	20.0	11.17	8.00	Medium
Khalas	237.0	44.00	2.17	16.0	11.00	7.17	Wide
Khadrawy	226.0	36.00	1.90	14.0	8.67	7.83	Narrow
Shamran	261.3	47.33	2.58	13.0	12.23	9.00	Wide
Zahidi	290.0	48.00	3.50	24.0	10.67	7.25	Wide
Braim	352.3	45.33	2.90	20.0	8.00	7.17	Wide
Zaglool	170.0	37.67	3.00	15.0	11.43	6.67	Narrow
Chip-Chap	295.0	47.00	2.17	27.0	12.33	7.50	Narrow
Sewi	327.0	37.67	3.67	14.0	8.00	8.00	Medium
Khuneizi	280.0	46.00	2.77	16.0	12.00	6.50	Wide
Binte-A-Isha	210.0	29.67	2.83	20.0	6.50	8.17	Narrow
Nagal Hilali	194.0	33.67	3.67	20.0	12.17	6.83	Narrow
Medjool	237.3	44.00	3.17	26.0	13.17	8.50	Narrow
Punjab red	252.7	46.33	3.27	21.0	10.00	5.50	Medium
Gijaj	225.0	37.00	2.17	14.0	14.67	9.67	Medium
Gulchati	236.7	43.33	3.23	19.3	8.83	4.00	Narrow
Bikaner Local	282.0	56.00	3.23	16.0	11.83	5.00	Wide
Javantri	285.0	34.67	2.33	30.0	7.60	7.50	Narrow
Sabiah	353.0	48.33	3.23	24.0	8.00	9.17	Medium
Saidy	292.0	52.67	3.23	20.0	9.83	6.50	Wide
Medini	260.0	46.33	2.17	14.0	6.13	7.17	Narrow
Dayari	280.0	48.67	2.17	12.0	8.50	10.50	Narrow
Khairpur-Pakistan	250.0	42.67	2.90	19.0	11.83	5.67	Medium
Sakloti	240.0	37.33	2.07	20.0	8.17	9.67	Narrow
Hayani	341.7	56.67	3.17	10.0	9.33	10.33	Wide
Khasab	260.0	51.33	2.67	29.3	12.33	7.00	Medium
Muscat	260.0	45.67	2.23	8.0	7.83	5.67	Wide
Sayar	235.0	39.67	2.57	13.0	6.60	5.83	Medium
Tayer	200.0	41.00	3.17	15.0	7.33	6.83	Wide
Nagal	260.0	42.00	2.50	20.7	6.67	6.33	Wide
Suriya	265.0	45.33	2.83	19.3	7.50	6.00	Narrow
Ahmat	175.0	37.67	3.33	20.3	8.00	6.33	Medium
Abdul-Rehman	285.0	47.00	2.57	17.0	10.33	6.67	Narrow
Hatemi	232.7	32.33	1.77	18.0	13.00	9.67	Medium
Bhukso	205.0	31.00	2.77	20.0	8.33	7.00	Wide
Kotho	300.0	42.67	2.93	20.0	10.50	8.17	Medium
Hillali	160.0	32.00	2.17	9.3	6.07	6.50	Medium
Umshok	230.0	38.67	2.50	34.3	7.17	7.83	Narrow
Amiri	235.0	34.33	1.83	12.0	12.83	8.33	Medium
Hamara	257.7	44.67	2.40	11.0	6.83	3.17	Wide
Sadhami	237.7	38.00	2.77	12.0	11.67	9.50	Wide
Siwi	241.7	31.33	3.33	18.0	8.23	7.33	Wide
Barhee	325.0	32.67	2.90	21.3	10.83	7.67	Wide
KCS-1	248.0	38.00	2.93	28.0	9.17	6.50	Narrow
SEm±	8.91	1.54	0.19	2.79	1.51	1.81	-
CD (5%)	25.10	4.34	0.55	7.87	4.25	NS	-

Table 5. Yield attributes of different germplasm of date palm

Varieties/ germplasm	Date of harvest	No. of bunch/plant	Stalk length (cm)	Bunch length (cm)	No. of strands /bunch	Strands length (cm)
Halawy	23.07.20	12.3	53.33	31.33	45.7	39.0
Khalas	16.07.20	10.7	50.67	16.67	50.3	46.2
Khadrawy	27.07.20	11.7	59.33	29.33	48.0	45.4
Shamran	10.08.20	10.7	34.00	26.67	45.7	28.0
Zahidi	21.07.20	12.7	55.00	15.67	41.0	40.2
Braim	23.07.20	9.0	26.67	22.67	29.7	33.5
Zaglool	16.07.20	11.0	53.33	13.50	20.3	22.2
Chip-Chap	24.07.20	11.7	56.67	37.67	52.0	44.0
Sewi	05.08.20	15.0	71.67	33.33	45.3	61.0
Khuneizi	04.08.20	14.3	30.00	25.33	38.3	36.4
Binte-A-Isha	27.07.20	7.3	39.67	14.33	25.0	28.0
Nagal Hillali	27.07.20	6.7	38.00	23.00	21.3	36.0
Medjool	27.07.20	13.0	32.67	18.33	28.0	28.8
Punjab Red	16.07.20	10.7	75.33	34.00	48.3	50.4
Gizej	28.07.20	6.3	45.67	11.00	21.3	39.4
Gulchati	28.07.20	9.7	14.33	19.67	45.0	30.4
Bikaner Local	05.08.20	8.3	65.00	25.00	49.3	37.0
Javantri	05.08.20	9.0	36.67	12.67	39.0	25.6
Sabiah	09.07.20	11.7	80.00	29.67	50.3	38.4
Saidy	13.07.20	7.0	45.67	23.33	55.3	25.0
Medini Red	28.07.20	8.0	57.67	24.67	42.3	34.0
Dayari	06.08.20	9.3	41.00	24.33	47.7	35.0
Khairpur-Pakistan	04.08.20	7.7	57.33	24.33	39.3	36.4
Sakloti	10.08.20	4.0	24.33	5.00	19.3	36.0
Hayani	15.07.20	10.7	61.67	39.00	49.7	43.2
Muscat	21.07.20	7.0	47.67	26.33	58.3	34.4
Sayar	05.08.20	7.7	31.67	20.00	34.7	31.2
Tayer	08.07.20	6.7	27.00	12.00	33.7	30.0
Nagal	01.07.20	9.3	50.67	23.67	55.0	30.4
Suriya	07.08.20	4.7	41.67	14.33	36.0	46.0
Ahmat	07.08.20	9.0	35.00	18.33	33.7	40.6
Abdul Rehman	10.08.20	5.0	38.33	8.33	28.0	46.2
Bhukso	28.07.20	6.7	47.67	14.67	32.0	24.8
Kotho	28.07.20	9.7	64.67	36.00	43.0	31.0
Umshok	05.08.20	4.7	53.33	6.67	23.3	33.6
Amiri	05.08.20	6.0	48.33	11.00	31.3	43.6
Sewi	10.08.20	12.3	61.67	23.33	24.3	56.4
Dhamas	28.06.20	10.3	56.01	16.67	51.7	37.6
SEm±		1.39	8.39	0.91	3.27	2.69
CD (5%)		3.94	23.69	2.56	9.28	7.55

Table 6. Yield attributes of different germplasm of date palm

Varieties/ germplasm	No. of fruits at pea stage /strand	No. of fruits drop	No. of harvested fruits/ strand	Fruit drop (%)	Fruit set (%)	Bunch weight (kg)
Halawy	27	14.2	12.7	52.6	47.4	4.6
Khalas	27	15.4	11.7	57.0	43.0	6.6
Khadrawy	40	25.0	14.7	63.0	37.0	4.6
Shamran	21	8.8	12.0	42.3	57.7	3.3
Zahidi	23	2.2	20.7	9.1	90.9	6.5
Braim	20	8.8	11.3	42.5	57.5	4.7
Zaglool	22	10.0	11.7	45.7	54.3	3.0
Chip-Chap	19	6.6	12.3	33.7	66.3	5.1
Sewi	21	9.4	11.7	44.6	55.4	4.5
Khuneizi	31	18.6	12.0	58.5	41.5	4.8
Binte-A-Isha	21	14.0	7.3	63.8	36.2	1.5
Nagal Hillali	19	13.6	5.0	72.5	27.5	1.5
Medjool	26	17.0	9.0	64.8	35.2	5.2
Punjab Red	39	21.6	17.3	55.6	44.4	6.0
Gizej	23	16.2	6.3	70.3	29.7	1.3
Gulchati	20	16.2	3.7	80.8	19.2	1.6
Bikaner Local	17	8.6	8.0	52.0	48.0	3.6
Javantri	16	8.8	7.0	55.9	44.1	2.0
Sabiah	31	16.6	14.3	51.8	48.2	5.2
Saidy	30	10.6	19.0	35.0	65.0	5.4
Medini Red	18	9.0	9.3	47.0	53.0	3.7
Dayari	20	7.4	12.7	37.2	62.8	2.8
Khairpur-Pakistan	23	8.6	14.7	36.9	63.1	3.6
Sakloti	24	15.4	9.0	62.8	37.2	2.0
Hayani	34	21.4	13.0	62.2	37.8	8.2
Muscat	15	7.2	8.3	46.6	53.4	4.9
Sayar	19	8.2	11.0	42.3	57.7	1.9
Tayer	19	12.2	6.7	62.8	37.2	1.7
Nagal	18	4.4	13.7	23.1	76.9	4.8
Suriya	29	19.0	11.3	64.4	35.6	3.1
Ahmat	30	11.6	18.7	38.4	61.6	4.4
Abdul Rehman	27	21.6	5.7	77.9	22.1	2.0
Bhukso	20	8.2	11.7	37.1	62.9	2.5
Kotho	23	11.2	10.7	48.9	51.1	3.1
Umshok	16	4.8	10.7	30.9	69.1	2.6
Amiri	17	11.4	6.0	64.5	35.5	1.9
Siwi	22	13.8	8.0	63.3	36.7	2.7
Dhamas	23	17.0	6.0	71.0	29.0	4.5
SEm±	2.53	1.84	1.59	5.02	5.02	0.55
CD (5%)	7.14	5.14	4.49	14.04	14.05	1.54

Table 7. Physical parameters of fruit and stone of different germplasm of date palm

Varieties/ germplasm	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Stone weight (g)	Pulp weight (g)	Pulp stone ratio
Halawy	7.3	31.3	17.5	0.9	6.4	6.9
Khalas	10.7	36.8	22.6	1.1	9.6	8.8
Khadrawy	5.9	28.8	19.0	1.3	4.5	3.6
Shamran	5.5	26.9	17.6	1.8	3.7	2.0
Zahidi	6.9	31.6	19.6	1.4	5.5	4.0
Braim	7.3	37.7	20.0	1.1	6.2	5.8
Zaglool	10.6	42.3	20.5	1.9	8.7	4.6
Chip-Chap	7.7	37.5	21.0	1.4	6.3	5.8
Sewi	7.9	31.0	21.3	1.5	6.4	4.4
Khuneizi	9.5	36.5	23.9	1.6	8.0	5.3
Binte-A-Isha	5.7	27.6	17.5	0.9	4.7	5.2
Nagal Hillali	4.5	27.8	17.5	1.0	3.5	3.5
Medjool	17.0	37.7	26.0	1.0	16.0	11.8
Punjab Red	6.4	30.9	18.4	1.4	5.0	3.6
Gizej	7.3	33.8	19.8	1.6	5.7	3.5
Gulchati	6.8	25.1	20.2	1.2	5.7	4.9
Bikaner Local	7.6	31.6	20.7	1.3	6.3	5.3
Javantri	4.9	24.0	19.1	1.3	3.6	2.9
Sabiah	5.9	27.5	18.4	1.2	4.7	3.8
Saidy	4.4	24.6	16.2	1.1	3.3	3.0
Medini Red	6.2	33.0	17.7	1.5	4.7	3.2
Dayari	3.6	30.0	15.6	2.1	1.5	0.8
Khairpur-Pakistan	4.1	27.5	16.1	0.9	3.2	3.5
Sakloti	6.1	27.4	18.4	1.8	4.3	2.4
Hayani	10.1	41.6	21.0	1.6	8.5	5.5
Muscat	5.1	28.9	15.3	0.9	4.2	4.7
Sayar	3.9	26.7	15.7	1.2	2.8	2.4
Tayer	3.3	25.1	15.0	0.7	2.6	3.9
Nagal	5.5	31.4	16.6	1.5	4.0	2.8
Suriya	5.5	29.2	18.3	1.9	3.6	1.9
Ahmat	4.9	26.3	17.0	1.9	3.1	1.6
Abdul Rehman	5.7	29.0	18.9	1.7	3.9	2.5
Bhukso	4.4	24.1	17.2	1.0	3.4	3.5
Kotho	5.5	34.1	16.3	1.3	4.3	3.5
Umshok	5.1	30.8	17.0	0.9	4.2	4.7
Amiri	6.8	28.8	17.4	1.6	5.2	3.3
Siwi	9.7	33.9	21.5	1.8	7.8	4.2
Dhamas	11.6	45.7	20.5	1.8	9.8	5.6
SEm±	0.46	0.91	0.37	0.15	0.50	0.87
CD (5%)	1.29	2.56	1.04	0.44	1.40	2.45

Table 8. Yield and quality characters of different germplasm of date palm

Varieties/ germplasm	Stone length (mm)	Stone width (mm)	Pulp thickness (mm)	Fruits colour	TSS (°Brix)	Yield/plant (kg)
Halawy	21.4	8.9	4.23	Yellow	28.8	57.2
Khalas	24.7	8.5	6.85	Yellow	39.8	69.9
Khadrawy	20.0	9.7	4.70	Greenish yellow	46.5	52.1
Shamran	19.8	9.8	4.01	Greenish yellow	30.1	35.9
Zahidi	22.2	9.0	4.27	Yellow	47.7	82.0
Braim	25.8	8.3	5.82	Yellow	38.4	40.4
Zaglool	27.9	10.5	4.25	Dark Red	19.9	32.9
Chip-Chap	23.0	7.7	5.12	Yellow	30.4	61.3
Sewi	21.5	11.2	5.09	Yellow	43.4	68.5
Khuneizi	25.1	10.0	6.90	Red	37.9	65.7
Binte-A-Isha	18.7	8.9	3.43	Greenish yellow	51.9	11.5
Nagal Hillali	20.7	9.2	3.84	Red	43.0	10.0
Medjool	21.2	8.6	9.17	Greenish yellow	52.6	66.3
Punjab Red	21.3	10.8	4.62	Red	22.8	64.5
Gizej	24.3	11.0	3.34	Red	41.5	8.3
Gulchati	18.4	10.0	5.34	Greenish yellow	47.5	15.8
Bikaner Local	20.9	9.5	5.65	Yellow	39.2	29.3
Javantri	18.9	11.4	4.82	Greenish yellow	49.8	17.7
Sabiah	18.9	9.7	4.17	Red	39.0	61.8
Saidy	18.0	10.3	3.37	Red	37.8	36.6
Medini Red	22.8	9.6	3.67	Light Red	43.3	28.2
Dayari	22.1	10.1	2.95	Light Red	49.3	25.1
Khairpur-Pakistan	18.7	8.9	4.76	Greenish yellow	36.8	26.2
Sakloti	19.8	9.8	4.01		30.1	8.1
Hayani	25.2	9.7	5.11	Dark Red	38.1	86.6
Muscat	20.2	7.6	3.83	Greenish yellow	44.9	34.0
Sayar	19.5	9.2	3.18	Green brownish yellow	46.4	14.4
Tayer	16.9	8.8	2.77	Light yellow	45.6	11.1
Nagal	23.2	9.1	4.08	Yellow	37.5	44.1
Suriya	20.5	9.5	4.70	Yellow	31.5	14.1
Ahmat	20.8	9.8	3.78	Yellow	35.1	40.9
Abdul Rehman	22.7	9.3	4.10		28.6	9.6
Bhukso	18.7	10.0	2.94	Red	45.0	18.0
Kotho	23.3	9.3	3.28	Orange Yellow	41.5	29.3

Varieties/ germplasm	Stone length (mm)	Stone width (mm)	Pulp thickness (mm)	Fruits colour	TSS (°Brix)	Yield/plant (kg)
Umshok	21.3	8.4	5.03	Red	50.1	12.5
Amiri	20.7	10.1	4.68	Red	41.9	12.0
Siwi	23.3	11.4	5.47	Orange Yellow	30.5	32.5
Dhamas	31.2	9.0	4.05	Light yellow	50.2	46.7
SEm±	0.77	0.35	0.47	-	1.44	7.45
CD (5%)	2.14	0.99	1.32	-	4.06	21.04

Evaluation of wood apple (*Feronia limonia* L.) germplasm under semi-arid conditions

The existing old wood apple germplasm (16) were evaluated for their morphological, qualitative and yield characters. The fruit colour of genotypes was observed from dull white to greyish. Genotypes CHESW-1, CHESW-3, CHESW-5, CHESW-6, CHESW-7, CHESW-8, CHESW-9, CHESW-11, CHESW-13 and CHESW-16 expressed round fruit shape while CHESW-2, CHESW-4 (Thar Gaurav) and CHESW-15 had oblong fruit shape. In addition, the genotype CHESW-10 was recorded with peculiar flat fruit shape. The fruit pulp colour was noted pale gold to coffee brown. Among them, genotype CHESW-2, CHESW-6 and CHESW-10 were found to be promising on the basis of qualitative and yield traits. The maximum fruit weight was recorded in Thar Gaurav (452.53 g) followed by CHESW-6 (388.10 g) while it was found minimum in CHESW-7 (168.57 g) followed by CHESW-8 (220.0 g). Genotypes CHESW-6 was recorded with maximum fruit pulp (58.42%) followed by CHESW-10 (53.53%) and CHESW-15 (52.62%). The highest yield/plant was noted in CHESW-6 (162.0 kg) followed by CHESW-4 (129.27 kg), CHESW-10 (123.96 kg) and CHESW-15 (115.43 kg) whereas it was found minimum in CHESW-1 (52.43 kg). The highest total soluble solid (TSS) was recorded in genotype CHESW-6 (19.80°Brix) in fruit pulp (Table 9).

CHESW-6

The genotype CHESW-6 noted with 388.10 g average fruit weight and having 19.80 °Brix TSS. The fruit start ripening from second fortnight of December and it come under late maturity group. The average fruit yield per plant was recorded 162.00 kg/plant in fourteenth year plant age under rainfed conditions of hot semi-arid ecosystem (Fig. 5).p

Fig. 5. Fruit bunches of wood apple genotype CHESW-6

CHESW-10

The average physio-chemical attributes of genotype CHESW-10 in respect of fruit weight, total number of seed/fruit, pulp per cent and TSS were recorded as 351.25 g, 518.20, 53.53% and 17.50 °Brix, respectively. This genotype observed with flat-round fruit shape. Fruits ripening started from first week of December and fruit yield per plant was recorded 123.96 kg/plant during fourteenth year of planting under rainfed conditions of hot semi-arid ecosystem. The growth and fruiting characters of newly established germplasm block of wood apple were recorded which were planted in 2015-16. The plant root stock diameter, scion diameter, plant height, plant

Table 9. Fruit and yield attributes of existing wood apple genotypes

Genotypes	Fruit weight (g)	Fruit shape	Fruit colour	Pulp colour	Pulp (%)	TSS (°Brix)	Fruit yield (kg/ plant)
CHESW-1	249.43	Round	Dull white	Brown	42.85	16.60	052.43
CHESW-2	390.00	Oblong	Dull white	Pale gold	51.80	18.20	113.43
CHESW-3	318.00	Round	Grayish	Brown	47.20	13.00	068.50
CHESW-4 (Thar Gaurav)	452.53	Oblong	Grayish	Brown	50.22	15.14	129.27
CHESW-5	266.34	Round	Grayish	Toffee brown	50.00	14.80	072.60
CHESW-6	388.10	Round	Dull white	Brown	58.42	19.80	162.00
CHESW-7	168.57	Round	Dull white	Brown	45.66	13.50	087.75
CHESW-8	220.00	Round	Dull white	Toffee brown	44.18	14.00	082.82
CHESW-9	310.20	Round	Dull white	Toffee brown	44.64	13.30	065.52
CHESW-10	351.25	Flat-round	Dull white	Brown	53.53	17.50	123.96
CHESW-11	298.34	Round	Dull white	Toffee brown	47.14	14.35	088.98
CHESW-12	288.35	Triangular	Grayish	Pale gold	46.25	15.47	082.15
CHESW-13	265.62	Round	Dull white	Brown	44.47	15.20	076.23
CHESW-14	281.43	Triangular	Grayish	Pale gold	45.62	15.80	092.56
CHESW-15	316.45	Oblong	Grayish	Pale gold	52.62	17.12	115.43
CHESW-16	265.34	Round	Grayish	Brown	43.67	16.21	085.54
CD (5%)	014.21	-	-	-	3.53	1.34	09.50

spread, total fruit and fruit weight were recorded 16.39-43.12 cm, 13.62-42.13 cm, 1.52-4.79 m, 0.97-3.96 m E-W & 0.92-3.66 m N-S, 8.56-65.23 and 220.23-319.53 g, respectively (Table 10).

CHESW-22: Genotype, CHESW-22 was collected from Umreth, Kheda district of Gujarat. Bearing of fruit has initiated in third year of planting and fruits bearing habit was observed as erect terminal. On an average, 38.63 fruits were harvested in fourth year. The fruit attributes such as fruit weight, fruit colour, pulp colour, TSS and acidity were recorded as 310.63 g, greyish, creamy, 18.12 °Brix and 5.1%, respectively.

CHESW-25: This was collected from Jambughoda, Panchmahals district of Gujarat. It has started fruit bearing in fourth year of planting and showed semi-spreading growth habit with both terminal and leteral fruiting. On average, forty four fruits were harvested in fourth year. The fruit attributes such fruit weight, fruit colour, pulp colour, TSS and acidity were noted as 315.32, greyish, creamy, 17.62°Brix and 6.2%, respectively.

CHESW-27: This genotype was collected from Ghughambha, Panchmahal district of Gujarat. The plants started bearing of fruit just after 4th year of planting and 65.23 fruits per plant were harvested. The fruit morphological characters like fruit weight, fruit colour, pulp colour, TSS and acidity were observed as 319.53, greenish, creamy, 18.30 °Brix and 5.53%, respectively (Fig. 6).

Fig. 6. Fruit appearance of wood apple genotype CHESW-27

Table 10. The growth characters of newly established germplasm of wood apple

Genotypes	Root stock dia. (cm)	Scion dia. (cm)	Plant height (m)	Plant spread (m)		No. of fruits/plant	Fruit weight (g)
				E-W	N-S		
CHESW-17	28.12	26.41	3.48	02.65	02.98	18.23	224.56
CHESW-18	36.35	33.15	4.12	03.47	03.28	22.53	276.85
CHESW-19	29.27	28.11	3.88	02.97	02.82	24.56	250.23
CHESW-20	18.64	17.12	2.95	01.95	01.89	12.36	235.23
CHESW-21	38.26	37.42	3.78	02.86	02.73	15.12	300.36
CHESW-22	37.68	32.15	4.37	02.98	02.79	38.63	310.63
CHESW-23	43.12	42.13	4.79	03.68	03.66	41.13	292.36
CHESW-24	19.65	16.36	2.69	01.75	01.74	No fruiting	
CHESW-25	38.28	34.45	3.84	03.65	03.49	44.00	315.32
CHESW-26	18.50	16.52	1.52	00.97	00.92	No fruiting	
CHESW-27	42.18	39.53	4.65	03.96	03.25	65.23	319.53
CHESW-28	19.23	18.23	3.27	01.94	01.92	Fruit stolen	
CHESW-29	24.25	23.30	3.62	02.23	02.20	19.12	265.56
CHESW-30	28.74	26.23	4.10	02.13	02.10	Fruit stolen	
CHESW-31	26.53	24.25	3.49	02.19	02.17	24.27	245.21
CHESW-32	16.39	13.62	1.89	01.59	01.52	No fruiting	
CHESW-33	17.56	15.12	1.83	01.47	01.43	17.36	280.23
CHESW-34	24.52	22.36	3.65	02.41	02.45	29.26	294.56
CHESW-35	19.23	17.59	2.56	01.56	01.50	08.56	243.25
CHESW-36	21.36	20.15	2.69	01.58	01.45	10.43	220.23
CD (5%)	03.66	02.15	0.19	00.16	00.85	03.62	015.24

Evaluation of custard apple (*Annona squamosa* L.) germplasm under semi-arid conditions

The existing forty seven custard apple germplasm were evaluated for their qualitative and quantative characters. The significant variation was found in fruit weight (118.12-340.36 g), fruit length (5.42-8.16 cm), fruit diameter (5.02-8.31 cm), pulp weight (48.30-240.30 g), rind weight (40.28-135.20 g), pulp percentage (40.23-64.51%), rind thickness (2.33-4.48 mm), fruit pulp color (creamy white to dull white), fruit core length (1.23-3.45 cm), pulp texture (soft to gritty), total sugars (13.28-18.37%), reducing sugars (12.30-15.30%), ascorbic acid (16.93-38.38 mg), no. of flakes (40.87-90.20), no. of flakes with seed (35.25-80.12), firmness of flesh (firm to medium), TSS (23.27-30.15°Brix), acidity (0.24-0.54%), pulp aroma (mild-strong), eating quality (good and very good), shelf life (3-5 days) and yield (10.37-26.58 kg/tree). Among the evaluated existing germplasm, CHESCA-4, CHESCA-13, CHESCA-23 and CHESCA-27 were found superior in respect of fruit quality and yield characters under rainfed conditions of hot semi-arid ecosystem (Fig. 7 & 8).

Fig. 7. Custard apple genotype CHESCA-21

Fig. 8. Custard apple genotype CHESCA-4

The newly established germplasm block of custard apple was also evaluated for their morphological and fruit characters. The plant root stock and scion diameter varied from 18.30 to 30.60 cm and 16.14 to 27.35 cm, respectively. The plant height was recorded from 0.92 to 2.68 m being maximum in CHESCA-24 (2.68 m) and minimum in CHESCA-37 (0.92 m). The fruit weight ranged from 132.48-280.20 g. The pulp percentage of fruit was recorded maximum in CHESCA-21 (50.22%). The highest seed number (71.33) was recorded in CHESCA-33 (Table 11).

Table 11. Fruit attributes of newly established custard apple genotypes

Genotypes	Root stock dia. (cm)	Scion dia. (cm)	Plant height (m)	Fruits /plant	Fruit weight (g)	Seed no./ fruit	TSS (°Brix)	Fruit pulp (%)
CHESCA-1	18.30	16.30	0.96	15.60	212.23	60.00	30.22	40.15
CHESCA-2	20.33	20.30	1.40	6.35	215.23	50.23	27.16	42.24
CHESCA-3	21.66	20.10	1.48	-				
CHESCA-4	22.60	21.30	1.56	9.60	224.00	56.10	30.10	43.13
CHESCA-5	22.33	20.10	1.58	16.23	138.30	28.12	28.12	43.56
CHESCA-6	27.22	25.30	1.30	12.35	150.40	32.23	24.20	40.68
CHESCA-7	22.66	21.30	1.42	-				
CHESCA-8	20.33	20.10	1.30	15.16	152.10	42.13	27.26	46.52
CHESCA-9	22.12	20.60	1.48	9.23	132.48	38.12	27.32	40.26
CHESCA-10	24.05	21.86	1.60	8.35	280.10	58.10	29.10	43.30
CHESCA-11	22.67	20.36	1.52	-				
CHESCA-12	23.60	20.30	1.42	9.24	198.20	34.22	26.32	48.20
CHESCA-13	20.00	17.36	1.25	15.24	140.20	44.10	27.23	46.44
CHESCA-14	26.14	21.12	1.20	10.31	201.25	52.16	26.61	45.30
CHESCA-15	22.18	20.34	1.43	12.87	228.23	60.25	39.20	46.20
CHESCA-16	20.33	20.30	1.38	-				
CHESCA-17	28.57	23.42	1.76	14.58	240.23	57.23	26.12	38.45
CHESCA-18	21.67	20.34	1.36	12.42	238.22	52.13	27.12	42.12
CHESCA-19	27.20	26.80	1.35	17.23	225.23	42.26	25.12	46.26
CHESCA-20	23.14	19.36	1.20	14.50	180.18	40.12	29.13	45.30
CHESCA-21	20.20	19.52	0.98	10.25	197.23	42.36	28.74	50.22
CHESCA-22	25.50	23.72	1.05	22.32	175.22	38.23	27.20	43.20
CHESCA-23	30.10	25.45	2.36	24.12	185.23	40.12	29.10	42.60
CHESCA-24	30.58	25.52	2.68	19.23	200.12	52.36	26.26	40.26
CHESCA-25	30.60	27.35	2.45	-				
CHESCA-26	30.60	24.80	2.56	9.24	185.65	50.12	28.79	48.07
CHESCA-27	24.45	21.30	1.36	17.23	165.23	32.12	29.10	45.20
CHESCA-28	24.50	20.53	1.42	16.23	170.25	38.56	25.12	43.20
CHESCA-29	26.40	24.73	1.32	15.12	210.23	56.23	24.36	46.30
CHESCA-30	25.00	21.32	1.53	9.62	192.24	54.23	27.16	40.26
CHESCA-31	27.40	23.60	1.34	10.12	187.34	51.36	25.13	38.26
CHESCA-32	24.50	20.30	1.58	7.58	270.36	66.23	30.13	44.35
CHESCA-33	20.70	20.10	1.32	15.36	235.23	71.33	25.56	43.26
CHESCA-34	28.00	24.30	1.80	-				
CHESCA-35	20.50	18.60	1.42	8.53	249.29	68.12	29.16	45.63
CHESCA-36	21.60	20.30	1.60	9.23	193.23	51.56	26.23	47.23
CHESCA-37	19.00	16.14	0.92	9.53	215.36	56.27	29.56	48.23
CHESCA-38	22.56	21.36	1.12	10.23	172.23	47.23	27.10	46.56
CD (5%)	02.62	01.75	0.21	0.35	015.23	06.25	02.51	02.70

An attempt was made to cross between the elite gemplasm and superior varieties of custard apple. About 230 crosses were made among the genotype and varieties. The crossed fruits were harvested after horticultural maturity and seeds were stored for sowing in next year (Table 12).

Evaluation of ramphal (*Annona reticulata* L.)

One genotype of ramphal (CHESR-1) has started flowering and fruiting this year. The flowering was observed in the month of October and the plants produced 10-12 fruits/plant. Plant is erect; grow up to height 3.0-3.5 m with a rounded or spreading crown. Trunk and stem are cylindrical with lenticels and very short coffee-coloured hairs. The leaves are alternate, oblong or narrow lanceolate, size 15-20 cm x 2-4.2 cm, with 10-17 conspicuous pair veins. It has long, narrow, glabrous leaves and compact fruit unlike custard apple (Fig. 9).

Fig. 9. Elite genotype of Ramphal: CHESR-1

Table 12. Qualitative characters of crossed fruit of custard apple

Female parent	Male parent	Initial fruit set number	Fruit retention number	Fruit weight (g)	Seed / fruit	TSS (^{0}Brix)
Balanagar	HS-1	7.0	5.0	170.24	29.25	24.26
HS-1	Balanagar	5.0	-	-	-	-
HS-2	Balanagar	8.0	4.0	335.12	32.50	25.45
Balanagar	Sindhan	8.0	-	-	-	-
Sindhan	Balanagar	10.0	-	-	-	-
Apk-1	Balanagar	9.0	3.0	365.65	33.12	23.36
Balanagar	Apk-1	5.0	3.0	260.23	42.26	26.86
Balanagar	Arka Sahan	10.0	-	-	-	-
Arka Sahan	Balanagar	7.0	-	-	-	-
G.S	Arka Sahan	3.0	2.0	192.23	22.23	27.36
Arka Sahan	G.S	9.0	5	179.00	20.10	32.5

Evaluation of sweet orange varieties under hot arid region of Rajasthan

Ten sweet orange cultivars namely Washington Navel, Blood Red, Newhall Navel, Jaffa, Satgudi, Hamlin, Mosambi, Pineapple, Valencia Olinda and Lane Late on Rough lemon rootstock were evaluated for growth, yield and fruit quality attributes under hot arid region of Rajasthan (Fig. 10). The plant height (315.45 cm), canopy spread N-S (325.58 cm) and E-W (322.80 cm), scion diameter (113.45 mm) and rootstocks diameter (118.19 mm) were found maximum in Satgudi followed by Hamlin with plant height (311.05 cm), canopy spread N-S (306.87 cm) and E-W (315.60 cm), scion diameter (110.21 mm) and rootstocks diameter (116.67 mm) while minimum plant height (230.11 cm), canopy spread N-S (238.71 cm) and E-W (237.22 cm), scion diameter (81.37 mm) and rootstock diameter (89.37 mm) were recorded in Lane Late. The S:R ratio (0.96) was found highest in Satgudi followed by Mosambi

(0.95) while it was recorded minimum (0.89) in both pineapple and Valencia Olinda. Maximum average number of fruits per plant was recorded (130.40) in Satgudi followed by Hamlin (118.60) as compared to lowest (10.80) in Washington Navel variety. Fruit yield was recorded maximum (25.04 kg/plant) in Satgudi followed by Hamlin (22.22 kg/plant) as compared to lowest (1.81 kg/plant) in Washington Navel variety. Fruit weight was ranged from maximum 230.98 g in Pineapple to minimum 170.12 g in Washington Navel. Highest TSS was recorded in Newhall Navel (15.43 °Brix) followed by Mosambi (15.13 °Brix) as compared to minimum in Valencia Olinda (9.58 °Brix). Acidity was found minimum (0.45%) in Satgudi and maximum (0.60%) in Valencia Olinda. Satgudi was found significantly superior as compared to other cultivars of sweet orange varieties in overall yield and fruit quality attributes under arid climatic conditions (Table 13 & 14).

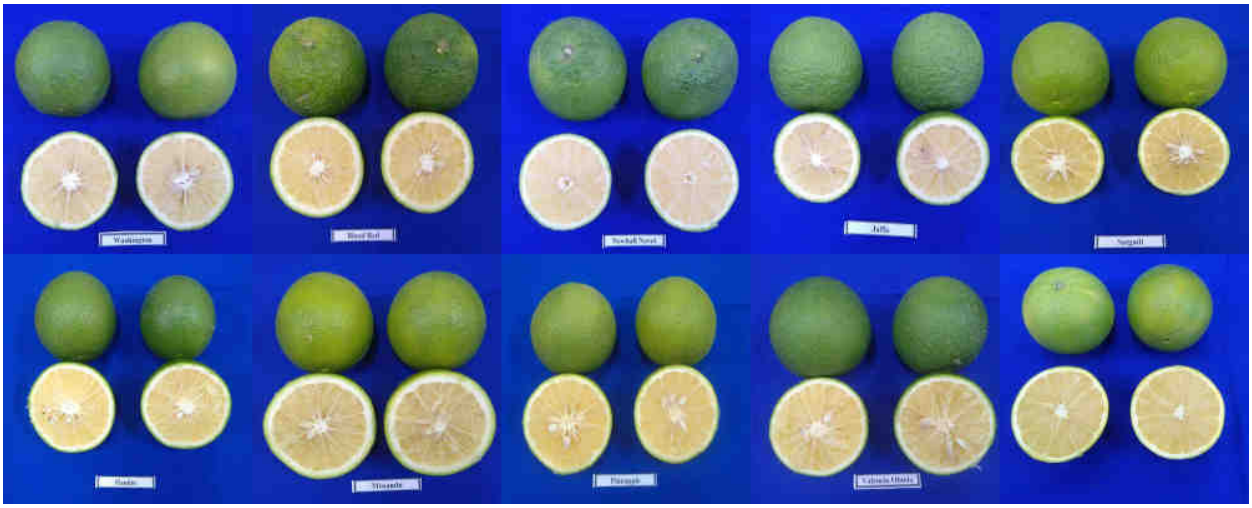


Fig. 10. Variability in fruit quality attributes of sweet orange cultivars under hot arid climate

Table 13. Growth and compatibility index of sweet orange cultivars under hot arid climate

Varieties	Plant height (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)	Scion dia. (mm)	Rootstock dia. (mm)	S:R ratio
Washington Navel	278.30	285.48	291.65	102.98	109.37	0.94
Blood Red	265.45	276.95	282.16	94.47	103.62	0.91
Newhall Navel	281.41	292.27	287.38	106.01	114.19	0.93
Jaffa	285.24	296.33	291.20	105.37	115.11	0.92
Satgudi	315.45	325.58	322.80	113.45	118.19	0.96
Hamlin	311.05	306.87	315.60	110.21	116.67	0.94
Mosambi	257.14	253.84	247.25	92.33	97.40	0.95
Pineapple	244.86	240.98	246.02	85.72	96.07	0.89
Valencia Olinda	235.18	249.25	260.79	84.60	95.09	0.89
Lane late	230.11	238.71	237.22	81.37	89.37	0.91
SEm ±	5.07	4.10	4.51	2.30	2.45	0.03
CD (5%)	15.22	12.31	13.54	6.92	7.35	0.08

Table 14. Fruit yield and quality attributes of sweet orange cultivars under hot arid climate

Varieties	Number of fruits /plant	Fruit dia. (mm)	Fruit weight (g)	Fruit yield (kg/plant)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)
Washington Navel	10.80	6.84	170.12	1.84	13.36	0.52	35.46
Blood Red	43.60	6.90	180.67	7.88	10.66	0.55	39.96

Varieties	Number of fruits /plant	Fruit dia. (mm)	Fruit weight (g)	Fruit yield (kg/plant)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)
Newhall Navel	87.20	7.06	191.33	16.68	15.43	0.59	37.55
Jaffa	104.00	6.02	138.46	14.40	11.13	0.52	40.38
Satgudi	130.40	6.82	192.05	25.04	12.90	0.45	42.74
Hamlin	118.60	7.13	187.37	22.22	11.57	0.58	35.60
Mosambi	89.80	7.76	190.54	17.11	15.13	0.49	41.18
Pineapple	30.38	7.21	230.98	7.17	14.03	0.47	38.90
Valencia Olinda	30.40	7.51	215.41	6.55	9.58	0.60	35.94
Lane late	35.50	7.86	190.18	6.75	11.70	0.49	37.18
SEm ±	2.50	0.71	2.57	0.11	0.23	0.02	1.05
CD (5%)	7.52	2.13	7.71	0.34	0.68	0.06	3.17

Evaluation of new interspecific hybrid mandarin cv. Fremont on different rootstocks under hot arid region

The Fremont mandarin plants budded on Rough lemon, Karna Khatta, Pectinifera and Troyer rootstocks were evaluated under hot arid condition (Fig. 11). The data were recorded on plant height, canopy spread, stonic difference (mm) and S:R ratio, no. of fruits/tree, fruit weight and diameter, fruit index, fruit yield, juice content, TSS, acidity, ascorbic acid, rind thickness and ripening index. The maximum tree height (2.31 m), canopy spread N-S (2.38 m) and E-W (2.24 m) were recorded on Karna

Rough lemon

Karna Khatta

Pectinifera

Troyer Citrange

Fig. 11. Evaluation of Fremont mandarin on different rootstocks under hot arid region

Khatta followed by Rough lemon with tree height (2.11 m), canopy spread N-S (2.03 m) and E-W (2.13 m). The stonic difference was found highest in Troyer citrange (12.11 mm) and lowest in Pectinifera (5.72 mm). The scion rootstock ratio was found maximum in Pectinifera (0.92) as compared to minimum in Troyer citrange (0.86). Fruit yield and quality attributes were significantly influenced by different rootstocks. The maximum number of fruits per tree, fruit weight and fruit yield per tree (241.25, 145.98 g and 35.22 kg) were recorded in Karna Khatta followed by Rough lemon (210.30, 140.10 g and 29.46 kg) as against minimum recorded in Troyer citrange (150.76, 125.74 g and 18.96 kg), respectively. Fruit juice content was ranged from minimum 50.35% in Rough lemon to maximum 55.60% in Pectinifera. TSS of fruit juice was found highest in Pectinifera (13.62 °Brix) followed by Karna Khatta (13.10 °Brix) in comparison to minimum in Rough lemon (11.89 °Brix). Titrable acidity was found minimum (0.91%) in Pectinifera and maximum in Karna Khatta (1.09%). Ripening index was found highest (14.97) in Pectinifera followed by Karna Khatta (12.02) and minimum (11.32) in Rough lemon (Table 15 to 17).

Table 15. Effect of rootstocks on growth and compatibility index of Fremont mandarin

Rootstocks	Plant height (m)	Canopy spread N-S (m)	Canopy spread E-W (m)	Stonic difference (mm)	S:R ratio
Rough lemon	2.11	2.03	2.13	7.92	0.91
Karna Khatta	2.31	2.38	2.24	10.04	0.89
Pectinifera	1.86	1.84	1.92	5.72	0.92
Troyer citrange	1.94	1.89	1.97	12.11	0.86
SEm±	0.25	0.21	0.30	0.78	0.02
CD (5%)	0.77	0.65	0.91	2.36	0.05

Table 16. Effect of rootstocks on fruit yield attributes of Fremont mandarin

Rootstocks	No. of fruits/tree	Fruit weight (g)	Fruit dia. (cm)	Fruit index	Fruit yield kg/tree
Rough lemon	210.30	140.10	6.21	0.85	29.46
Karna Khatta	241.25	145.98	6.85	0.79	35.22
Pectinifera	174.12	134.05	7.81	0.75	23.34
Troyer citrange	150.76	125.74	6.10	0.83	18.96
SEm±	3.10	1.21	0.72	0.01	1.25
CD (5%)	9.31	3.64	2.17	0.03	3.78

Table 17. Fruit quality attributes of Fremont mandarin as affected by rootstocks

Rootstocks	Fruit juice (%)	TSS (°Brix)	Acidity (mg/100 ml)	Ascorbic acid (mg/100 ml)	Rind thickness (mm)	Ripening index
Rough lemon	50.35	11.89	1.05	55.60	3.15	11.32
Karna Khatta	51.87	13.10	1.09	48.33	3.31	12.02
Pectinifera	55.60	13.62	0.91	61.45	3.10	14.97
Troyer citrange	53.15	12.57	1.05	58.09	3.09	11.97
SEm±	0.63	0.08	0.02	0.51	0.03	0.10
CD (5%)	1.89	0.25	0.06	1.53	0.09	0.31

Evaluation of Daisy mandarin on different rootstocks under hot arid region

The Daisy mandarin plants budded on Karna Khatta, Rangpur lime, Sour orange, Troyer citrange, Pectinifera and Rough lemon rootstocks were evaluated under hot arid condition. The data were recorded on plant height, canopy spread, stonic difference (mm) and S:R ratio, no. of fruits/tree, fruit weight and diameter, fruit index, fruit yield, juice content, TSS, acidity, ascorbic acid, rind thickness and ripening index. Plant growth, scion-rootstock compatibility index, fruit yield and quality attributes were significantly influenced by different rootstocks. The maximum tree height, canopy spread N-S and E-W were found in Rough lemon rootstock (3.09, 2.91 and 3.10 m) followed by Troyer citrange (2.65, 2.55 and 2.73 m) as compared to minimum recorded in Karna Khatta (2.10, 2.15 and 2.18 m), respectively. The stionic difference was ranged from minimum 5.90 in Rough lemon to maximum 13.39 mm in Troyer citrange while S:R ratio was ranged from minimum 0.87 in Troyer citrange to maximum 0.94 in Rough lemon rootstock. The maximum number of fruits and yield per tree (98.18 and 22.11 kg) was found on Rough lemon followed by Pectinifera (91.51 and 21.10 kg) while minimum in Troyer citrange (42.28 and 8.89 kg), respectively. Fruit weight was found maximum on Karna Khatta (238.47 g) followed by Sour orange (235.50 g) while minimum found on Troyer citrange (210.18 g). Fruit juice content was ranged from minimum 52.68% in Karna Khatta to maximum 58.60% in Pectinifera. Fruit juice TSS was found highest in Pectinifera (13.95 °Brix) followed by Troyer citrange (13.68 °Brix) in comparison to minimum in Karna Khatta (12.80 °Brix). Titrable acidity was found minimum (0.80%) in Pectinifera and maximum in Karna Khatta (1.02%). Ripening index was found highest (17.44) in Pectinifera followed by Troyer citrange (16.29) and minimum (12.55) in Karna Khatta (Table 18 to 20).

Table 18. Effect of different rootstocks on growth and compatibility index of Daisy mandarin

Rootstocks	Plant height (m)	Canopy spread N-S (m)	Canopy spread E-W (cm)	Stonic difference (mm)	S:R ratio
Karna Khatta	2.10	2.15	2.18	7.50	0.91
Rangpur lime	2.43	2.49	2.41	10.56	0.89
Sour orange	2.13	2.20	2.19	9.10	0.89
Troyer citrange	2.65	2.55	2.73	13.39	0.87
Pectinifera	2.40	2.49	2.41	7.05	0.92
Rough lemon	3.09	2.91	3.10	5.90	0.94
SEm±	0.30	0.27	0.22	0.60	0.03
CD (5%)	0.91	0.82	0.67	1.81	0.10

Table 19. Effect of different rootstocks on fruit yield attributes of Daisy mandarin

Rootstocks	No. of fruits/tree	Fruit weight (g)	Fruit diameter (cm)	Fruit index	Fruit yield (kg/tree)
Karna Khatta	58.15	238.47	8.20	0.81	13.87
Rangpur lime	45.59	221.68	7.90	0.75	10.11
Sour orange	68.47	235.50	8.17	0.78	16.12
Troyer citrange	42.28	210.18	7.80	0.80	8.89
Pectinifera	91.51	230.57	8.04	0.73	21.10
Rough lemon	98.18	225.12	7.96	0.74	22.11
SEm±	2.26	1.72	0.64	0.02	1.32
CD (5%)	6.79	5.16	1.92	0.06	3.98

Table 20. Fruit quality attributes of Daisy mandarin as affected by different rootstocks

Rootstocks	Fruit juice (%)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 ml)	Rind thickness (mm)	Ripening index
Karna Khatta	52.68	12.80	1.02	58.64	2.23	12.55
Rangpur lime	55.87	13.50	0.96	57.87	2.26	14.06
Sour orange	57.60	13.12	0.95	52.33	2.54	13.81
Troyer citrange	55.15	13.68	0.84	61.25	2.29	16.29
Pectinifera	58.60	13.95	0.80	63.57	2.12	17.44
Rough lemon	57.45	12.96	0.91	58.67	2.25	14.24
SEm±	0.61	0.11	0.02	0.42	0.01	0.23
CD (5%)	1.83	0.32	0.06	1.26	0.03	0.71

Evaluation of guava germplasm under semi-arid conditions

One red fleshed guava cv. Lalbahadur was collected from AAU, Anand. Fifty five guava accessions are being conserved in the field gene bank. Seven accessions were clonally propagated through *in-situ* patch budding/wedge grafting and air layering for addition in the field gene bank. During the reporting period, twenty two red fleshed and 23 white fleshed guava genotypes were evaluated for tree growth, yield, bio-chemical and mineral contents.

Evaluation of red fleshed guava germplasm

Among various red fleshed accessions, CHESG-24 recorded maximum plant height (4.70 m) while CHESG-16 was found most spreading genotype (5.10 x 5.50 m). However, Taiwan pink was recorded minimum plant height and spread. CHESG-34 recorded maximum stem girth (12.27 cm) while Taiwan pink recorded the least (3.40 cm). The maximum number of fruits/tree was observed in CHESG-15 (235) followed by Hyb 4/18 (185), CHESG-31 (165) and CHESG-21 (110) while it was found minimum in Bhavnagar-1 (45) followed by Taiwan Pink (48) and Suv Pink (53). Similarly, the maximum fruit yield/tree was recorded in CHESG-15 (34.08 kg) followed by Hyb 4/18 (29.65 kg) and Hyb 4/3 (26.34 kg) while minimum fruit yield was found in CHESG-30 (6.15 kg) and Bhavnagar-1 (7.88 kg). The maximum average fruit weight was observed in Hyb 4/7 (248.15 g) followed by Suv Pink (239.86 g) and Hyb 4/17 (229.97 g). However, the minimum fruit weight was recorded in CHESG-40 (135.98 g) followed by Lalit (147.34 g). The maximum fruit length was recorded in CHESG-30 (9.61 cm) followed by CHESG-32 (9.27 cm) while the maximum fruit width was recorded in Hyb 4/7 (8.24 cm) followed by CHESG-34 (7.88 cm). However, the minimum fruit length and width were observed in CHESG-40 (5.29 x 6.09 cm) and Lalit (5.72 x 6.57 cm). CHESG-24 recorded maximum seed core diameter (4.64 cm) while Suv Pink recorded the highest pulp thickness (1.92 cm). The highest 100 seed weight was observed in CHESG-1 (1.54 g) followed by CHESG-24 (1.49 g) while it was found minimum in Hyb 4/3 (0.89 g) followed by CHESG-15 (0.98 g). The maximum seed hardness was recorded in CHESG-30 (16.64 kg/cm^2) followed by CHESG-24 (16.41 kg/cm^2) while Hyb 4/3 recorded minimum seeds hardness (10.25 kg/cm^2) (Table 21 & 22).

The highest TSS was recorded in Bhavnagar-1 (13.95 °Brix) followed by CHESG-15 (13.92 °Brix) while the minimum TSS was observed in HYb 4/17 (9.78 °Brix) followed by CHESG-36 (10.07 °Brix). The maximum acidity (0.94%) and ascorbic acid (278.13 mg/100 g) was recorded in CHESG-21 while the minimum acidity (0.42%) was observed in CHES-30. The maximum ascorbic acid (267.98 mg/100 g) was found in CHESG-15.

The highest TSS:acidity ratio was observed in CHESG-31 (30.46) followed by Hyb 4/3 (26.93) while CHESG-21 recorded minimum TSS:acidity ratio (14.68) followed by CHESG-37 (16.46) and CHESG-40 (17.34).

Table 21. Vegetative growth and yield attributes of red fleshed guava genotypes

Germplasm	Plant height (m)	Canopy spread		Stem girth (cm)	No. of fruits/tree	Fruit weight (g)
		N-S (m)	E-W (m)			
CHESG-2	3.43	3.30	3.40	9.21	85.0	168.70
CHESG-15	3.83	4.63	4.53	11.04	235.0	166.25
CHESG-16	3.73	5.10	5.50	11.73	89.0	202.05
CHESG-21	3.90	3.83	4.32	9.16	95.0	218.03
CHESG-24	4.70	5.20	4.87	11.88	62.0	196.49
CHESG-30	3.22	3.32	3.22	8/06	35.0	191.06
CHESG-31	3.30	4.10	4.37	8.76	165.0	159.90
CHESG-32	2.96	3.76	4.10	8.23	110.0	182.42
CHESG-33	4.03	4.60	4.23	10.91	110.0	144.45
CHESG-34	4.30	3.80	4.30	12.27	125.0	254.82
CHESG-36	3.20	3.49	3.59	9.49	130.0	184.17
CHESG-37	3.70	3.77	3.97	9.16	95.0	204.25
CHESG-40	3.60	3.70	3.70	9.38	89.0	135.98
Lalit	3.36	3.66	4.13	8.15	139.0	147.34
Taiwan Pink	1.62	1.61	1.84	3.40	48	231.31
Suv Pink	1.96	2.06	2.03	4.62	53	239.86
Bhavnag-1	2.35	2.62	2.53	5.37	45	192.98
Hyb 4/3	3.81	4.61	4.11	11.43	148	226.23
Hyb 4/6	3.77	3.91	3.52	9.09	125	179.68
Hyb 4/7	3.71	3.61	3.91	9.79	79	248.15
Hyb 4/17	3.61	3.51	4.21	9.84	84	229.97
Hyb 4/18	4.02	4.42	4.82	11.84	185	186.44
SEm±	0.11	0.15	0.15	0.23	2.94	15.18
CD (5%)	0.31	0.42	0.43	0.65	8.41	43.35
CV (%)	5.49	6.85	6.75	4.25	4.81	12.95

Table 22. Yield attributes of red fleshed guava genotypes

Germplasm	Yield/tree (kg)	Fruit length (cm)	Fruit width (cm)	Seed core dia. (cm)	Pulp thickness (cm)
CHESG-2	13.18	6.19	6.61	4.64	1.52
CHESG-15	34.08	6.43	6.87	4.20	1.50
CHESG-16	15.58	7.33	7.25	4.30	1.55
CHESG-21	17.20	8.44	7.41	4.63	1.33
CHESG-24	10.85	6.48	7.13	4.64	1.46
CHESG-30	6.15	9.61	6.39	3.80	1.51
CHESG-31	22.28	7.49	6.42	3.73	1.33
CHESG-32	17.05	9.27	6.29	3.77	1.33
CHESG-33	14.30	6.57	6.47	5.20	1.43
CHESG-34	26.88	8.73	7.88	3.63	1.27
CHESG-36	22.18	7.96	6.59	4.33	1.33
CHESG-37	16.15	8.54	7.11	4.05	1.53
CHESG-40	11.13	5.29	6.09	3.75	1.25
Lalit	18.76	5.72	6.57	4.03	1.33
Taiwan Pink	9.60	7.57	7.78	4.52	1.50
Suv Pink	11.18	7.54	7.54	3.97	1.92
Bhavnagar 1	7.88	6.90	7.18	4.57	1.37
Hyb 4/3	26.34	8.02	7.03	3.30	1.47
Hyb 4/6	19.37	7.04	6.53	3.78	1.56
Hyb 4/7	17.37	8.44	8.24	4.13	1.86
Hyb 4/17	16.80	7.91	7.57	4.20	1.58
Hyb 4/18	29.65	7.32	7.59	4.40	1.60
SEm±	1.09	0.22	0.21	0.19	0.07
CD (5%)	3.12	0.63	0.59	0.54	0.21
CV (%)	10.82	5.07	5.09	7.75	8.68

CHESG-15 recorded the highest total sugar (10.17%) and reducing sugar (6.26%) while CHESG-16 recorded maximum non-reducing sugar (4.25%). However, Hyb 4/17 recorded minimum reducing sugar (3.64%) and total sugar (7.06%) while CHESG-33 recorded minimum non-reducing sugar (2.55%). The pectin content was ranged in between 0.78% in CHESG-31 to 1.27 in Suv Pink (Table 23 & 24).

Table 23. Physico-chemical characters of red fleshed guava genotypes

Germplasm	100 seed wt (g)	Seed hardness (kg/cm^2)	TSS (°Brix)	Acidity (%)	TSS:acidity
CHESG-2	1.54	15.85	13.18	0.65	20.28
CHESG-15	0.98	11.01	13.92	0.49	28.41
CHESG-16	1.23	12.58	13.03	0.62	21.02
CHESG-21	1.35	15.38	13.80	0.94	14.68
CHESG-24	1.49	16.41	12.73	0.60	21.21
CHESG-30	1.50	16.64	11.52	0.42	27.42
CHESG-31	1.06	10.46	11.88	0.39	30.46
CHESG-32	1.53	12.76	11.40	0.43	26.51
CHESG-33	1.48	11.39	10.54	0.41	25.70
CHESG-34	1.19	12.90	10.47	0.43	24.34
CHESG-36	1.36	14.95	10.07	0.36	27.97
CHESG-37	1.40	15.05	12.35	0.75	16.46
CHESG-40	1.17	10.60	12.49	0.72	17.34
Lalit	1.11	15.31	13.82	0.53	26.08
Taiwan pink	1.21	10.62	10.25	0.38	26.38
Suv Pink	1.27	10.64	10.29	0.39	26.38
Bhavnagar1	1.54	12.71	13.95	0.69	20.22
Hyb.4/3	0.89	10.25	12.93	0.48	26.93
Hyb. 4/6	1.11	10.52	12.17	0.61	19.95
Hyb. 4/7	1.02	11.86	11.16	0.68	16.41
Hyb. 4/17	1.18	10.71	9.78	0.59	16.44
Hyb. 4/18	1.35	10.86	13.00	0.53	24.53
SEm±	0.07	0.29	0.44	0.03	0.15
CD (5%)	0.21	0.83	1.25	0.08	0.41
CV (%)	10.32	3.99	6.31	8.15	1.12

Table 24. Physico-chemical characters of red fleshed guava genotypes

Germplasm	Sugars (%)			Pectin (%)	Ascorbic acid (mg/100 g)
	Reducing	Non-reducing	Total		
CHESG-2	5.18	3.14	8.48	1.04	252.27
CHESG-15	6.26	3.71	10.17	1.08	270.46
CHESG-16	5.39	4.25	9.87	1.10	238.81
CHESG-21	5.75	3.33	9.25	1.40	278.13
CHESG-24	5.73	2.64	8.51	1.05	177.35
CHESG-30	4.13	2.83	7.18	1.16	131.69
CHESG-31	4.84	2.67	7.65	0.78	133.43
CHESG-32	4.89	3.53	8.61	0.85	211.18
CHESG-33	4.68	2.55	7.37	0.92	221.43
CHESG-34	4.70	2.57	7.41	0.96	211.08
CHESG-36	4.41	3.00	7.57	1.11	157.15
CHESG-37	4.26	3.03	7.45	1.03	247.54
CHESG-40	5.14	4.13	9.49	0.94	276.48

Germplasm	Sugars (%)			Pectin (%)	Ascorbic acid (mg/100 g)
	Reducing	Non-reducing	Total		
Lalit	4.76	3.44	8.38	1.14	184.65
Taiwanpink	3.81	2.80	6.76	1.22	128.13
Suv. Pink	3.84	2.83	6.83	1.27	224.72
Bhavnag. 1	4.40	3.29	7.87	0.85	127.18
Hyb.4/3	5.19	3.73	9.12	1.16	179.15
Hyb. 4/6	4.88	3.59	8.66	1.05	158.48
Hyb. 4/7	3.92	3.32	7.42	1.06	171.04
Hyb. 4/17	3.64	3.24	7.06	1.09	164.80
Hyb. 4/18	4.39	3.63	8.22	1.01	131.23
SEm±	0.24	0.15	0.48	0.04	1.91
CD (5%)	0.68	0.33	1.37	0.13	5.44
CV (%)	8.72	9.95	10.22	7.29	1.70

Bio-chemical and mineral contents were varied significantly amongst evaluated red fleshed guava genotypes. The highest β-carotene (0.43 mg/100 g FW), total phenols (476.51 GAE/100 g), flavonoids (18.38 mg Cat. Equi./100 g) and total antioxidant activity (536.81 AAE/100 g) were recorded in CHESG-15 while CHESG-21 recorded maximum lycopene (22.31 mg/100 g FW), K (284.66 mg/100 g FW) and Ca (38.70 mg/100 g FW). Hyb 4/7 recorded maximum P (25.05 mg/100 g FW) while Hyb 4/17 recorded the Mg (52.10 mg/100 g FW). Hyb 4/3 recorded maximum Fe (30.33 ppm) followed by CHESG-16 (31.03 mg/100 g FW). The minimum β-carotene (0.13 mg/100 g FW) was recorded in CHESG-31 and Lalit while Hyb 4/17 recorded highest Mg (52.10 mg/100 g FW) followed by Taiwan Pink (51.66 mg/100 g FW). Suv pink recorded minimum lycopene (2.61 mg/100 g FW). CHESG-31 recorded minimum total phenols, flavonoids and anti-oxidant activity (Table 25 to 26).

Table 25. Bio-chemical and mineral content of red fleshed guava genotypes

Germplasm	β-carotene (mg/100 g FW)	Lycopene (mg/100g FW)	Total phenols (GAE/100 g)	Flavonoids (mg Cat. Equi./100 g)	TAA (AAE/100 g)
CHESG-2	0.24	5.13	242.91	10.17	241.94
CHESG-15	0.43	4.93	476.51	18.38	536.81
CHESG-16	0.43	5.30	480.28	16.42	445.35
CHESG-21	0.39	22.31	332.25	16.94	456.12
CHESG-24	0.28	5.19	240.42	13.26	239.63
CHESG-30	0.19	4.95	241.98	11.19	195.33
CHESG-31	0.13	5.67	186.99	8.68	184.09
CHESG-32	0.15	4.43	254.70	9.77	242.06
CHESG-33	0.23	5.47	328.01	13.12	398.49
CHESG-34	0.24	5.19	342.36	14.74	456.28
CHESG-36	0.23	4.87	308.28	14.45	418.25
CHESG-37	0.29	6.57	313.49	13.92	393.02
CHESG-40	0.16	8.20	277.93	17.54	402.76
Lalit	0.13	7.78	196.64	19.87	388.48
Taiwan Pink	0.41	2.63	418.24	13.12	438.01
Suv Pink	0.42	2.61	404.33	12.98	424.55
Bhavnagar 1	0.37	3.11	221.03	12.80	377.44
Hyb 4/3	0.34	6.73	306.85	18.11	415.80
Hyb 4/6	0.26	5.29	276.44	15.29	410.54
Hyb 4/7	0.20	5.49	221.68	16.13	325.22
Hyb 4/17	0.19	4.90	247.02	11.33	278.77
Hyb 4/18	0.30	5.35	279.11	18.18	416.50
SEm±	0.012	0.21	15.07	0.42	5.71
CD (5%)	0.035	0.60	43.02	1.20	16.31
CV (%)	7.65	6.11	8.71	5.06	2.69

Table 26. Bio-chemical and mineral content of red fleshed guava genotypes

Germplasm	Mineral content (mg/100 g FW)				Fe (ppm FW)
	K	P	Ca	Mg	
CHESG-2	268.33	17.11	23.10	26.54	25.02
CHESG-15	214.12	19.66	20.03	30.66	21.66
CHESG-16	240.05	17.66	19.02	22.66	30.03
CHESG-21	284.66	13.19	38.70	29.33	20.66
CHESG-24	228.70	17.66	23.26	25.33	22.01
CHESG-30	175.33	16.33	19.03	23.02	23.02
CHESG-31	126.55	23.36	28.43	38.46	27.38
CHESG-32	128.17	22.97	31.46	41.29	29.70
CHESG-33	176.97	19.33	27.28	22.44	19.85
CHESG-34	190.08	18.66	30.63	44.43	18.37
CHESG-36	160.99	33.62	19.29	23.81	22.94
CHESG-37	169.76	30.95	20.37	25.01	18.77
CHESG-40	218.16	20.22	23.66	20.55	21.03
Lalit	185.42	16.33	31.18	21.55	28.06
Taiwan pink	168.38	19.54	36.01	51.66	28.96
Suv pink	171.74	18.50	32.01	45.89	30.01
Bhavnagar1	272.66	16.82	20.54	22.90	22.11
Hyb 4/3	204.04	22.33	31.33	49.78	30.33
Hyb 4/6	227.66	20.18	32.86	36.01	25.11
Hyb 4/7	242.70	25.05	27.23	46.84	26.60
Hyb 4/17	262.03	24.33	28.50	52.10	28.10
Hyb 4/18	203.07	23.33	32.46	49.50	24.20
SEm±	3.34	0.99	0.86	0.92	0.87
CD (5%)	9.53	2.81	2.47	2.62	2.49
CV (%)	2.84	7.77	5.64	4.67	6.02

CHESG-15: Trees are moderately tall with spreading loose canopy. It bears heavily in bunches, fruits round in shape, medium in size weighing around 166 g. Fruit peel colour is yellowish green with deep red pulp colour. At mature ripened stage fruit pulp is firm with medium number of seeds of small size, having pleasant aroma and good taste with TSS:acidity ratio of around 28. It is soft seeded with 100 seed weight of 0.98 g and seed hardness of 11.01 kg/cm^2. Fruit pulp is rich in lycopene (4.93 mg/100 g), total antioxidants activity (536.81 mg AAE/100 g), total sugars (10.17%), pectin (1.08%) and ascorbic acid (270.46 mg/100 g pulp). It ripens early in the season *i.e.* in second week of November. Yield potential is high (34 kg/tree in fourth year).

Hyb 4/3: It is precocious and prolific bearer, fruits round in shape, medium in size and weighing around 230 g. Fruit peel is yellowish pink, while pulp is deep pink at mature ripe stage. Keeping quality of fruits is good at ambient storage (5-6 days). It is soft seeded with 100 seed weight of 0.89 g with seed hardness of 10.25 kg/cm^2. Fruit pulp is rich in β-carotene (0.34 mg/100 g), lycopene (6.73 mg/100 g), antioxidants (415.80 mg AAE/100 g) and ascorbic acid (179.15 mg/100g pulp). It is rich in minerals (mg/100 g FW) like P (22.33), Ca (31.33) and iron (30.33 ppm). The fruits are matured in second week of November (Fig. 12).

Fig. 12. Peel and pulp colour of Hyb 4/3

Evaluation of white fleshed guava germplasm

Among the evaluated white fleshed genotypes, CHESG-1 recorded maximum plant height (4.07 m) and plant spread (4.93 x 4.70 m). However, Shweta recorded minimum plant height (1.93 m) while Dhawal recorded the least spread. CHESG-29 recorded the highest stem girth (11.01 cm) while it was found the least in Shweta (6.15 cm). The average fruit weight of white fleshed genotypes ranged between 118.18 and 288.52 g being maximum in MPUAT-2 followed by CHESG-38 (256.86 g). However, the minimum fruit weight was observed in MPUAT-1 (118.18 g) followed by Dhawal (133.34 g). The maximum fruit length was recorded in CHESG-11 (10.02 cm) while it was minimum fruit length was recorded in Dhawal (6.14 cm). The fruit width varied from 6.02 cm in MPUAT-1 to 8.26 cm in MPUAT-2 followed by 7.58 cm in CHESG-38. The maximum number of fruits/tree was observed in MPUAT-1 (116.67) followed by CHESG-38 (115.33) while it was found minimum in Shweta (40) followed by Dhawal (40). Similarly, the maximum fruit yield/tree was recorded in CHESG-38 (16.98 kg) followed by L-49 (15.42 kg) while Dhawal recorded minimum fruit yield (5.60 kg) (Table 27).

Table 27. Vegetative and yield attributes of white fleshed guava genotypes

Germplasm	Plant height (m)	Canopy spread		Stem girth (cm)	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	No. of fruits /tree	Yield /tree (kg)
		N-S (m)	E-W (m)						
CHESG-1	4.07	4.93	4.70	10.98	152.53	7.58	6.22	73.33	10.45
CHESG-4	2.80	3.66	3.70	10.10	142.85	6.20	6.85	87.66	8.58
CHESG-5	3.15	4.42	4.20	8.95	156.55	6.55	6.53	115.50	11.55
CHESG-11	3.48	3.97	4.00	9.32	156.65	10.02	6.15	46.66	8.01
CHESG-17	3.03	3.53	3.37	9.27	160.57	8.23	6.60	56.50	8.26
CHESG-19	3.68	4.30	4.00	9.51	142.18	7.84	6.05	114.33	12.92
CHESG-23	3.02	3.66	3.47	8.38	154.25	7.90	6.28	69.66	8.58
CHESG-28	2.51	2.92	2.81	6.39	228.35	7.68	7.23	61.70	10.25
CHESG-29	3.90	4.36	4.37	11.01	221.43	6.93	7.05	43.33	7.32
CHESG-38	2.63	3.90	3.50	9.33	256.86	7.32	7.58	115.33	16.98
CHESG-39	2.43	2.27	2.30	7.49	193.69	6.56	7.35	62.70	9.92
L-49	3.25	4.94	4.72	10.18	228.18	6.95	6.55	103.33	15.45
Shweta	1.93	2.60	2.36	6.15	135.35	6.22	6.08	38.67	5.73
Dhawal	2.19	2.43	2.53	8.59	133.34	6.14	6.28	40.00	5.60
Thai Guava	2.46	3.06	3.17	8.38	248.69	8.15	7.72	59.13	13.03
VNR Bihi1	2.70	3.46	3.60	7.22	255.53	7.61	7.77	54.24	10.93
MPUAT-1	3.33	4.33	4.00	8.18	118.18	5.48	6.02	116.67	10.68
MPUAT-2	3.50	4.66	4.33	9.44	288.52	7.87	8.26	63.33	12.32
Seedless	3.16	3.56	4.13	6.81	148.93	6.16	6.49	66.25	10.02
Dholka	3.80	3.63	4.00	9.22	152.05	7.38	5.65	72.33	11.36
Hyb 4/1	3.61	3.72	3.62	7.59	209.76	6.96	6.78	92.66	15.59
Hyb 4/2	3.81	4.22	4.22	9.59	190.93	8.13	6.91	95.00	15.36
Hyb 4/8	3.62	3.83	4.12	8.83	218.82	6.48	7.56	43.33	7.89
SEm±	0.17	0.19	0.15	0.48	13.58	0.26	0.22	4.12	0.51
CD (5%)	0.48	0.53	0.43	1.39	38.31	0.76	0.65	11.74	1.45
CV (%)	9.33	8.63	6.75	9.70	13.43	6.13	5.11	10.19	9.13

The seed core diameter was varied from 3.35 in CHESG-17 to 5.80 cm in MPUAT-2. The highest pulp thickness was observed in MPUAT-2 (1.70 cm) and least in CHESG-5 (1.20 cm). The maximum 100 seed weight was recorded in CHESG-11 and CHESG-29 (1.62 g) followed by VNR Bihi1 (1.59 g), while it was found minimum in Hyb 4/1 (1.28 g). The maximum seed hardness was recorded in CHESG-29 (23.86 kg/cm^2) followed by VNR Bihi1 (22.58 kg/cm^2) while Shweta recorded minimum seed hardness (11.97 kg/cm^2) followed by Hyb 4/2 (12.41 kg/cm^2).

The maximum TSS was recorded in CHESG-4 (14.50 °Brix) followed by CHESG-39 (14.35 °Brix) while the minimum TSS was observed in Seedless (10.55 °Brix). The maximum acidity was recorded in CHESG-4 (0.71%) while the minimum acidity (0.42%) was observed in Seedless. The maximum ascorbic acid (304.84 mg/100 g) was found in CHESG-39 while it was recorded minimum in CHESG-29 (63.59 mg/100 g). The highest TSS:acidity ratio was observed in CHESG-23 (26.56) followed by CHESG-38 (26.25) while CHESG-21 recorded minimum TSS:acidity ratio (18.23) followed by CHESG-17 (20.15) (Table 28 & 29).

Table 28. Physico-chemical characters of white fleshed guava germplasm

Germplasm	Seed core dia. (cm)	Pulp thickness (cm)	100 seed weight (g)	Seed hardness (kg/cm^2)	TSS (°Brix)	Acidity (%)
CHESG-1	3.75	1.33	1.45	15.66	13.25	0.51
CHESG-4	4.95	1.30	1.21	14.37	14.50	0.71
CHESG-5	4.75	1.20	1.29	16.53	15.50	0.73
CHESG-11	4.40	1.30	1.62	16.63	13.45	0.65
CHESG-17	3.35	1.40	1.42	15.80	13.30	0.64
CHESG-19	3.47	1.30	1.29	14.07	13.15	0.63
CHESG-23	3.80	1.42	1.49	16.04	13.55	0.51
CHESG-28	4.50	1.60	1.58	18.29	12.65	0.53
CHESG-29	4.60	1.55	1.62	23.86	11.82	0.46
CHESG-38	4.80	1.55	1.25	12.53	13.65	0.52
CHESG-39	4.05	1.60	1.42	13.66	14.35	0.65
L-49	4.20	1.40	1.48	19.22	12.25	0.48
Shweta	3.60	1.33	1.18	11.97	13.20	0.62
Dhawal	4.00	1.30	1.52	15.77	14.15	0.59
Thai Guava	4.62	1.55	1.55	20.79	12.32	0.53
VNR Bihi 1	4.60	1.60	1.59	22.58	12.20	0.54
MPUAT-1	3.45	1.30	1.46	14.42	12.70	0.52
MPUAT-2	5.80	1.70	1.33	12.22	13.90	0.58
Seedless	3.55	1.65	1.62	18.81	10.55	0.42
Dholka	4.25	1.25	1.46	15.07	12.65	0.47
Hyb 4/1	4.43	1.50	1.28	12.53	12.60	0.48
Hyb 4/2	4.10	1.53	1.43	12.41	12.20	0.47
Hyb 4/8	4.60	1.85	1.53	14.50	11.85	0.65
SEm±	0.13	0.05	0.04	0.17	0.14	0.03
CD (5%)	0.39	0.14	0.12	0.44	0.41	0.10
CV (%)	5.95	6.83	6.20	1.84	6.68	8.54

Table 29. Physico-chemical characters of white fleshed guava germplasm

Germplasm	TSS:acidity	Total sugar	Reducing sugar	Non reducing sugar	Ascorbic acid (mg/100 g)	Pectin (%)
CHESG-1	25.98	8.57	6.08	2.37	165.60	0.56
CHESG-4	20.42	7.32	4.28	2.88	245.30	0.62
CHESG-5	21.23	7.42	4.30	2.94	188.63	0.69
CHESG-11	20.69	8.35	5.65	2.57	195.53	1.03
CHESG-17	20.15	8.18	5.15	2.88	167.80	1.18
CHESG-19	20.78	7.85	4.78	2.92	218.35	1.12
CHESG-23	26.56	8.15	5.62	2.40	185.65	1.27
CHESG-28	23.86	7.52	3.88	3.45	110.15	1.45
CHESG-29	25.69	6.63	3.68	2.80	63.52	1.33
CHESG-38	26.25	9.58	6.35	3.04	145.60	1.28
CHESG-39	22.07	9.82	5.56	4.26	304.84	1.39
L-49	25.52	9.67	5.23	4.21	204.27	1.27
Shweta	21.29	8.21	5.54	2.54	166.55	1.12
Dhawal	23.98	9.92	6.42	3.33	118.73	1.17
Thai Guava	23.24	7.85	4.64	3.05	86.87	1.55
VNR Bihi 1	22.59	7.93	4.79	2.98	155.43	1.58
MPUAT-1	24.42	9.42	5.10	4.10	208.60	1.09
MPUAT-2	23.96	9.23	5.03	3.99	275.55	1.19
Seedless	25.11	7.95	4.43	3.34	134.55	0.88
Dholka	26.91	8.07	4.89	3.02	142.54	1.22
Hyb 4/1	26.25	8.31	5.12	3.03	138.80	1.36
Hyb 4/2	25.95	8.25	5.08	3.01	135.16	1.28
Hyb 4/8	18.23	9.33	5.57	3.57	205.35	1.09
SEm±	0.13	0.56	0.04	0.03	9.18	0.012
CD (5%)	0.38	1.61	0.12	0.09	27.52	0.04
CV (%)	1.49	1.59	1.41	1.79	8.65	1.93

Dhawal recorded the highest total sugar (9.92%) and reducing sugar (6.42%) while L-49 recorded maximum non-reducing sugar (4.21%). However, CHESG-29 recorded minimum total sugar (6.63%) and reducing sugar (3.68%) while CHESG-1 recorded minimum non-reducing sugar (2.37%). The pectin content was ranged between 0.56% in CHESG-1 to 1.58 in VNR Bihi 1.

CHESG-38: It has medium tree vigour and compact semi-spreading canopy. Fruits are roundish in shape, bigger in size and weighing around 260 g. Fruit peel is yellowish green in colour while pulp is creamish white at mature ripened stage. Keeping quality of fruits is good at ambient storage (5 days). At ripened mature stage, the fruit pulp is firm with less seeds of small size, having pleasant aroma and have good taste with TSS:acidity ratio of around 26.25. It is soft seeded with 100 seed weight of 1.25 g and having seed hardness of 12.53 kg/cm^2. Fruit pulp is rich in pectin (1.28), TSS (13.65 °Brix) and total sugars (9.58%) (Fig. 13).

Fig. 13. Peel and pulp colour attribute in guava genotype CHESG-38

Collection, characterization and evaluation of acid lime germplasm under semi-arid condition

In totality, thirty four genotypes including varieties of acid lime were conserved in field gene bank. Twenty seven genotypes of acid lime including varieties were evaluated on the basis of growth and yield. The maximum plant height was recorded in Sai Sarbati (3.40 m) followed by CHESL-22 (3.30 m) and CHESL-13 (3.20 m) while Ganganagar-1 was found most dwarfing (1.90 m) followed by CHESL-31 (2.23 m). Canopy spread in both the direction was found maximum in CHESL-13 (4.13 and 4.46 m) followed by CHESL-22 (4.10 and 4.36 m) while minimum canopy spread was observed in Ganganagar-1 (2.70 and 2.70 m). The maximum stem girth was recorded in Pramalini (10.02 cm) followed by CHESL-22 (10.01 cm) and Sai Sarbati (9.80 cm). The data recorded on number of fruits and fruit yield/tree revealed that CHESL-32 (990 and 27.72 kg/plant), CHESL-27 (862 and 25.86 kg/plant) and CHESL-12 (943 and 24.51 kg/plant) were superior and recorded significantly higher yield as compared to remaining clones and varieties. Significantly highest average fruit weight was recorded in CHESL-21 (47.44 g) followed by CHESL-5 (42.26 g) and CHESL-12 (41.77 g) while minimum average fruit weight was observed in Ganganagar-1 (29.40 g) followed by CHESL-20 (32.86 g) (Table 30).

Table 30. Yield and yield attributing characters of acid lime germplasm

Germplasm	Plant height (m)	Plant spread (m)		Stem girth (cm)	No. of fruits/plant			No. of fruits/plant	Fruit weight (g)	Yield/ tree (kg)
		N-S	E-W		Ambe	Mrig	Hasta			
CHESL-3	2.80	2.83	3.66	8.59	248	75	48	371	36.49	11.32
CHESL-5	2.93	3.20	3.23	8.40	435	131	85	651	42.26	17.59
CHESL-6	2.80	3.73	3.76	8.83	315	95	62	472	34.67	14.17
CHESL-7	2.97	3.78	3.67	8.63	365	110	71	546	35.82	14.83
CHESL-8	2.77	3.66	3.53	8.12	445	134	112	691	34.83	18.34
CHESL-9	2.87	3.60	3.46	9.82	615	138	150	903	37.36	20.62
CHESL-10	3.03	4.06	4.40	8.79	526	135	110	771	39.76	17.78
CHESL-11	2.56	3.86	3.80	7.80	255	77	52	384	37.48	9.90
CHESL-12	2.87	3.66	3.90	9.02	575	218	150	943	41.77	24.51
CHESL-13	3.20	4.13	4.46	9.03	375	140	104	519	38.46	10.38
CHESL-14	2.63	3.23	3.46	8.05	515	165	136	816	35.95	22.03
CHESL-15	2.96	3.36	3.86	7.77	455	136	98	689	41.39	21.73
CHESL-17	3.00	4.26	4.26	9.69	487	148	120	755	35.45	17.78
CHESL-20	2.83	3.46	3.83	6.77	314	94	63	471	32.86	11.77
CHESL-21	2.60	2.89	3.30	7.73	458	134	96	688	47.44	19.39
CHESL-22	3.30	4.10	4.36	10.01	522	157	104	783	38.45	21.14
CHESL-23	3.13	4.20	4.16	9.13	445	135	102	682	34.44	17.05
CHESL-24	2.66	3.10	2.90	6.82	273	85	60	418	37.46	10.86
CHESL-27	3.06	3.73	3.66	8.18	535	192	135	862	42.18	25.86
CHESL-29	2.86	4.30	4.12	7.78	525	163	105	793	36.45	19.82
CHESL-31	2.23	3.63	3.33	7.35	435	278	185	898	33.25	22.45
CHESL-32	2.95	3.45	4.15	9.08	585	215	190	990	39.31	27.72
Pramalini	2.83	3.53	3.93	10.02	517	156	115	788	34.68	19.70
Sai Sarbati	3.40	4.43	4.33	9.80	498	150	103	751	37.40	18.44
Vikram	2.73	4.16	4.10	8.07	525	157	105	787	37.25	18.88
Pusa Udit	2.50	3.03	3.30	6.98	160	55	25	240	35.25	7.25
Ganga-1	1.90	2.70	2.70	6.04	275	295	95	665	29.40	13.30
SEm±	0.14	0.22	0.26	0.63	0.17	6.41	1.69	45.69	1.73	0.18
CD (5%)	0.39	0.64	0.73	1.78	0.50	18.20	4.81	129.67	4.92	0.51
CV (%)	8.60	10.67	11.83	12.95	0.67	7.56	2.86	11.73	7.99	1.58

The highest fruit length was observed in CHESL-14 (46.47 mm) followed by CHESL-22 (46.03 mm) while it was found minimum in Pusa Udit (33.77 mm). However, significantly maximum fruit width was recorded in CHESL-22 (43.97 mm) followed by CHESL-13 (42.66 mm) while Pusa Udit (31.52 mm) recorded minimum fruit width. The maximum peel thickness was noted in CHESL-29 (1.85 mm) followed by Pramalini (1.55 mm) while the minimum peel thickness was recorded in CHESL-7 (1.17 mm). The number of fruit segments were varied between 8 in Ganganagar-1 to 12 in CHESL-11, CHESL-22 and CHESL-32. The maximum number of seeds/fruit was observed in Pusa Udit (14) followed by Ganganagar-1 and CHESL-17 (13.33) while CHESL-32 recorded minimum number of seed/fruit (6.66) (Table 31 & Fig. 14).

Table 31. Physico-chemical characters of acid lime germplasm

Germplasm	Fruit length (mm)	Fruit width (mm)	Peel thickness (mm)	No. of segments	No. of seeds/fruit	Juice (%)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100ml)
CHESL-3	39.56	40.88	1.30	10.00	10.33	53.18	6.99	7.44	32.88
CHESL-5	45.69	42.32	1.66	10.66	9.66	47.46	7.94	8.24	37.61
CHESL-6	37.58	37.62	1.30	11.00	10.66	45.68	8.63	7.29	30.40
CHESL-7	38.96	37.81	1.17	10.00	9.33	47.01	9.45	7.56	35.10
CHESL-8	36.83	38.51	1.29	10.00	8.00	48.86	8.78	6.64	37.63
CHESL-9	41.28	40.68	1.28	10.00	10.66	47.63	9.11	7.69	27.84
CHESL-10	42.39	40.59	1.39	11.00	7.66	49.68	7.81	7.42	34.26
CHESL-11	43.50	41.30	1.26	12.0	9.00	48.02	8.68	7.87	30.06
CHESL-12	45.31	42.66	1.54	10.66	9.33	51.16	8.84	8.52	40.82
CHESL-13	46.47	41.33	1.22	10.00	8.66	45.94	8.05	6.90	37.33
CHESL-14	35.39	36.37	1.22	11.00	7.33	45.95	8.19	7.86	33.66
CHESL-15	43.53	41.94	1.42	12.00	8.33	50.13	8.46	8.19	38.26
CHESL-17	35.84	34.75	1.49	11.33	13.33	45.95	7.93	7.16	31.32
CHESL-20	38.91	36.70	1.46	11.00	10.33	46.52	7.92	7.63	27.79
CHESL-21	46.03	43.97	1.32	11.00	9.00	45.50	7.95	7.51	37.14
CHESL-22	41.80	41.19	1.45	12.00	12.00	51.38	8.35	7.70	35.30
CHESL-23	37.66	38.87	1.53	10.00	8.00	47.52	8.15	7.73	29.37
CHESL-24	43.76	41.01	1.39	11.66	11.33	47.27	8.20	7.51	29.25
CHESL-27	42.50	41.63	1.45	10.33	9.66	48.98	7.34	6.84	33.40
CHESL-29	45.53	42.56	1.85	12.00	9.00	51.66	8.32	7.48	32.47
CHESL-31	38.79	39.62	1.40	11.00	7.66	48.07	8.43	7.69	38.96
CHESL-32	42.16	41.02	1.52	12.00	6.66	48.97	9.09	8.18	30.84
Pramalini	38.33	35.32	1.55	10.00	9.00	46.14	9.18	8.22	33.46
Sai Sarbati	40.10	40.52	1.45	10.33	11.66	46.09	8.90	8.22	30.02
Vikram	33.77	31.52	1.48	10.00	9.00	46.53	8.97	8.35	27.50
Pusa Udit	37.90	37.97	1.54	11.00	14.00	43.59	8.39	7.54	28.59
Ganga-1	38.35	37.60	1.19	8.00	13.33	46.79	7.25	5.42	24.62
SEm±	1.28	0.92	0.07	0.27	1.51	1.03	0.14	0.13	1.17
CD (5%)	3.65	2.60	0.19	0.77	4.29	2.93	0.40	0.39	3.30
CV (%)	5.48	4.03	8.10	4.42	26.91	3.73	2.93	3.17	6.15

CHESL-32 CHESL-14 Fruit bunch and fruits of CHESL-27

Fig. 14. Acid lime genotypes

The highest juice content was recorded in CHESL-3 (53.18%) followed by CHESL-29 (51.66%) while CHESL-21 recorded the least juice content (45.50%). CHESL-7 recorded maximum TSS (9.45 °Brix) followed by Pramalini (9.18 °Brix) while CHESL-3 recorded minimum TSS (6.99 °Brix). The highest acidity was observed in CHESL-12 (8.52%) followed by Vikram (8.35%) while Ganganagar-1 recorded minimum acidity (5.42%). The highest ascorbic acid was recorded with CHESL-12 (40.82 mg/100 ml) followed by CHESL-31 (38.96 mg/100 ml) while Ganganagar-1 recorded minimum ascorbic acid (24.62 mg/100 ml).

Evaluation of bael germplasm under hot arid conditions

An experiment was conducted to evaluate the genetic variability of bael (*Aegle marmelos* Correa) germplasm grown in field repository. The total eighteen germplasm having wide range of variability in morphological and qualitative traits were studied. Among the germplasm, thirteen seedling plants were screened on the basis of fruit bearing. The fruits of selected plants were evaluated for physical and qualitative characters (fruit weight, length & width, pulp weight, shell weight & thickness, number of seeds in fruits, TSS in pulp and mucilage, colour of fruit, colour of pulp, fruit shape, styler end cavity, stem end cavity, fruit shape, seed shape and locule arrangement), qualitative (TSS of pulp and mucilage) and yield attributing parameters (number of fruits and yield per plant). Wide diversity among the physical parameters like fruit weight (0.597-1.973 kg), length (92.2-156.8 mm), width (103.4-193.5 mm), pulp weight (0.427-1.158 kg), shell weight (0.141-0.777 kg) and number of seeds per fruit (51.4- 101.8) was observed.

The physical and quality attributes of fruit characters like fruits shape, surface, stem end cavity and styler end cavity with quality aspects *viz*., pulp colour, TSS of pulp and mucilage, number of seed per fruits and shell thickness was analysed (Fig. 15 & 16).

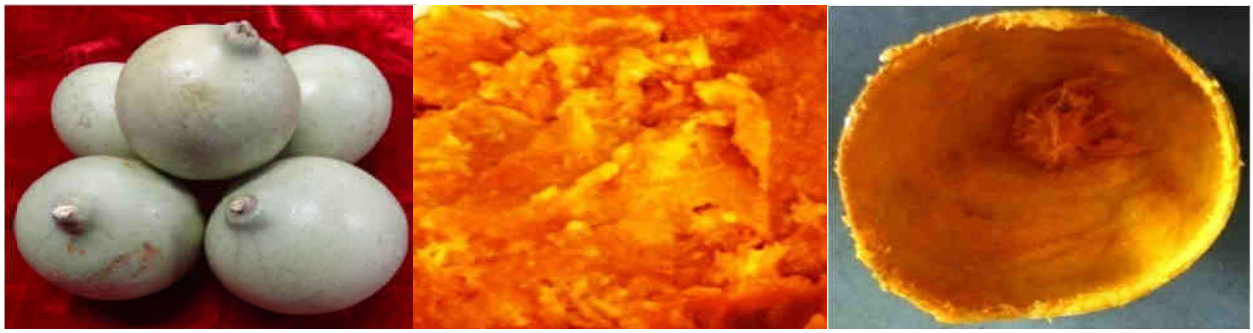


Fig. 15. Harvested fruits, extracted pulp and fruit shell of bael

Fig. 16. Physical variability in bael fruits

Maximum yield per plant (34.2 kg) and minimum (14.4 kg) was recorded among the germplasm. Differences in growth, yield and fruit quality behaviour among evaluated germplasm might be due to the genetical constitution of the individual genotype and their acclimatization under hot arid agro climatic conditions (Table 32 to 35).

Table 32. Evaluation of different bael germplasm for physical parameters of fruits

Seedlings	Fruit weight (kg)	Fruit length (mm)	Fruit width (mm)	Pulp weight (kg)	Shell weight (kg)
1.	0.793	97.8	111.4	0.490	0.288
2.	0.877	127.3	109.8	0.574	0.286
3.	0.636	130.8	104.9	0.471	0.153
4.	1.973	137.7	193.5	1.158	0.777
5.	0.843	105.3	121.6	0.459	0.367
6.	1.091	117.0	110.9	0.660	0.410
7.	0.679	128.7	103.4	0.517	0.149
8.	0.757	156.8	116.3	0.517	0.226
9.	1.305	124.9	146.5	0.887	0.393
10.	1.047	123.8	106.6	0.751	0.275
11.	0.968	127.8	112.9	0.606	0.343
12.	1.122	152.2	133.2	0.687	0.413
13.	0.579	92.2	116.9	0.427	0.141
SEm±	0.124	5.091	4.282	0.079	0.092
CD (5%)	0.354	14.521	12.213	0.226	0.262

Table 33. Evaluation of different bael germplasm for physical and quality parameters

Seedlings	Shell thickness (cm)	Number of seeds/fruit	TSS on pulp (°Brix)	TSS of mucilage (°Brix)	Yield/plant (kg)
1.	0.22	94.2	48.8	49.2	19.0
2.	0.21	101.8	44.2	47.6	23.1
3.	0.34	52.0	44.6	47.4	13.5
4.	0.24	108.6	40.6	51.4	25.7
5.	0.27	99.6	35.2	42.6	20.0
6.	0.27	38.6	36.2	41.4	22.8
7.	0.22	64.6	46.2	48.6	14.4
8.	0.21	47.8	38.8	46.2	16.0
9.	0.24	66.2	39.0	40.6	23.9
10.	0.29	82.6	41.4	44.6	34.2
11.	0.24	67.6	41.0	42.6	27.4
12.	0.36	51.4	46.4	49.0	20.9
13.	0.24	64.60	50.2	54.2	22.5
SEm±	0.029	7.321	2.506	2.292	3.985
CD (5%)	0.085	20.880	7.149	6.638	11.366

Table 34. Evaluation of different bael germplasm for physical parameters of fruits

Seedlings	Fruit colour	Fruit shape	Pulp colour	Styler end cavity
1.	Yellowish green	Globose	Dark yellow	Shallow
2.	Green	Globose	Yellow	Shallow
3.	Greenish yellow	Round	Dark yellow	Depressed
4.	Greenish pale yellow	Pumpkin shape	Yellow	Highly depressed
5.	Yellowish green	Round	Yellow	Flattened
6.	Greenish yellow	Elliptical	Yellow	Highly depressed

Seedlings	Fruit colour	Fruit shape	Pulp colour	Styler end cavity
7.	Green	Round	Yellow	Highly depressed
8.	Greenish yellow	ovate	Yellow	Shallow
9.	Greenish pale yellow	Round	Yellow	Depressed
10.	Greenish yellow	Ovate	Yellow	Shallow
11.	Greenish pale yellow	Globose	Yellow	Shallow
12.	Green yellow	Ovate	Yellow	Shallow
13.	Yellowish green	Round	Pale yellow	flattened

Table 35. Evaluation of different bael germplasm for physical parameters of fruits

Seedlings	Fruit surface	Stem end cavity	Seed shape	Locule arrangement
1.	Smooth	Depressed	Oblong	Scattered
2.	Rough	Flattered	Oblong	Centric
3.	Smooth	Highly depressed	Oblong	Centric
4.	Smooth	Depressed	Round	Centric
5.	Rough	Highly depressed	Oblong	Centric
6.	Rough	Depressed	Oblong	Scattered
7.	Smooth	Flattered	Oblong	Centric
8.	Smooth	Flattered	Oblong	Highly centric
9.	Smooth	Depressed	Oblong	Centric
10.	Smooth	Depressed	Oblong	Centric
11.	Smooth	Flattered	Oblong	Centric
12.	Smooth	Flattered	Round	Centric
13.	Smooth	Depressed	Round	Centric

Evaluation of aonla under semi-arid conditions

Aonla varieties *viz*., Chakaiya, Banarsi, Francis, Krishna, Kanchan, NA-6, NA-10, Anand-1, Anand-2, NA-7, Goma Aishwarya, BSR-1, Laxmi-52 and BSR-2 were studied for their morphomatrix, yield and qualitative attributes of fruits during the year 2020. Genotypes (CHESA-1 to CHESA-12) were studied for their growth, flowering and fruiting characters.

Evaluation of aonla varieties

Upright spreading growth habit was observed 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, Laxmi-52 and BSR-1 whereas the dense foliage in Francis, NA-7, BSR-1 and NA-10 while Banarasi, Chakaiya, Krishna, Kanchan, Anand-1, BSR-2 and Anand-2 had sparse foliage. The tree trunk colour of varieties were grey in Banarasi, Krishna, Francis, Chakaiya, Anand-1 and Anand-2 and whitish grey in Kanchan, Goma Aishwarya, 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.

Triangular fruit shape was observed in Banarasi and Krishna; flattened round in Francis, NA-7, Goma Aishwarya, Chakaiya, Kanchan and NA-10, and flattened oval in Anand-1, BSR-1 and BSR-2 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; short and thin was observed in Francis, Chakaiya, Kanchan, Anand-1 and Anand-2. Fruit stem end cavity

was noticed shallow in Banarasi, Francis, Chakaiya, Kanchan, Anand-1 and Anand-2, whereas it was deep in Krishna, NA-7 and NA-10. Styler end cavity 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 were observed. Most of the varieties showed whitish green colour flesh excluding Krishna which had yellowish green colour. The highest fruit set was recorded in the NA-7 (51.00%) followed by Goma Aishwarya (50.00%), Krishna (45.12%), NA-10 (40.37%), NA-10 (35.40%) and Kanchan (37.70%) and the same was the lowest in Banarasi (21.00%) followed by Chakaiya (32.23%).

Fruit weight varied between 27.25-38.20 g, being maximum in Banarasi (37.20 g) followed by NA-7 (31.50 g) and it was measured minimum in BSR-1 (12.08 g) and Kanchan (25.50 g). The fruit length ranged between 3.11-3.60 cm, whereas it was observed maximum in Banarasi (3.60 cm) followed by Krishna (3.41 cm) and NA-7 (3.63 cm). Fruit breadth ranged between 3.38-4.20 cm and maximum breadth was observed in Banarasi (4.22 cm) followed by NA-7 and Chakaiya, while it was minimum in BSR (1.88 cm). The percentage of fruit retention (29.30%) was recorded maximum in NA-7 followed by Krishna (24.17%) and minimum fruit retention was recorded in Banarasi (17.49%) among the evaluated varieties.

The juice content was recorded the highest in NA-7 (58.20%) followed by Goma Aishwarya (47.77%), however Chakaiya had the lowest juice content (41.28%) followed by Banarasi (39.10%) and Anand-2 (38.00%). The acidity was ranged between 1.97-2.23% being maximum in BRS-1 (2.24%) followed by Krishna (2.12%), whereas it was recorded the lowest (1.98%) in Kanchan followed by Anand-1 (2.15%). The vitamin C content ranged between 350.63- 499.00 mg /100 g. It was observed the highest in NA-7 (490.00 mg/100 g) followed by Kanchan (475.70 mg/100g) and the same was found the lowest in Banarasi (398.07 mg/100 g) followed by Francis (369.20 mg/100 g) and Krishna (354.00 mg/100 g). The total soluble solids were recorded maximum in NA-7 (9.50 °Brix) followed by Anand-1 (9.00 °Brix) and Anand-2 (9.20 °Brix) while Banarasi had minimum value (8.75 °Brix) followed by NA-10 (9.00 °Brix). The value of specific gravity was ranged between 1.02-1.40 being the highest in Banarasi (1.40) followed by Anand-1 (1.37) and it was least in Francis (1.03) followed by NA-7 (1.22).

Characterization of aonla varieties for different value added products

Different varieties of aonla were studied for their qualitative characters. Based on the various components, varieties NA-6, NA-7, NA-10, Banarasi and Laxmi-52 were found suitable of *murabba* and candy making, whereas BSR-1, BSR-2, Kanchan for pickle; Anand-1, Anand-2 and Chakaiya for powder making. Among the varieties, NA-7, Banarasi and Goma Aishwarya are highly suitable for juice extraction.

Evaluation of aonla genotypes

Among the 12 genotypes, maximum plant height (3.70 m) was recorded in CHESA-4 followed by CHESA-7 (3.57 m) and it was recorded least in CHESA-1 (3.00 m) followed by CHESA-2 (2.85 m) whereas yield per plant was recorded maximum in CHESA-4 (30.00 kg) under rainfed semi-arid conditions. Among the genotypes, tree growth which was observed semi-spreading in CHESA-1 and CHESA-2; tall upright in CHESA-7 and CHESA-8; tall spreading in CHESA-5 and CHESA-6, semi-drooping in CHESA-4 under rainfed conditions of western India. The foliage density was observed dense and sparse in different genotypes under semi-arid condition.

Evaluation of bael genotypes under semi-arid condition of Gujarat

Germplasm, collection and evaluation

Among 213 established germplasm in field repository, flowering and fruiting was noticed in 102 genotypes during the year 2020. Wide genetic diversity was noticed in their morphological, quantitative and qualitative fruit characters. Variation in growth habit was observed as upright, spreading, semi spreading and drooping type, whereas foliage was

observed compact, dense and sparse among all the 102 characterized genotypes. Tree shapes of different genotypes were dome, irregular, semi circular, broad vase and elliptical types. Wide range of variability was recorded in their leaf, flower, fruit yield, quality attributes and maturity period under rainfed semi-arid conditions. Genotypes exhibited wide range of variability in terms of yield/plant (54.24-115.75 kg), fruit weight (0.60-2.60 kg), fruit length (7.10-22.37 cm), fruit circumference (28.70-53.45 cm), shell thickness (1.40-3.00 mm), seed number/fruit (59.34-257.52), number of seed sacs (10.47-16.70), seed weight (0.10-0.20 g), shell weight (107.80-440.00 g) and pulp weight (0.38-2.19 kg), and for chemical composition including TSS in pulp (30.20- 42.50 °Brix), TSS in mucilage (40.17-54.50 °Brix), acidity (0.31-0.57%), vitamin C (12.09-24.80 mg/100 g), total phenol contents (1783-2770 mg/100 g) and total sugar (14.15-19.10%). Among the germplasm, considerable variability with regards to physical composition of fruit *viz.,* pulp (45.33-76.00%), shell (12.95-26.20%), fibre content (2.50-6.40%), mucilage (11.07-17.41%) and seed content (1.70-4.65%) were recorded. Genotypes showed wide variation in ripening period (February to June). Based on the observation on various aspects particularly fruiting pattern and quality attributes, genotypes *viz.,* CHESB-11, CHESB-16, CHESB-27, CHESB-29, CHESB-31, CHESB-42, CHESB-48 CHESB-59, CHESB-60, CHESB-62, CHESB-69, CHESB-71, CHESB-73, CHESB-77 and CHESB-78 were found to be superior for morphological, quantitative and qualitative characters. Details of striking features of promising genotypes, CHESB-11, CHESB-16, CHESB-21, CHESB-27 and CHESB-29 are as follows (Fig. 17).

Fruiting behavior in CHESB-11 | Bunch bearing in CHESB-16 | Branches laden with fruits in CHESB-27 | Attractive colour of fruit after ripening in CHESB-29

Fig. 17. Elite bael genotypes

CHESB-11 (IC-0629384): Average yield per plant 115.75 kg in 12th year, whereas qualitative and quantitative attributes were ranged between fruit weight 1.40-1.44 kg, fruit size 14.03 cm x 15.00 cm, fruit girth 42.45-44.20 cm, shell thickness 0.14-0.15 cm, total number of seed 60.20-67.22, seed weight 0.17- 0.19 g, total seed weight 15.00-17.00 g, fibre weight 27.42-34.22 g, shell weight 170.30-185.25 g, locules in cross section 14.00-17.50, TSS pulp 36.50-38.25 °Brix, TSS mucilage 50.35-53.00 °Brix, acidity 0.31-0.34%) and vitamin C 20.00- 23.70 mg/100 g pulp were recorded. It is comparatively small in stature and belongs to late maturing group (first week May). The fruits of this genotype are attractive having good flavour and aroma, rich in total phenols and antioxidant activity. It is highly suitable for *sharbat*; *murabba* and powder making. It is free from gummosis under rainfed semi-arid conditions of Gujarat.

CHESB-16 (IC-0629385): Average yield per plant 109.15 kg on eleventh year, fruit weight 1.43 kg, fruit size 14.15 x 15.18 cm, fruit girth 43.37 cm, shell thickness 0.19 cm, total number of seed 78.32, seed weight 0.20 g, total seed weight 19.00 g, fibre weight 37.00 g, shell weight 180.20 g, locules in cross section 14-17, TSS pulp 37.25^{0}Brix, TSS mucilage 50.00 °Brix, acidity (0.35%) and vitamin C 21.00 mg/100 g pulp were recorded. It belongs to late

maturing group (third week of May). It is rich in antioxidants activity CUPRAC (micro MTE/g) was recorded 131.30 in mucilage and 64.19 in fruit pulp. Drooping branches, whitish green fruit surface colour and curved petals are identical and distinct characters of this genotype.

CHESB-27 (IC-06293867): Average yield per plant 121.00 kg in 11th year (heavy yielder), fruit weight ranged between 1.30-1.47 kg, fruit size 14.32 x 13.35 cm, fruit girth 41.7743.00 cm, shell thickness 0.23-0.24 cm, total number of seed 59.13, seed weight 0.18 g, total seed weight 29.59 g, fibre weight 45.77 g, shell weight 200.42 g, locules in cross section 15-17, TSS pulp 42.00 °Brix, TSS mucilage 45.50 °Brix, acidity (0.37%) and vitamin C 21.00 mg/100 g pulp. It is mid maturing variety (fourth week of April), heavy yielder, compact canopy, cluster bearing, deep yellow colour of fruit. It is having excellent shelf life (15 days) after harvesting. It is highly suitable for pickle, candy and powder making.

CHESB-29 (IC-0629388): In this promising genotype, average yield per plant 79.12 kg on eighth year (heavy yielder), fruit weight ranged between 0.67-0.79 kg, fruit size 11.17 x 10.25 cm, fruit girth 37.45-39.27 cm, shell thickness 0.17-0.19 cm, total number of seed 56.25, fibre weight 39.00 g, shell weight 197.13-104.00 g, locules in cross section 14-16, TSS pulp 32.47-35.10 °Brix, TSS mucilage 48.50 °Brix, acidity (0.35%) and vitamin C 22.63 mg/100 g pulp. It is mid maturing variety (fourth week of April) with compact canopy, cluster bearing, deep yellow colour of fruit. It is having very good shelf life (15 days) after harvesting. It is highly suitable for *sharbat* and slice. It is highly suitable for nuclear family.

Collection and evaluation of jamun under semi-arid condition

Total seventy germplasm were conserved in the field gene bank. Promising genotypes (15) of jamun were evaluated for growth, flowering, fruiting and fruit quality attributes. Maximum panicle length was recorded in CHESJ-30, closely followed by CHES-32 and CHESJ-35. Peak period of ripening was recorded in the month of May-June in all the genotypes. Fruit yield was noted highest in CHESJ-30. Fruit pulp and TSS was also found highest in CHESJ-30 (Table 36 & 37 and Fig. 18).

Fig. 18. Fruiting pattern in CHESJ-30

Table 36. Yield and quality attributes of promising genotypes of jamun

Genotypes	Growth habit	Panicle length (cm)	Ripening time	Fruit yield (kg/plant)
CHESJ-27	Spreading	10.10	3rd week June	24.30
CHESJ-28	Upright	11.50	4th week May	15.00
CHESJ-29	Semispreading	10.17	3rd week May	15.60
CHESJ-30	Spreading	13.32	3rd week June	32.20
CHESJ-31	Upright	10.10	4th week May	28.10
CHESJ-32	Semi-spreading	12.10	4th week May	29.40
CHESJ-33	Upright	10.05	2nd week June	20.90
CHESJ-34	Semispreading	12.12	4th week May	14.12
CHESJ-35	Upright	12.20	4th week May	23.00
CHESJ-36	Semispreading	11.25	3rd week May	24.20
CHESJ-37	Semispreading	11.21	3rd week June	27.10

Genotypes	Growth habit	Panicle length (cm)	Ripening time	Fruit yield (kg/plant)
CHESJ-38	Upright	10.50	4th week May	30.20
CHESJ-39	Upright	11.12	4th week June	19.00
CHESJ-40	Semispreading	10.13	4th week June	19.51
CHESJ-41	Upright	11 .13	4th week May	15.80
CD (5%)	-	0.21	-	2.10

Table 37. Fruit quality attributes of promising genotypes of jamun

Genotypes	Fruit weight (g)	Pulp weight	Pulp (%)	TSS (°Brix)	Acidity (%)	Total sugar (%)	Vit. C (mg/100 g)
CHESJ-27	17.00	13.60	80.00	14.10	0.41	9.40	40.13
CHESJ-28	14.10	10.75	76.24	12.00	0.36	8.00	40.07
CHESJ-29	16.20	13.40	82.71	12.20	0.38	8.00	42.00
CHESJ-30	19.00	16.20	85.26	16.40	0.39	12.02	45.00
CHESJ-31	15.20	12.70	83.55	14.00	0.40	8.10	42.11
CHESJ-32	13.20	10.18	77.12	13.12	0.42	8.00	40.43
CHESJ-33	13.00	10.71	82.38	15.12	0.42	11.80	42.13
CHESJ-34	14.70	10.43	70.95	14.10	0.40	10.20	41.00
CHESJ-35	16.20	12.22	75.43	14.11	0.40	10.70	40.00
CHESJ-36	17.60	13.19	74.94	13.00	0.38	9.72	43.50
CHESJ-37	09.10	07.20	79.12	13.00	0.38	10.40	42.13
CHESJ-38	17.70	13.34	75.36	12.50	0.36	9.65	43.00
CHESJ-39	16.80	13.25	78.86	14.00	0.40	10.80	40.10
CHESJ-40	14.50	11.67	80.48	13.00	0.43	9.90	42.00
CHESJ-41	13.10	10.10	77.09	12.10	0.40	8.60	42.30
CD (5%)	2.11	-	-	0.21	0.02	0.41	1.20

Tamarind and Manila tamarind

Tamarind: Twenty four promising genotypes of tamarind were evaluated for growth, flowering, fruiting and fruit quality attributes. On the basis of fruit yield and quality attributes, CHEST-10 was found promising (Fig. 19).

Fig. 19. Manila tamarind genotypeCHESM-30

CHEST-10: It has up-right growth habit, thick trunk and drooping branches. It recorded 75.00 kg fruit per plant. Peak period of ripening time was last week of March. It recorded 52.20 per cent pulp and 70.30°Brix TSS during ripening.

Manila tamarind: Total 29 germplasm have been established in the field. Peak period of flowering was noted in January-February in all genotypes. Earliest flowering took place in CHESM-4, while it was noted at the last in CHESM-12. Maximum panicle length, fruit weight 30.00 g with 73.00 per cent pulp was recorded in CHESM-4, while, highest TSS was recorded in CHESM-12 (25.10 °Brix). During the year 2020, one genotype (CHESM-30) from Dakore, Gujarat was collected.

Varietal trial on tamarind

The experiment was laid out in the month of July, 2008. Ten tamarind varieties such as Pratisthan, T-263, PKM-1, Ajanta, DTS-1, Red Type, Sweet Type, Bantoor, Urigum and Goma Prateek were planted in randomized block design with four replications and observations on growth pattern and fruit quality attributes were recorded (Fig. 20). Plant height of Ajanta was observed maximum *i.e.* 5.84 m while least plant height was recorded in Sweet Type (3.50 m). The stock girth was found to be least (54.20 cm) in Bantoor. Plant spread (E-W and N-S) was also found maximum in Ajanta. Maximum fruit yield was noted in Goma Prareek (40.12 kg/plant). Maximum pod length (14.55 cm) and pulp content (51.78%) was recorded in Goma Prateek, while maximum TSS and total sugar was recorded in Urigum. Plants are performing well under semi-arid condition of western India (Table 38 to 40).

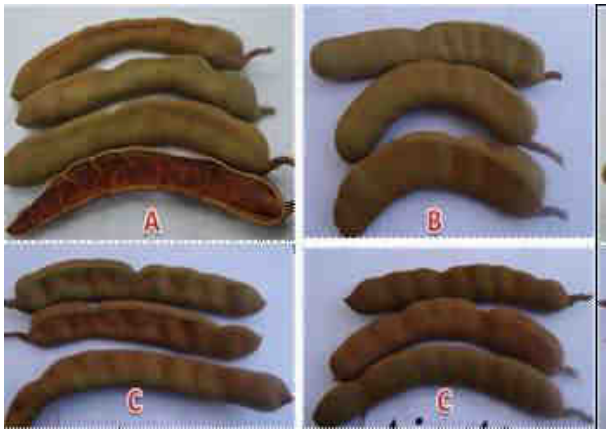


Fig. 20. Fruits of tamarind varities Goma Prateek (A), Bantoor (B), Urigam (C) and Ajanta (D)

Table 38. Growth pattern of tamarind varieties

Varieties	Stock girth (cm)	Scion girth (cm)	Plant height (m)	Plant spread (E-W)	Plant spread (N-S)	Fruit yield (kg/plant)
Pratisthan	58.11	48.30	3.61	3.82	3.84	25.10
T-263	60.21	56.31	3.72	3.52	3.66	12.20
PKM-1	70.30	70.20	3.82	3.35	3.60	13.60
Ajanta	83.00	74.60	5.84	5.25	5.60	19.30
DTS-1	74.00	68.20	5.10	5.15	5.45	16.20
Red Type	71.00	67.20	5.81	4.80	4.95	14.10
Sweet Type	64.20	60.10	3.50	3.45	5.40	12.10
Bantoor	54.20	50.20	3.91	3.35	3.40	13.12
Urigum	63.20	61.30	4.34	4.61	3.70	14.50
Goma Prateek	70.11	68.10	4.62	3.81	3.90	40.12
CD (5%)	0.18	0.21	0.22	1.11	1.20	1.31

Table 39. Fruit quality attributes of tamarind varieties

Varieties	Pod length (cm)	Pod breadth (cm)	Pod weight (g)	Seed weight (g)	Shell weight (g)	Pulp weight (g)
Pratisthan	11.70	2.36	16.65	4.90	5.32	6.43
T-263	11.75	2.25	15.70	4.30	4.41	6.99
PKM-1	10.96	2.78	18.60	6.48	5.64	6.48
Ajanta	12.60	2.22	17.80	6.49	5.25	6.06
DTS-1	12.11	1.92	11.50	3.70	3.32	4.48
Red Type	11.58	2.38	14.70	4.51	4.49	5.70
Sweet Type	10.44	2.44	16.44	5.49	5.30	5.65
Bantoor	10.58	2.58	19.49	4.40	5.47	9.62
Urigum	12.12	2.78	19.40	5.65	5.48	8.27
Goma Prateek	14.55	2.45	20.84	4.85	5.20	10.79
CD (5%)	0.41	0.42	1.31	0.62	0.42	0.50

Table 40. Fruit quality attributes of tamarind varieties

Varieties	Pulp (%)	TSS (°Brix)	Acidity (%)	Total sugar (%)	Vit. C (mg/100 g)
Pratisthan	38.62	65.54	12.40	49.50	13.50
T-263	44.52	54.22	13.30	43.90	14.80
PKM-1	34.84	65.71	13.43	50.19	16.30
Ajanta	34.04	62.53	12.59	47.59	16.90
DTS-1	38.96	62.66	12.40	45.89	21.30
Red Type	38.78	61.80	10.21	44.83	23.80
Sweet Type	34.37	59.90	8.43	43.74	22.10
Bantoor	49.36	61.93	10.70	44.69	21.80
Urigum	42.63	68.44	11.91	49.92	22.34
Goma Prateek	51.78	67.00	12.74	47.82	26.50
CD (5%)	0.62	1.10	1.11	0.71	1.11

Varietal trial on jamun

The experiment has been laid out during July-2013 with 4 varieties (Goma Priyanka, CISHJ-37, CISHJ-42 and Konkan Bardoli) with 5 replications. Maximum plant height was recorded in CISHJ-37 (5.60 m) followed by CISHJ-42 and Goma Priyanka. Stock and scion girth was found maximum in CISH-37 closely followed by CISHJ-37. Fruit yield was found maximum in Goma Priyanka followed by CISH-37. Minimum fruit yield per plant was noted in CISH 42. Maximum fruit weight, pulp content was recorded in Goma Priyanka closely followed by CISHJ-37 (Table 41 & 42 and Fig. 21).

Fig. 21. Fruit colour, pulp and stone appearance in Goma Pyiyanka (A) and CHESJ-37 (B)

Table 41. Growth pattern and fruit yield of jamun varieties

Varieties	Stock girth (cm)	Scion girth (cm)	Plant height (m)	Plant spread (E-W)	Plant spread (N-S)	Fruit yield (kg/plant)
Goma Priyanka	40.12	45.23	4.78	4.70	4.20	20.30
CISHJ-37	57.20	51.20	5.60	5.00	4.30	18.20
CISHJ-42	55.10	50.10	4.60	4.23	4.10	3.10
Konkan Bardoli	49.20	41.12	4.70	4.30	4.25	10.20
CD (5%)	0.39	0.21	0.31	0.10	0.12	1.13

Table 42. Fruit quality attributes of jamun varieties

Varieties	Fruit weight (g)	Pulp weight (g)	Pulp (%)	TSS (°Brix)	Acidity (%)	Total sugar (%)	Vit. C (mg/100 g)
Goma Priyanka	19.40	16.40	84.53	16.40	0.41	10.40	46.30
CISHJ-37	19.00	16.00	84.21	16.30	0.39	10.30	45.62
CISHJ-42	10.41	9.30	89.33	16.20	0.37	10.10	43.20
Konkan Bardoli	15.10	12.10	80.13	15.40	0.35	9.50	41.20
CD (5%)	1.10	1.11	1.30	0.12	0.01	0.20	1.10

Fruit characteristics of *ker* 'AHCD-1' at ripe stage

Different fruit characteristics of *ker* were recorded *viz.*, fruit weight, fruit length, fruit diameter, number of fruits per cluster, number of seeds per fruit and fruit drop percentage. Average fruit weight and size (length and dia.) at pea stage were measured 0.83 g and 1.24 x 0.91 cm, respectively. At ripe stage, these characters were recorded 4.87 g and 2.14 x 1.93 cm, respectively. Number of fruits per cluster was observed 6.41 and 4.56 at pea size and ripe stage, respectively. Average fruit retention and fruit drop in *ker* was noted 71.09 and 28.91%, respectively. Average number of seeds per fruit at ripe stage was observed 24.71% (Table 43). Obtained IC number (IC-0634593) of thornless *ker* 'AHCD-1' from ICAR-NBPGR, New Delhi.

Table 43. Characteristics of thornless *ker* 'AHCD-1' at pea size and ripe stage

S.No.	At pea size stage				At ripe stage				
	Fruit weight (g)	Fruit length (cm)	Fruit dia. (cm)	No. of fruits/ cluster	Fruit weight (g)	Fruit length (cm)	Fruit dia. (cm)	No. of fruits/ cluster	No. of seeds/ fruit
1	1.10	1.17	0.95	6.80	6.73	2.2	2.17	4.80	23.10
2	0.76	1.26	0.89	5.80	4.93	1.9	1.74	4.20	25.00
3	0.86	1.08	0.80	6.20	4.18	2.1	1.93	3.80	22.80
4	0.64	1.42	0.90	6.27	5.28	2.3	2.02	4.00	23.63
5	0.80	1.27	1.03	7.00	3.24	2.2	1.80	6.00	29.00
Mean	0.83	1.24	0.91	6.41	4.87	2.14	1.93	4.56	24.71

Establishment of new orchard of thornless *ker* 'AHCD-1'

Total 45 well rooted plants (15 from cuttings and 30 from seedlings) were transplanted in the field condition during September, 2020 for studying establishment, survival, growth and other necessary parameters. The plant height of *ker* plants made from cuttings was more than 40 cm and from seedlings more than 25 cm during transplanting. All plants were established and growing well in the field condition. Plants were covered with white polyethylene sheet having 3-4 holes for protecting during winter months (Fig. 22).

Fig. 22. Transplanting of thornless *ker* 'AHCD-1'

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

A total of 49 genotypes of drumstick, 28 of ivy gourd, 25 of spine gourd, 7 of bottle gourd, 3 of tomato and one variety of pumpkin were maintained and multiplied at CHES, Vejalpur. The promising lines of bottle gourd, drumstick, ivy gourd, spine gourd and tomato exhibited wide range of variability with respect to growth, yield and quality attributes under dryland semi-arid condition.

Evaluation of brinjal germplasm

On the basis of intensive native germplasm utilization, a promising brinjal genotype CIAH-22 (AHB-03) was identified, evaluated and designated as CIAH-22-6-1 with further purification during spring-summer and rainy season. The plants were moderate in growth and thorny in nature including stem, leaf and fruit calyx. It took 56-62 days from transplanting for first marketable fruit harvest. It is moderate bearer (16-27 fruits) and marketable yield potential is 2.85–3.72 kg per plant/season. Tender fruits at marketable stages

are oblong, bluish-purple in colour, 7.56-8.33 cm in length, 7.19-7.48 cm in diameter and 120.5-155.8 g in weight (Fig. 43). The plants exhibited good growth and continuous harvesting of quality fruits with temperature range of 42-46 ˚C during May-June months. Based on performance over the season, the genotype has potential for cultivation during both rainy-winter and spring-summer season under hot arid environment. Based on fruit quality attributes, individual plant selection was done for further advancement.

Fig. 23. Brinjal genotype CIAH-22

Germplasm collection and evaluation of *jhaar* karela

Jhaar karela (*Momordica balsamina*) is a wild Cucurbitaceous crop naturally found in forest land of arid and semi-arid tract of Rajasthan. It contain wide spectrum of medicinal and nutritional values. The main therapeutic agent is 'Momordin' which possess very good anti-diabetic activity. The fruits are harvested from neglected places from July to October in arid zone. Keeping in view the medicinal potential, collected six germplasm from Nagaur and Sikar area of Rajasthan and evaluated during rainy season of 2020. The evaluated material showed variability with respect to fruit weight (5-8 g), fruit diameter (1.5-2.3 cm), fruit length (2-2.70 cm) and yield/plant (0.7-1.0 kg). It is monoecious and propagated through seeds (Fig. 24).

Fig. 24. Bearing vines and fruits of *jhaar* karela

Evaluation of antioxidants and nutritional properties of drumstick

Thirty four genotypes including one variety of moringa were evaluated for their antioxidants and nutrient content in leaves and pods. Among the antioxidants, total phenolics, and ascorbic acid were quantified. Besides, antioxidant activities of the moringa germplasm leaves were also measured using *in vitro* assays-2, 2-diphenyl-1- picrylhydrazyl (DPPH). In addition to this, the content of selected elements such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) was estimated. A wide variation was observed in the content of antioxidants and nutrients. The highest total phenolic content was recorded in CHES D-40 pod, pulp and leaf among all moringa germplasm. The maximum total phenolic content in skin was assessed in CHES D-42. Likewise, the highest vitamin C in leaves and

pods were recorded in CHES D-40. The moringa germplasm CHES D-40 recorded highest nitrogen, potassium, calcium, sulphur, iron and copper in dry leaves powder. Likewise, the phosphorus and copper in CHES D-42, zinc in CHES D-45 and magnesium in CHES D-50 leaves. The protein content was analyzed in moringa germplasm leaves with maximum in CHES D-40. The dry matter (%) and moisture content (%) were recorded with a wide range of variation from 10.86-17.98 and 83.08 to 89.14 (pod), 8.16 to 14.80 and 83.40 to 93.38 (pulp), 16.00 to 22.80 and 72.20 to 84.00 (skin) and 24.62 to 30.54 and, 69.46 to 75.38 (leaves), respectively (Fig. 25 to 27).

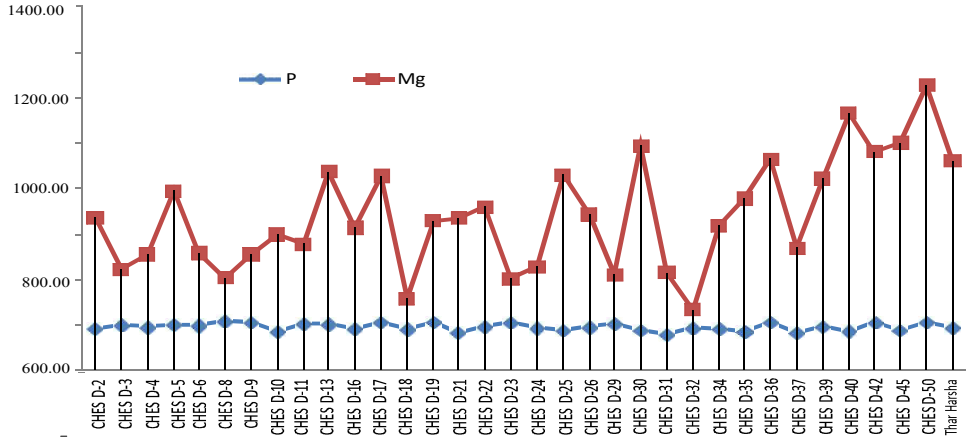


Fig. 25. Nutrient profiling of drumstick germplasm leaves (mg/100 dry leaves)

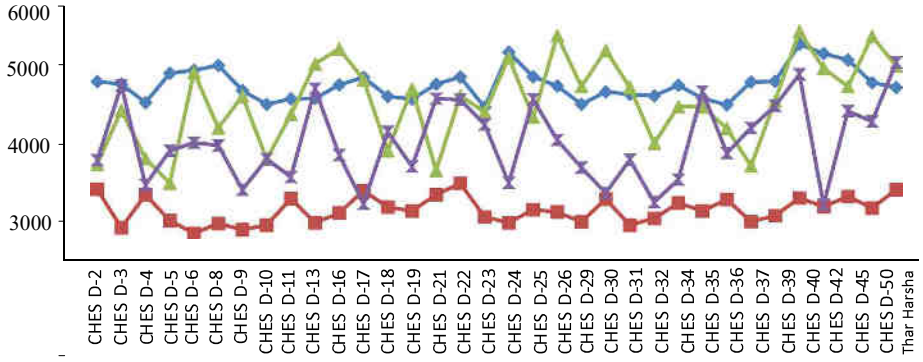


Fig. 26. Micronutrient profiling of drumstick germplasm leaves (mg/100 dry leaves)

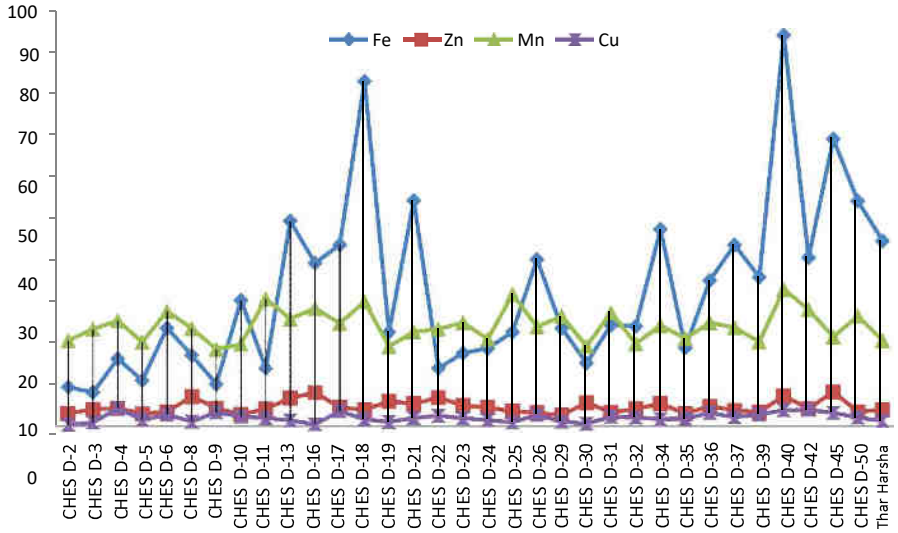


Fig. 27. Nutrient profiling of drumstick germplasm leaves (mg/100 dry leaves)

Introduction, collection, characterization, conservation and evaluation of vegetable crops (Dolichosbean, Clusterbean and Cowpea) under rainfed semi-arid conditions

Evaluation and maintenance of dolichos bean/Indian bean

The experiment was carried out to check uniformity and to assess the variability for qualitative and quantitative characters in promising lines of pole type dolichos bean (*Lablab purpureus var. typicus*) along with released varieties. The data were recorded for plant height, number of branches, days to 50% flowering, no. of pods/plant, weight, length, girth and yield/plant. The promising genotypes for their different horticultural traits are given below (Fig. 28).

CHESIB-07: The pods are very attractive dark pink in colour. The pods are medium having an average pod length of 10.6 cm and an average pod girth of 4.6 cm with pod weight of 07.0 g. The fresh green pods harvest was starts at 110 to 115 days after sowing. A total of 800-1200 pods per plant with on an average yield of 8-9 kg/plant of fresh pink pods. It is having field tolerance to dolichos bean yellow mosaic virus disease.

CHESIB-31: The pods are attractive light greenish white in colour. The pods are long having an average pod length of 15.0 cm and an average pod girth of 4.2 cm with pod weight of 8.8 g. The fresh pods were harvested at 115 to 120 days after sowing. A total of 700-900 pods per plant with on an average yield of 6.5- 7 kg/plant of fresh pods.

CHESIB-40: The pods are light pink in colour. The pods are sickle shaped having an average pod length of 15.5 cm and an average pod girth of 4.0 cm with pod weight of 7-7.5 g. The fresh pods were harvested at 95 to 97 days after sowing. The total number of pods per plant was 900-1400 with an average yield of 7.0 to 8.5 kg/plant of fresh green pods. It is having field tolerance to dolichos bean yellow mosoic virus disease.

CHESIB-50: The pods are very attractive green in colour. The pods are long having an average pod length of 17.6 cm and an average pod girth of 5.2 cm with pod weight of 15.2 g. The fresh green pods were harvested at 98 to 105 days after sowing. A total of 600-700 pods per plant were obtained with on an average yield of 6-7 kg/plant of fresh green pods.

CHESB-07 CHESB-31 CHESB-40

Fig. 28. Variability in Indian bean genotypes

Evaluation and maintenance of vegetable cowpea/yardlong bean

The experiment was carried out to check uniformity and to assess the variability for qualitative and quantitative characters in promising lines of pole type vegetable cow pea (*Vigna unguiculata* var. *sesquipedalis)* as well as bush type (*Vigna unguiculata* var. *unguiculata)* along with suitable released varieties. The genotypes were grown in a RCBD

with three replications at CHES (ICAR-CIAH), Vejalpur, Gujarat. The data were recorded for plant height, number of branches, days to 50% flowering, no. of pods/plant, weight, length, girth and pod yield/plant. Among them, the genotypes (pole types) like CHESVC-01, CHESVC-10, CHESVC-15, CHESVC-22 and CHESVC-45 and bush types *viz*., CHESVC-33 and CHESVC-20 were found superior with respect to fresh number of pods and pod yield. The variable quantitative parameters of superior genotypes are as described below.

CHESVC-01: The pods are very attractive parrot green in colour. The pods are long having an average pod length of 66 cm and an average pod girth of 3.4 cm with pod weight of 45.2 g. The fresh tender green pods were harvested at 55-60 days after sowing. The total number of pods per plant varies 80-120 pods/plant with an average yield of 2.5 to 3 kg/plant of fresh green pods (Fig. 29).

Fig. 29. Elite genotype of cowpea CHESVC-01

Early maturing genotypes of yardlong bean

CHESVC-15: The pods are dark red in colour. The pods are long having an average pod length of 52-54 cm and an average pod girth of 2.6 cm with pod weight of 20-22 g and days taken for first flowering is 38-40 days. The total pod per plant varies 180-220 pods/plant with an average yield of 3.0-3.5 kg/plant.

CHESVC-16: This is early flowering genotype with attractive light green colour pods having an average pod length of 50-52 cm and an average pod girth of 3.2 cm with pod weight of 28-30 g and days taken for first flowering is 29-30 days. The total number of pods per plant varies 150-180 with an average yield of 3.5- 4.0 kg/plant of fresh pods.

CHESVC-20: This genotype is also photo insensitive with pale green colour pods, having an average pod length of 17.50 cm and an average pod girth of 2.3 cm with pod weight of 5.8 g and days taken for first flowering is 43-45 days. The total number of pods per plant varies 120-130 with an average yield of 1.0 kg/plant of fresh pods.

CHESVC-33: This genotype is photo insensitive with attractive green colour pods, having an average pod length of 26.50 cm and an average pod girth of 2.5 cm with pod weight of 9.65 g and days taken for first flowering is 42-45 days. The total number of pods per plant varies 140-150 with an average yield of 1.5 to 2.0 kg/plant of fresh pods (Fig. 30).

CHESVC-15 CHESVC-16 CHESVC-20 CHESVC-33

Fig. 30. Elite genotypes of yardlong bean

Evaluation and maintenance of cluster bean

The experiment was carried out to assess the variability in promising genotypes of cluster bean along with released varieties. They were grown in a RCBD with three replications at CHES (ICAR-CIAH) Vejalpur, Gujarat. The data were recorded for plant height, number of branches, days to 50% flowering, no. of pods/plant, weight, length, girth and pod yield/plant. Among them, the genotypes like CHESCB-25 and CHESCB-24 were found superior with respect to fresh number pods and pod yield.

CHESCB-24: It is single stem growth behavior with green colour pods having an average pod length of 11.02 cm and an average pod girth of 2.8 cm with pod weight of 3.12 g. The total number of pods per plant varied 300-320 with an average yield of 1 kg/plant of fresh pods.

CHESCB-25: It is single stem growth behavior with green colour pods having an average pod length of 11.00 cm and an average pod girth of 2.5 cm with pod weight of 3.93 g. The total number of pods per plant varied 280-320 with an average yield of 1.2 kg/plant of fresh pods.

Maintenance and conservation of arid vegetable germplasm

During the report period of 2020, regular monitoring of arid vegetable genetic resources (500 lines) which mainly consisted of desert melons (125), non-dessert melons (161), gourds (60), cluster bean and beans (35) was done for their safe conservation in gene-bank (–20 0C deep freeze) facilities at ICAR-CIAH, Bikaner. In addition, germplasm of *khejri*, sahjan, guarpatha, ivy gourd, *phog* and other perennial crop-plants of vegetable significance were maintained in the field repository.

Under germplasm maintenance and seed enhancement, okra, cluster bean, pumpkin and cucumber was taken during 2020. Seed enhancement of brinjal variety Thar Rachit and CIAH-22, and okra (AHO-1) was done in summer and deposited to ICAR-NBPGR for obtaining IC number (Fig. 31). Rooted suckers of 03 guarpatha genotypes deposited at NAGS of PDMAP, Anand. IC number 0634264 was obtained for ivy gourd variety Thar Sundari (AHIG-1) during 2020. In rainy season, 17 cluster bean genotypes were studied for vegetable use pod quality potentials and dehydration attributes. The germplasm were evaluated for agro-morphological characters and categorized to isolate potential material for use in hybridization breeding under arid conditions at Bikaner. Seed enhancement is done for conserving the land-races of desert eco-system. The immature pod length, width and weight at marketable harvest stages were ranged from 4.63-12.10 cm, 0.46-0.75 cm and 0.51-2.15 g, respectively. Based on performance, line AHG-23, AHG-21, MDU-1, Thar Bhadavi, AHG-25, AHG-22, M-83 and AHG-26 were found suitable for breeding (Fig. 32).

Two vegetable use cowpea advanced lines namely AHCP-1-4-1 and AHCP-2-3 were tested with check during rainy season of 2020 at ICAR-CIAH, Bikaner. Both the lines exhibited

Fig. 31. Fruits of unique okra AHO-1germplasm

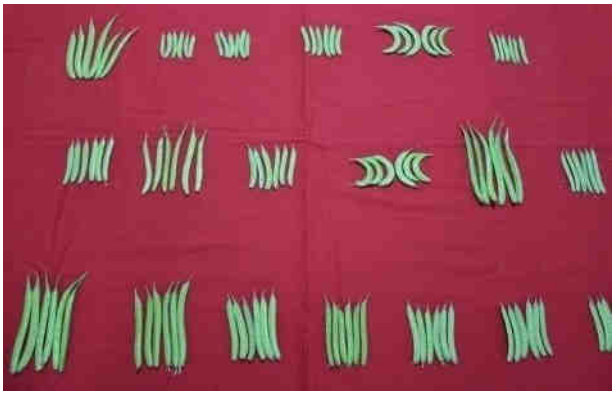


Fig. 32. Variability in tender pods of cluster bean germplasm evaluated at ICAR-CIAH, Bikaner

superiority for their growth performance, tender pod quality and marketable harvest under hot arid environment. Over the year characterization data is summarized as under:-

Cowpea AHCP-1-4-1: It is vegetable pod quality material and suitable for irrigated condition. Plants are semi-erect and height at 90 DAS recorded 112.57-142.35 cm. Leaves are green in colour and 10.75 cm length and 7.95 cm width. It is early maturing and took 38.7-44.5 days for 50% flowering and first harvesting of tender pods starts at 46.5-58.2 DAS. Flowers are purple in colour and each flower cluster has 3.56-4.28 pods. Pod attachment to peduncle is semi-erect and pods are straight with smooth surface. It bears highest quality vegetable use pods which are green to dark-green in colour. The marketable quality tender pods for vegetable culinary are 12.25-13.52 cm length, 0.50-0.64 cm diameter and 1.95-2.47 g weight and each pod has 12.45 seeds. The rhomboid shaped dry seeds are yellowish white in colour and weight of 100 seeds ranged from 11.46-12.52 g. Vegetable quality pod harvest was 262.57-356.25 g/plant and yield potential of 132-174 q/ha under arid environment (Fig. 33).

Fig. 33. Pod bearing pattern and marketable stages pod quality of vegetable type cowpea selection AHCP-1-4-1

Cowpea AHCP-2-3: It is vegetable pod and multiple-use material and suitable for rainfed crop. Plants are erect and height at 90 DAS 90.48-110.25 cm. Leaves are green in colour and 11.32 cm length and 7.93 cm width. It is very early maturing and took 32.6-40.2 days for 50% flowering and first harvesting of tender pods starts at 40.5-48.7 DAS. Flowers are purple in colour and each flower cluster has 3.97-4.56 pods. Pod attachment to peduncle is erect and pods are straight with smooth surface. Tender pods are green to dark-green colour and multiple-use quality. The marketable quality tender pods of vegetable culinary are 10.86-11.87 cm length, 0.47-0.58 cm diameter and 1.62-2.35 g weight and each pod has 13.05 seeds. The rhomboid shaped dry seeds are grey brown in colour and weight of 100 seeds ranges from 9.86-10.37 g. Vegetable quality pod harvest is 252.36-345.72 g/plant and yield potential is 124-168 q/ha under arid environment (Fig. 34).

Fig. 34. Pod bearing pattern and marketable pod quality of cowpea selection AHCP-2-3

IET varietal trial - ridge gourd

Seven entries of ridge gourd were evaluated during summer season of 2020. The entry 2019/RIGVAR-6 produced maximum fruit weight (130.57 g), number of fruits/plant (16.23) and marketable yield (130.67 q/ha) (Table 44).

IET hybrid trial - ridge gourd

Evaluated a total of eight hybrid entries of ridge gourd and found that entry 2019/RIGHYB-4 produced maximum fruit weight (134.73 g), number of fruits/ plant (22.60) and marketable fruit yield (156.41 q/ha) (Table 45).

AVT-I hybrid trial - ridge gourd

Seven hybrid entries of ridge gourd were evaluated during summer season of 2020. Among the evaluated entries, 2018/RIGHYB-5 performed best with respect to fruit weight (134.87 g), number of fruits per plant (22.93) and marketable fruit yield (163.57 q/ha) (Table 46).

Table 44. IET varietal trial of ridge gourd conducted during summer 2020

Entry	Days to first picking	Fruit weight (g)	Fruit/ plant	Fruit length (cm)	Fruit dia. (cm)	Marketable yield (q/ha)	Colour of fruit	Reaction to mosaic disease
2019/RIGVAR-1	52.07	93.10	10.60	15.27	2.95	95.83	Dark green	Tolerant
2019/RIGVAR-2	50.87	97.23	11.47	16.26	2.82	102.57	Green	Tolerant
2019/RIGVAR-3	59.80	87.43	11.40	15.89	2.86	93.57	Green	Moderately resistant
2019/RIGVAR-4	57.20	117.70	13.73	16.95	3.62	118.30	Green	Moderately resistant
2019/RIGVAR-5	58.47	125.53	14.33	21.27	2.93	123.87	Light green	Moderately resistant
2019/RIGVAR-6	56.33	130.57	16.23	19.31	3.19	130.67	Green	Moderately resistant
2019/RIGVAR-7	59.53	98.33	13.27	14.71	3.22	104.88	Green	Moderately resistant
CD (5%)	5.26	12.98	2.06	2.80	0.30	12.07		

Table 45. IET hybrid trial of ridge gourd conducted during summer 2020

Entry	Days to first picking	Fruit weight (g)	Fruit/plant	Fruit length (cm)	Fruit dia. (cm)	Marketable yield (q/ha)	Colour of fruit	Reaction to mosaic disease
2019/RIGHYB-1	52.13	108.23	13.40	17.55	3.52	124.63	Green	Tolerant
2019/RIGHYB-2	55.53	118.07	16.80	16.73	3.69	139.57	Dark green	Tolerant
2019/RIGHYB-3	61.07	97.30	10.30	15.43	3.30	114.37	Green	Moderately resistant
2019/RIGHYB-4	57.07	134.73	22.60	20.31	3.50	156.41	Dark green	Moderately resistant
2019/RIGHYB-5	52.60	123.73	16.73	30.63	3.22	143.03	Dark green	Moderately resistant
2019/RIGHYB-6	56.60	128.17	19.33	21.90	3.23	149.13	Dark green	Tolerant
2019/RIGHYB-7	67.53	105.33	10.93	19.25	2.88	126.10	Light green	Moderately resistant
2019/RIGHYB-8	49.50	115.83	15.47	14.37	3.05	136.10	Green	Tolerant
CD (5%)	5.14	15.17	3.29	2.33	0.41	12.01		

Table 46. AVT-I hybrid trial of ridge gourd conducted during summer 2020

Entry	Days to first picking	Fruit weight (g)	Fruit/ plant	Fruit length (cm)	Fruit dia. (cm)	Marketable yield (q/ha)	Colour of fruit	Reaction to mosaic disease
2018/RIGHYB-1	48.43	111.07	16.40	17.73	3.27	147.93	Green	Tolerant
2018/RIGHYB-2	56.40	101.47	13.97	18.67	3.52	133.35	Light green	Moderately resistant
2018/RIGHYB-3	50.47	108.17	13.53	19.61	3.33	130.23	Green	Moderately resistant
2018/RIGHYB-4	57.33	129.43	17.47	21.41	2.60	148.67	Light green	Moderately resistant
2018/RIGHYB-5	56.20	134.87	22.93	26.67	3.47	163.57	Green	Tolerant
2018/RIGHYB-6	56.43	129.50	21.80	20.31	3.65	154.37	Dark green	Moderately resistant
2018/RIGHYB-7	55.93	115.40	16.40	16.10	2.96	148.00	Green	Susceptible
CD (5%)	5.37	15.41	3.52	3.82	0.63	14.28		

AVT-II varietal trial - ridge gourd

Conducted AVT-II varietal trial of ridge gourd during summer season of 2020 comprising six entries. Maximum fruit weight (1120.55 g), fruit length (26.03 cm), number of fruits/ plant (21.45) and marketable yield (153.87 q/ha) was recorded in 2017/RIGVAR-6 (Table 47).

AVT-I varietal trial – long melon

Four entries of long melon were evaluated during summer season of 2020. Among the evaluated entries 2018/LGMVAR-4 produced maximum fruit weight (216.12 g), number of fruits/ plant (14.84) and marketable yield (168.78 q/ha) (Table 48).

IET varietal trial - watermelon

Conducted IET varietal trial of watermelon comprising five entries during summer season of 2020. The maximum TSS (12.58%), fruit weight (2.88 kg) and marketable yield (143.50 q/ha) was recorded in 2019/WMVAR-4 (Table 49).

Table 47. AVT-II varietal trial of ridge gourd conducted during summer 2020

Entry	Days to first picking	Fruit weight (g)	Fruit/ plant	Fruit length (cm)	Fruit dia. (cm)	Marketable yield (q/ha)	Colour of fruit	Reaction to mosaic disease
2017/RIGVAR-1	57.25	87.45	11.10	21.95	2.91	110.45	Green	Moderately resistant
2017/RIGVAR-2	54.75	98.70	12.20	20.08	3.06	112.23	Green	Tolerant
2017/RIGVAR-3	53.95	117.50	15.05	19.38	2.76	128.27	Green	Moderately resistant
2017/RIGVAR-4	56.00	115.58	13.30	16.50	3.60	126.32	Light green	Tolerant
2017/RIGVAR-5	58.20	123.73	18.00	19.58	3.43	142.79	Green	Moderately resistant
2017/RIGVAR-6	50.75	120.55	21.45	26.03	3.24	153.87	Green	Tolerant
CD (5%)	3.58	9.38	2.65	3.71	0.28	11.14		

Table 48. AVT-I varietal trial of longmelon conducted during summer 2020

Entry	Days to first picking	Fruit weight (g)	Fruit/ plant	Fruit length (cm)	Fruit girth (cm)	Marketable yield (q/ha)	Duration of crop (days)
2018/LGMVAR-1	65.66	272.36	7.36	14.44	17.14	151.13	85.34
2018/LGMVAR-2	54.44	162.64	9.80	17.42	11.90	137.88	88.80
2018/LGMVAR-4	51.34	216.12	14.84	37.10	9.08	168.78	86.04
2018/LGMVAR-6	60.40	187.80	10.60	43.18	9.78	139.76	81.14
CD (5%)	4.50	21.38	1.60	3.50	1.56	11.90	5.17

Table 49. IET varietal trial of watermelon conducted during summer 2020

Name of entry	Days to first picking	Fruit weight (kg)	Marketable yield (q/ha)	TSS (°Brix)	Shape of fruit	Colour of fruit	Flesh colour	Reaction to mosaic disease
2019/WMVAR-1	79.00	2.58	135.53	12.28	Round	Light green	Red	Moderately resistant
2019/WMVAR-3	77.50	2.40	117.65	11.25	Round	Dark green	Red	Highly susceptible
2019/WMVAR-4	72.25	2.88	143.50	12.58	Round	Light green	Red	Moderately resistant
2019/WMVAR-5	73.75	1.90	127.50	10.00	Round	Dark green	Red	Moderately resistant
2019/WMVAR-6	80.50	2.03	123.30	9.78	Oval	Light green	Red	Susceptible
CD (5%)	5.05	0.41	10.61	1.11				

CROP IMPROVEMENT

Thar Srishti: Improved bael variety with highly centric seed cavity

Thar Srishti is first bael variety with highly centric seed cavity (locule arrangement), attractive pulp, appealing fruit colour and having no off flavour. It is suitable for both table and processing purpose. It is prolific in bearing, Thar Srishti become ready in 300 days after fruit setting, yielding 91.50 kg/plant from 9th year onwards. The average fruit weight is 1.55 kg, pulp TSS-36.85 ºBrix, mucilage TSS-51.50 ºBrix, acidity-0.35 per cent and rich in fine fibres. It is free from gummosis under semi-arid conditions of western India.

Thar Srishti is vigorous and lustrous growth with dense canopy. It has less incidence of fruit sunscald. It is drought hardy and prolific bearer. It starts bearing in 4th year after budding. It has large and shining leaves. In view of the availability of fruits in the market for longer duration, endurance to moisture stress, scorching irradiation and temperature prevailing in hot rainfed dry tracts of the country, Thar Srishti has been developed to fulfill the long standing demand of growers and consumers for livelihood, nutritional and health security. The promising genotype was identified and selected on the basis of its elite qualitative traits. It is medium in height, semi-spreading growth habit, compact canopy and deliquescent branching habit with spines. Bud initiation commences during 2nd week of May, peak period of bud emergence between 15 - 30 May and peak period of bloom 30 May-20 June under semi-arid conditions (Fig. 35 to 37).

Fig. 35. Thar Srishti tree laden with fruits

Fig. 36. Large leaves with peculiar size and shape

Fig. 36. Fruits of bael variety Thar Srishti

Distinct quality characters of Thar Srishti fruits

The average fruit size (21 x 14 cm), fruit girth (43.53 cm), shell thickness (0.20 cm), number of locules in cross section (14), peel weight (200 g), pulp weight (1.20 kg), fibre weight (62.32 g), total seed weight (19.00 g), total number of seed/fruit (98.15), TSS of pulp (36.58 °Brix), total sugar (21.40%), acidity (0.35%) and TSS/acidity ratio (104.51) were recorded in this variety under rainfed semi-arid conditions of western India. It belongs to mid maturity group (April) and attains maximum size of fruit up to 20 October and then more or less stationary phase until the fruits are harvested. Fruit matures in February- March and ripening started in April under rainfed hot semi-arid conditions. Fruits of this variety are comparatively less affected (18.13%) by sunscald due to dense canopy. Colour of pulp is deep yellow after ripening. Fully mature fruits can be kept for 8-15 days and ripe fruits for 7-9 days under ambient condition. Thar Srishti is having very peculiar distinct quality character with respect to adherence of locules, highly centric locule arrangement, rich in fine fibres and having no off flavour, seeds embedded in the mucilage in cavity can be easily scooped out by spoon and consumed fresh as table fruit. It is very sweet in taste and having high pulp and mucilage total soluble solids with pleasant TSS and acidity blend under rainfed hot semi-arid ecosystem.

Hybridization studies in ber

Hybridization in ber was carried out to obtain superior progeny in Thai ber. In this direction, the crosses were made for improvement in TSS (donor parent Reshmi) and fruit shape-colour (donor parent Kathaphal) in Thai ber. During the year 2020, total 735 crosses were made and set fruits forty seven were recorded (6.4%). Last year crossed in same combination and harvested twelve fruits obtained fourteen seeds, sown in protray (Table 50 and Fig. 38 & 39).

Table 50. Hybridization studies in Thai ber

Cross combination	Crossing time	Status of crosses made in 2020			Last year cross status	
		No. of cross made	No. of fruit set	Fruit set (%)	Total fruit harvest	Seed sown
Thai ber x Reshmi	10 AM to afternoon	189	14	7.4	0	0
Thai ber x Kathaphal	9.30 AM to afternoon	178	06	3.4	0	0
Reshmi x Thai ber	3.30 PM to evening	92	08	8.7	2	4
Kathaphal x Thai ber	3.30 PM to evening	156	04	2.6	0	0
Selfing of Thai ber	Full day	120	15	12.5	10	10
Total		735	47	6.4	12	14

Fig. 38. Thai ber flowering and crossing

Reshmi ♀ x Thai ber ♂ Selfing of Thai ber

Fig. 39. Harvested fruits in different cross combinations

Promising pomegranate germplasm

CIAH PG-1: It was found highly suitable for anardana purpose due to high yield, more anardana recovery and high acidity of juice. Plants are vigorous, evergreen and semi spreading type. It has fruit weight 245 g, fruit length 8.64 cm, fruit diameter 8.15 cm, aril weight 35.61 g/100 arils, aril length 11.40 mm, aril width 8.50 mm and TSS 14.20 °Brix. It has 15.60 kg/plant fruit yield. Fruit are light reddish in colour, aril very bold with bright red colour.

CIAH PG-2: It was found highly suitable for table purpose. Plants are dwarf, evergreen, semi spreading type growth habit and fruits red in colour. It has fruit weight 215.16 g, fruit length 7.41 cm, fruit diameter 6.95 cm, aril weight 27.95 g/100 arils, aril length 8.45 mm and aril width 6.30 mm, TSS 15.30 °Brix and juice 43.85% on fruit basis. Fruits are round in shape, dark reddish in colour and aril colour dark pink. It has fruit yield 10.27 kg/plant (Fig. 40).

CIAH PG-1 CIAH PG-2

Fig. 40. Promising pomegranate germplasm

Identification of superior germplasm of acid lime

Two superior germplasm of acid lime namely CIAH acid lime-3 and CIAH acid lime-11 were identified for higher yield and quality under hot arid condition of Rajasthan (Fig. 41). CIAH acid lime-3 has semi vigorous plant. Fruits are harvested in summer months during June-August. The fruits are oblong shape, medium size, pleasant flavour and greenish colour with fruit weight 45.30 g. Fruits have 7.60 °Brix TSS and 6.12% acidity. The juice content is 55.10% by weight. The fruit yield on third year is 10.60 kg per plant. CIAH acid lime-11 has highly vigorous plant and produce fruits almost round the year. Fruits are oblong shape, medium size, pleasant flavour and light greenish colour, fruit weight 40.05 g. Fruits have 7.30 °Brix TSS and 5.58% acidity. The juice content is 52.31% by weight. The fruit yield on third year is 14.28 kg per plant. It is very less affected by citrus canker, which is very serious problem under hot arid condition of Rajasthan.

CIAH acid lime-3 CIAH acid lime-11

Fig. 41. Promising germplasm of acid lime

Hybridization and evaluation of F_1 hybrids in guava

An attempt was made to develop guava varieties with pink pulp and peel by introgression of genes with 10 cross combinations involving 11 parents during July-Aug., 2019. All the selected parents are red fleshed except MPUAT-2, Thai guava and CHESG-28. Hybrid seedlings (509) were raised and field planted on 17 July, 2020 for evaluation. However, CHESG-15 x Thai guava was planted on 19 December, 2019 which is now in fruiting stage (Fig. 42 & 43).

Fig. 42. Flower buds and newly set fruits in Thai x Suv Pink

Fig. 43. Fruiting in CHESG -15 x Thai

Performance of F_1 progenies: Hybrid seedlings showed healthy growth at nursery stage and after establishment in the field. The cross Bhavnagar local x SP had significantly shorter plant height and spread in comparison to other crosses. The cross of MPUAT-2 x CHESG-15 had tallest plant stature while CHESG-31 x Purple, CHESG-31 x TP, Lalit x CHESG-28, Thai x CHESG-30 and Thai x SP were showed moderately tall trees. However, Thai x SP had maximum spread while Bhavnagar local x SP produced minimum spread. Four hybrids (Thai x CHESG-30, Thai x SP, SP x CHESG-28 and Bhavnagar local x SP) flowered earlier than other six crosses with highest percentage of flowering seedlings in Thai x CHESG-30 and Thai x SP. Colour variation was observed in newly emerged leaf and shoot, which is given in Table 51.

Table 51. Plant growth and flowering characters of guava hybrids

Cross[1]/parents	Hybrids planted	Height (m)	Spread (m)	Stem girth (mm)	Days to 1 st flower	% of flowering seedlings	Newly emerged leaf/shoot characters			
							Midrib colour	Shoot colour	New leaf colour	Anthocyanin pigmentation
G-28 x G-32	58	1.06	0.77	16.81	-	-	Purple	Purple	Gr purple	Present
G-32 x G-28	36	1.20	0.77	21.67	-	-	Purple	Purple	Purple	Present
G-31 x Purple 1	51	1.33	1.02	25.44	-	-	Purple	Purple	Purple	Present
G-31 x TP	93	1.26	1.10	20.91	-	-	Purple	Purple	Purple	Present
MPUAT-2 x G-15	82	1.60	0.98	24.58	-	-	Purple	Gr purple	Gr purple	Present
Bhav local x SP	26	0.90	0.74	22.07	165	16.66	Purple	Purple	Gr purple	Present
Thai x G-30	18	1.30	1.02	26.68	148	40.0	Purple	Purple	Gr purple	Present
Thai x SP	52	1.26	1.25	24.73	145	33.33	Purple	Purple	Gr purple	Present
SP x G-28	26	1.25	1.22	22.16	152	16.66	Purple	Purple	Purple	Present
Lalit x G-28	52	1.36	0.96	21.76	165	4.00	Purple	Purple	Purple	Present
*G-15 x Thai	15	1.73	1.47	31.00	**	100.0	Purple	Purple	Gr purple	Present
CHESG-15	-	-	-	-	-	-	Green	Green	Green	Absent
Thai	-	-	-	-	-	-	Green	Green	Green	Absent
MPUAT-2	-	-	-	-	-	-	Green	Green	Green	Absent
Lalit	-	-	-	-	-	-	Green	Pinkish	Gr pink	Present
CHESG-30	-	-	-	-	-	-	Green	Green	Gr pink	Slight
CHESG-31	-	-	-	-	-	-	Green	Gr pink	Gr pink	Slight
CHESG-32	-	-	-	-	-	-	Green	Green	Green	Absent
Purple 1	-	-	-	-	-	-	Purple	Purple	Purple	Present
CHESG-28	-	-	-	-	-	-	Pink	Gr pink	Gr pink	Slight
Suv Pink (SP)	-	-	-	-	-	-	Green	Green	Green	Absent
Taiwan pink (TP)	-	-	-	-	-	-	Green	Green	Green	Absent

* Plant age: 01 year ** 4-12 months [1]Age of plants: 167 days

Various crosses were also made in 2020 in guava for developing white fleshed and red fleshed hybrids with bigger fruit size, crunchy pulp with longer shelf life. Details of cross combinations are given in Table 52.

Flower buds which were pollinated by different male parents had 75.0-100.0% fruit set (Fig. 44) and good seed numbers (35-373 seeds/fruit). Highest fruit weight and dimension was recorded with MPUAT-2 x MPUAT-1 while minimum fruit weight and dimension was observed with Purple 2 x MPUAT-1. Highest TSS:acidity ratio was recorded with MPUAT-2 x Purple 2 (33.68).

Table 52. Cross combinations and their success and number of seeds/fruit

Cross combination		No. of crosses made	Success rate (%)	No. of seed/fruit	Fruit wieght (g)	FL (cm)	FW (cm)	TSS (^{0}Brix)	Acidity (%)	TSS:acidity
Female	Male									
Purple 2	Suv Pink	3	100.0	116	164.59	8.16	6.44	13.45	1.80	7.47
Purple 2	MPUAT -1	3	100.0	123	119.62	7.35	6.17	14.50	1.78	8.15
MPUAT -2	MPUAT -1	7	85.71	373	351.50	7.25	8.76	13.0	0.39	33.33
MPUAT -1	MPUAT -2	5	80.00	115	111.51	4.87	5.97	12.5	0.40	31.29
Thai	MPUAT -2	8	75.00	48	254.50	7.20	7.62	9.55	0.31	30.80
MPUAT -2	Purple 2	5	60.00	269	129.62	5.83	6.24	12.80	0.38	33.68
Thai	CHESG-30	4	100.0	35	210.61	6.95	7.66	10.20	0.33	30.30
Thai	Suv Pink	5	80.00	39	228.59	7.15	7.53	12.80	0.42	30.47

MPUAT 2 x MPUAT-1

MPUAT-1 x MPUAT-2

Purple 2 x Suv Pink

Fig. 44. Fruits of different crosses in guava

Promising genotypes of acid lime under semi-arid condition

CHESL-12: It is high yielding clone of acid lime with high juice content (51.16%). Fruit weight is 41.77 g with bigger fruit size 43.50 x 41.30 mm. Tree is vigorous with spreading growth habit which bears mostly inside the canopy.

CHESL-14: It is dwarf and has drooping canopy with less thorn density. Fruits are round, medium size with prominent green vescicles. It is cluster bearer with average fruit weight of 36 g having fruit size of 46.47 x 41.33 mm.

CHESL-27: It is a profusely cluster bearing clone with high yield potential. Fruits are bigger in size (43.76 x 41.01 mm). Average fruit weight is around 42 g and juice content is high (49 %). It yielded 29 kg/tree during fourth year.

CHESL-31: It is another dwarfing clone with medium plant spread and upright growth. It bears equally thrice in a year. Yield potential is high with an average fruit size of 45.53 x 42.56 mm.

CHESL-32: It mostly bears inside the canopy in clusters, having spreading growth habit. It is higher yielder and fruit size is bigger (39 mm) with high juice content (49%) and lesser seeds (6-7).

Evaluation of tomato variety Thar Annant

The tomato variety Thar Annant was

developed through induced mutation followed by selection of desired phenotypic traits in the induced populations in the year 2019-20. The mutant having superior phenotypic traits was identified and homogenized based on the horticultural attributes and performance. It is having high flesh thickness (0.85 cm), deep red fruit colour rich in lycopene content (7.9 mg/100 g) with medium acidity (0.42%) under semi-arid conditions. It is highly vigorous in growth with dark green dense foliage. The mutant has bigger size of inflorescence length (16.3 cm) and distinguished by indeterminate plant habit, fruit size, fruit color and yield potential over the parent. It is highly tolerant to heat stress and drought having high yield potential. The each fruit weight about 120-130 g with attractive deep red colour fruits of round shape. Plant yield were varied between 4.2-4.9 kg. The fruits mature in 70-80 days after transplanting, comes under medium maturity group. It is moderately resistance to TLCV disease. The variety is highly suitable for table, processing and export purposes (Fig. 45).

Fig. 45. Field view and fruiting in Thar Annant

AHMM/BR-47: A promising selection of muskmelon

AHMM/BR-47 (IC-0624305) was found promising with respect to days to first fruit harvesting (80-85 DAS) which produced 3-4 marketable fruits/plant weighing 600-750 g. The TSS, rind thickness and flesh thickness was varied from 11.0-11.6%, 0.3-0.4 cm and 3.0-3.4 cm, respectively. The width of seed cavity is small 4.0-5.1 cm and flesh colour is salmon orange. The rind is netted with clear sutures (Fig. 46).

Fig. 46. A promising selection of muskmelon AHMM/BR-47

Germplasm registration

Watermelon is an important crop and being highly cross pollinated. It possess varying flesh colour *viz*., red, white, yellow and saffron having different profile of nutrients. Keeping in view, identified and homogenized a saffron flesh coloured genotype of watermelon (YF 5-2-7; IC-0633085) having high carotenoid content. YF 5-2-7 is high in carotenoid content (7.10-9.18 µg/ g FW) in comparison to popular red fleshed varieties which have 3.92-4.14 µg /g FW carotenoid content. It is characterized by non-lobed (entire) leaves, round fruits having dark green rind with very narrow stripes, saffron flesh and blackish brown seeds. YF 5-2-7 produced round fruits weighing 2.5-3 kg, rind thickness (1.0-1.3 cm), TSS (10-11%) and bear 3-4 fruits/plant. Fruits become ready for harvesting in 80-85 days after sowing. This material (YF 5-2-7) is registered with ICAR-NBPGR, New Delhi under INGR 20117 for saffron coloured flesh with high carotenoid content and non-lobed (entire) leaves (Table 53 and Fig. 47).

Fig. 47. YF-5-2-7 (IC-0633085): Saffron fleshed and non-lobed (entire) leaves pof watermelon

Table 53. Salient characteristics of YF 5-2-7 (IC-0633085)

S. No.	Trait	Description
1.	Days to first fruit harvest after sowing	80-85 days
2.	Number of fruit/ plant	3-4
3.	Fruit weight	2.5-3.0 kg
4.	Fruit diameter	14.8-18.0 cm
5.	Rind thickness	1.0-1.3 cm
6.	TSS	10.0-11.0%
7.	Carotenoid content	7.10-9.18 µg/ g FW
8.	Sex form	Monoecious
9.	Leaf shape	Non-lobed (entire)
10.	Fruit shape	Round
11.	Rind colour	Dark green with very narrow stripes
12.	Flesh colour	Saffron

Performance evaluation of watermelon

Among breeding lines developed, AHW/BR-40 continued to perform best and produced 260 q/ha marketable fruit yield with high TSS (12.10%). YF 5-2-7 having saffron flesh produced maximum carotenoid content (8.57 µg/g FW) followed by Durgapura Kesar (6.41 µg/ g FW). Maintained the seed of best performing advance lines for further utilization in breeding programme (Table 54).

Table 54. Performance of watermelon lines

Genotypes	Fruit weight (kg)	TSS (%)	Marketable fruit yield (q/ha)	Carotenoid content (µg/g FW)	Flesh colour	Rind characteristics
AHW/BR-5 (IC-0627526)	2.70	11.20	220	3.92	Red	Light green devoid of stripes
AHW/BR-37	3.10	11.00	245	3.87	Red	Green with clear stripes
AHW/BR-40	2.80	12.10	260	3.97	Red	Dark green with narrow stripes
YF 5-2-7 (IC-0633085)	2.70	10.90	248	8.57	Saffron	Dark green with very narrow stripes
Durgapura Kesar	2.60	11.00	215	6.41	Saffron	Light green devoid of stripes
Sugar Baby	2.30	11.30	205	4.19	Red	Dark green with weak stripes

Performance studies on predominant gynoecious ridge gourd

During rainy season of 2020, an advance breeding line of ridge gourd AHRG-15-4-1 was further studied based on uniqueness for several generations. The predominantly gynoecious sex form was advanced by crossing with male flowers of the same plants which appeared later at higher nodes. The absolute gynoecious sex forms which only had female flowers in clusters was also observed in some plants which were maintained by crossing with male flowers of monoecious line. The line exhibited earliness for days to first harvest of

tender fruits and potentiality for marketable fruit quality yield. Selected plants with potential trait were advanced for further evaluation and purification.

Development and evaluation of advanced lines

Bottle gourd

LS-4 x LS3-2 (round shape): The superior phenotype of cross between LS-4 x LS3-2 and advanced to F8 for homogeneity. Plants are highly vigorous with dense foliage, male and female flowers emerge from 7th and 11th nodes, respectively. Each plant produces about 24-32 female flowers and set harvestable sized fruits in 57-62 days after sowing. The fruits are round in shape, with 22.8 cm in length weighing 750 g each. Each plant produced about 12.91 kg fruits. The fruits are characterized with high TSS (8.1-8.7 ^{0}Brix) with creamy white flesh colour.

Drumstick

CHESD-40 (IC-0629352): A heavy yielder drumstick genotype with medium plant height 2.74 m, 248 pods, parrot green colour, pod weight 218 g, fruit length 45-48 cm, 9-10 seed per pod, and TSS 9.5 °Brix was evaluated under dryland semi arid conditions. The fruit length was recorded 33-42 cm at tender stage with 258.9 mg/100 g vitamin C, 0.017% acidity and 9.0 °Brix TSS. The 100 g dry leaves contains 4779.96 mg nitrogen, 173.96 mg phosphorus, 1843.12 mg potassium, 5052.12 mg calcium, 1134.17 mg magnesium, 4544.75 mg sulphur, 94.29 mg iron, 7.20 mg zinc, 32.89 mg manganese and 3.74 mg copper.

Ivy gourd

CHESIG-2 (IC:632331): It is a promising genotype having high yield potential with maximum fruit weight (29.3 g) as compared to other genotypes with identical appearance in form of attractive dark green shining colour with discontinuous strips, round oblong fruit shape without neck under the dryland semi arid conditions.

CHESIG-10 (632337): It is a unique genotype having heart shape leaf, small size lush green colour pear shape fruit with sparse white stripes, high yield potential, tolerant to drought stress for hot semi arid conditions. The plant has 1423 total number of fruits in a year. The average weight of single fruit weight was recorded 18.7 g with 26.1 kg total yield per plant.

Spine gourd

Three promising lines of spine gourd namely CHES SG1 (IC:632328), CHES SG11 (IC:632329) and CHES SG15 (IC:632330) were evaluated for their specific traits including yield potential, colour, appearance, shape of fruit. Accordingly, CHES SG1 recorded maximum yield having round shape, CHES SG11 recorded maximum fruit weight having round oblong fruit shape and CHES SG15 recorded maximum number of fruits per vine having soft seeded, feathery spine, small size conical shape fruit.

Utilization of genetic resource for crop improvement

Round melon (*Praecitrullus fistulosus)*

Breeding for high temperature tolerant and fruit quality: Two advanced breeding material of round melon (AHRM-1/2017/17-a/whitish-green-Bikaneri type series) were studies during summer and rainy season of 2020. Both the lines exhibited variations with seasons. However, good initial plant growth, flowering and fruiting was recorded in the material as rainy season crop. The progeny took 45 DAS for first marketable harvest. Based on fruit quality attributes, individuals selected and advanced.

Bottle gourd (*Lagenaria siceraria*)

Breeding for high temperature tolerant and marketable yield: During the summer season, two long fruited bottle gourd selections namely AHLS/2017/01 and AHLS/2017/02 were tested with checks (Thar Samridhi, AHLS-24 and Pusa Naveen). On average, both the selections recorded first picking at 64 days after sowing and 3.12 kg fruit yield/plant. However, these selections exhibited high temperature susceptibility and fruits were crocked. Under varietal maintenance, bottle gourd var. Thar Samridhi was taken during rainy-winter season of 2020.

Snapmelon *(Cucumis melo var. momordica)*

Varietal maintenance breeding and seed production: During summer season of 2020, snapmelon var. AHS-82 was taken for varietal

maintenance breeding and 60.5 kg seed produced and 250 farmer's benefited (Fig. 48). Snapmelon-AHS-82 technology is gaining popularity in Hanumangrah and Sri Ganganagar area. This variety is also taken by ICAR for technology assessment. The advanced breeding material of snapmelon cross AHS-10 x AHS-82 was evaluated and selections made for fruit quality characters.

Fig. 48. Field view of seed production crop of snap melon variety AHS-82 and selected fruits

Kachri (Cucumis melo var. callosus)

Varietal maintenance breeding and seed production: During rainy season, *kachri* AHK-119 was taken for varietal maintenance breeding and commercial seed production programme. The variety AHK-119 was assessed for seed quality standard traits with number of fruits/plant and yield characters adopting various bio-regulators as treatment under rainfed crop production. During report period, 30 kg seed was produced. *Kachri* AHK-119 is selected by ICAR for technology assessment.

Khejri (Prosopis cineraria)

Maintenance and evaluation: Eighteen elite genotypes collected clonally for *ex situ* conservation at ICAR-CIAH, Bikaner from the year 2001 were maintained in *khejri* germplasm plot. Variety Thar Shobha and Selection–2 were compared with reference to growth, pod yield and bio-mass production over the years under rainfed conditions. *Khejri* Selection–2 was studied for picking intervals and *sangri* yield in response to pruning. Varietal block area of Thar Shobha was maintained with good management practices under rainfed conditions and about 4,000 bud-sticks were supplied for plant multiplication.

CROP MANAGEMENT AND AGRO-TECHNIQUES

Performance of ber varieties under different training systems

Four ber varieties (Gola, Thai ber, Goma Kirti & Thar Sevika) were trained on Y shape, Espalier, Telephone and modified centre leader training system for evaluating of performance on different production aspects. Fruit yield and physiological parameters (canopy temperature and photosynthetic active radiation) of ber significantly influenced by different varieties and training systems individually. Maximum fruit yield was recorded in variety Thai ber (29.13 kg/plant & 16.20 t/ha) followed by Goma Kirti and minimum in Thar Sevika (12.88 kg/plant & 20.97 t/ha). It's probably due to difference in genetic makeup of the varieties. Among the training systems, Y shape was recorded higher fruit yield (26.14 kg/plant & 20.97 t/ha) over other systems, might be due to higher canopy coverage. PAR value below canopy was recorded on fruit set, maturity and after harvest. Maximum PAR value was noted in the espalier system (184.6-534 µmol m^{-2} s^{-1}) and minimum in control (161-445 µmol m^{-2} s^{-1}). Canopy temperature differed with season or growth stage, while variety Gola recorded minimum temperature over rest of the varieties. As far as the net photosynthetic rate (Pn) is concerned, a decreasing trend was observed from fruit set to fruit maturity stage in all the ber varieties. Maximum Pn value was recorded in variety Thar Sevika (34.24 µ mol $m^{-2}s^{-1}$) followed by Gola and minimum in Goma Kirti (18.97 µ mol $m^{-2}s^{-1}$). Among the training systems, espalier recorded minimum mean photosynthetic rate (16.49 µ mol $m^{-2}s^{-1}$) and Y shape maximum (35.74 µ mol $m^{-2}s^{-1}$) (Table 55 to 58 and Fig. 49).

Table 55. Effect training systems on fruit yield of ber varieties

Variety	Fruit yield (kg/plant)					Yield (t/ha)				
	Y Shape	Espalier	Tele-phone	Control	Mean	Y Shape	Espalier	Tele-phone	Control	Mean
Gola	22.08	19.04	19.51	18.04	19.67	12.28	10.47	10.85	10.03	10.94
Thai ber	33.14	27.47	28.63	27.28	29.13	18.42	15.27	15.92	15.17	16.20
Goma Kirti	32.80	25.80	27.70	28.39	28.67	18.24	14.34	15.40	15.78	15.94
T. Sevika	16.55	12.86	11.95	10.16	12.88	9.20	7.15	6.64	5.65	7.16
Mean	26.14	21.29	21.95	20.97		14.53	11.84	12.20	11.66	
	SEm±		CD (5%)			SEm±		CD (5%)		
V	0.44		1.26			0.24		0.70		
T	0.44		1.26			0.24		0.70		
VxT	0.88		NS			0.49		NS		

Table 56. PAR value below canopy (µmol $m^{-2}s^{-1}$) of ber varieties under different training systems

Variety	Y Shape			Espalier			Telephone			Control		
	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity
Gola	389	216	106.0	350	287	128.5	409	256	114	415	133	115
Thai ber	496	260	116.3	492	345	190	373	280	208	405	242	180
Goma Kirti	561	305	134.3	564	410	240	431	273	173.3	399	250	194
Thar Sevika	644	352	122.6	730	300	180	609	371	240.3	561	186	155
Mean	523	283	119.8	534	447	184.6	456	295	183.9	445	203	161
SEm±	6.13	5.8	3.59	12.9	13.6	15.4	18.4	18.4	36.6	19.1	7.7	8.8
CD (5%)	19.09	18.9	11.2	40.1	42.4	48.0	57.3	57.3	NS	59.5	23.7	27.4

PAR value above the canopy at different growth stages of the plant *i.e.*, after fruit harvest (March) 1503, fruiting set (Nov.) 1200 and at fruit maturity (January) 1050

Table 57. Canopy temperature (°C) of ber varieties under different training systems

Variety	Y Shape			Espalier			Telephone			Control		
	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity	After fruit harvest	Fruit set	Fruit maturity
Gola	26.6	25.1	21.2	28.8	27.8	24.7	27.2	24.5	23.6	28.0	23.2	22.6
Thai ber	28.7	22.6	21.9	30.0	26.4	24.1	29.4	25.2	22.9	29.6	24.3	22.1
Goma Kirti	30.1	23.5	21.2	29.6	27.0	22.9	30.5	26.7	23.0	30.7	25.4	21.5
Thar Sevika	29.1	27.0	24.6	31.1	27.6	25.0	30.4	26.4	22.8	30.7	22.3	21.7
Mean	28.6	24.6	22.2	29.8	27.2	24.2	29.4	25.7	23.1	29.7	23.6	22.0
SEm±	0.81	0.32	0.42	0.61	0.54	0.34	0.51	0.64	0.46	0.32	0.48	0.29
CD (5%)	NS	0.99	1.31	NS	NS	1.05	1.59	NS	NS	1.01	1.52	NS

Table 58. Net photosynthetic rate (µ mol $m^{-2}s^{-1}$) of ber varieties in different training systems

Variety	Y Shape		Espalier		Telephone		Control		Mean
	Fruit set	Fruit maturity	Fruit set	Fruit maturity	Fruit set	Fruit maturity	Fruit set	Fruit maturity	
Gola	47.0	40.9	11.1	8.9	29.3	10.98	28.8	19.01	24.66
Thai ber	30.6	30.49	27.6	9.78	16.5	12.09	17.0	18.65	20.19
Goma Kirti	24.1	25.4	19.3	12.41	17.7	8.52	28.9	8.84	18.97
Thar Sevika	46.3	41.1	36.8	6.03	45.4	31.36	40.8	25.31	34.24
Mean	35.74		16.49		21.48		23.41		
SEm+	0.04	2.53	2.85	0.09	4.08	2.05	2.18	2.53	
CD (5%)	1.36	7.71	8.67	2.70	12.43	8.64	6.63	7.72	

Fig. 49. Harvesting, handling & packaging of ber

Monthly observations of ber under different training systems after pruning

(a) May: Performed frame pruning each plant as per training systems. Maximum branch breakage was observed in Thai ber and least in Goma Kirti variety.

(b) June: Manure and fertilizer application (10 kg FYM with 100-50-50 g NPK per year per plant) through the trench method in the form of urea, DAP and MOP.

(c) July: Light or correction pruning for stimulating the side growth. Removal of water shoots. Maximum suckering habit observed in Thai ber and least in Gola.

(d) August: Espalier training system was better with growth and development of new flushes.

(e) September: Flowering in all the varieties, earliest observed in Gola followed by Thar Sevika and Goma Kirti and late in Thai ber.

(f) October: Fruit set and drop observed in all the varieties, maximum fruit drop in Thai ber and insect (stone weevil) incidence observed in Gola and least in Goma Kirti, whereas fruit rot was maximum recorded in Thai ber.

(g) November: Fruit set (marble to egg size) in all the varieties and flowering was observed in this month variety Thai ber. Fruit set in single to cluster (max. in Gola & T. Sevika) and also observed fruit drop (maximum in Thai ber) in all the varieties. Post fertilization fruit yellowing and drying was observed in variety Goma Kirti.

(h) December: In telephone training system maximum tensile load and branch breakage was observed over Y and espalier systems of training.

(i) January: Uniform and early fruit maturity were observed in variety Gola≥Thar Sevika≥Thai ber>Goma Kirti. Peak date of pickings in different varieties, when harvested maximum fruits was like Gola at first picking, Thai and Thar Sevika at second pickings and Goma Kirti (first week of March). Easy harvesting is possible in Espalier and tedious in control.

(j) February: Maximum mature fruits were damaged (birds, rodents, frost injury) in control of Thai ber due to ground touching of bearing branches or limbs breakage. Maximum fruit weight of 74 g was observed during this fruiting season in Thai ber followed by Goma Kirti and Gola (32 g).

Effect of planting density on fruit and yield attributes in Thai ber

Thai ber planted in different spacing (6 x 6 m, 6 x 3 m & 3 x 3 m) significantly influenced the yield attributes and yield. Higher density at 6 x 3 m was better with fruit retention (70.8%) and yield (62.16 kg/plot & 43.3 q/ha) over other spacings. While, 3 x 3 m spacing observed minimum fruit retention probably due to intermingling/overcrowded caused more birds and rodents damaged of over other spacings (Table 59).

Table 59. Yield parameters of Thai ber at varying spacing

Spacing	Fruit set (%)	Fruit drop (%)	Fruit retention (%)	Yield		
				kg/Plant	kg/ 144 m^2 plot	q/ha
6 x 6 m	11.5	77.5	68.4	7.00	26.64	20.0
6 x 3 m	13.0	60.4	70.8	7.73	62.16	43.3
3 x 3 m	14.2	53.7	62.2	3.69	59.04	42.2
SEm±	0.65	1.57	1.88	0.24	0.76	0.62
CD (5%)	2.01	4.89	5.64	0.71	2.26	1.86

Nutrient management in Thai ber

For nutrient management in Thai ber, the nutrient was imposed on uniformly selected ten plants of each treatment at 6 x 6 metre spacing during July. The plant received different nutritional doses as T_1-100% RDF (300 g Urea, 400 g DAP & 300 g MOP), T_2-50% RDF (150 g Urea, 200 g DAP & 150 g MOP) with 50 kg FYM, T_3-75% RDF (225 g Urea, 300 g DAP & 225 g MOP) with 25 kg FYM, T_4-100% organic as 100 kg FYM and T_5-80% RDF through water soluble fertilizers (Table 60 and Fig. 50).

The eggs were small, elongated, spindle shaped and creamy white in colour. The maggot was creamy white in color and started feeding on pulp. The adult was a small brownish yellow fly has specific brown longitudinal lines on dorsal, ventral and pleural surface of the thorax. Total life cycle of the ber fruit fly from egg to adult is 30.30 days (Table 61).

Table 60. Vegetative characteristics of selected plants for nutritional experiment

Treatments	Plant height (m)	Stem diameter (cm)	Plant spread (m)		Canopy volume (m^3)	Leaf chlorophyll (g/fw)
			EW	NS		
T_1	2.58	7.53	3.05	2.65	4.49	0.21
T_2	2.60	7.77	3.22	2.78	4.60	0.17
T_3	2.50	6.74	2.98	2.56	3.95	0.17
T_4	2.52	6.75	3.00	2.60	4.00	0.14
T_5	2.55	7.71	3.13	2.70	4.53	0.13
SEm±	0.04	0.35	0.08	0.04	0.23	0.02
CD (5%)	NS	NS	NS	0.12	NS	0.06

T_1 T_2 T_3 T_4 T_5

Fig. 50. Supplementation of fertilizer doses in Thai ber

Table 61. Biology of ber fruit fly (*Carpomoicia vesuviana*)

S. No.	Life stages	Duration in days (X±SEm)
1	Egg period	1.90±0.15
2	Maggot period	8.75±0.19
3	Pre-pupal period (hours)	4.43±0.24
4	Pupal period	8.40±0.24
5	Pre oviposition period	3.83±0.18
6	Oviposition period	7.13±0.25
7	Adult longevity	13.85±0.27
8	Total Life cycle (From egg to adult emergence)	29.95±1.13

Mean damage of fruit fly in ber cultivar Gola in arid region

The peak population of fruit fly was observed in October followed by December month and least population was recorded in the month of January (Fig. 51).

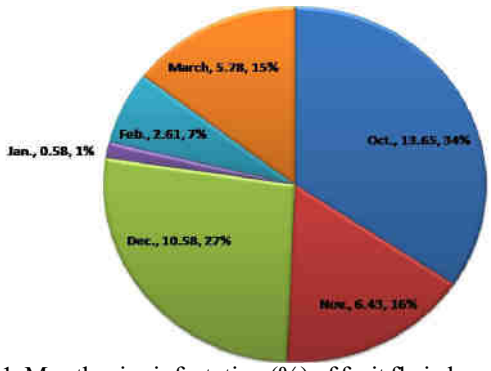


Fig 51. Month wise infestation (%) of fruit fly in ber cv. Gola

Effect of plant architectural engineering on fruit cracking and quality of pomegranate

Pomegranate plants were trained in different canopy management system of one, two and four stem training system. The branching were allowed at one and two feet height along with 10 and 20% pruning of growth during winter after fruit harvest for management of cracking and improvement of canopy, yield and quality. The experiment comprised of thirteen treatments *i.e.* T_1-Single stem branching at 1 feet + 10% pruning, T_2-Single stem branching at 1 feet + 20% pruning, T_3-Single stem branching at 2 feet + 10% pruning, T_4-Single stem branching at 2 feet + 20% pruning, T_5-Two stem branching at 1 feet + 10% pruning, T_6-Two stem branching at 1 feet + 20% pruning, T_7-Two stem branching at 2 feet + 10% pruning, T_8-Two stem branching at 2 feet + 20% pruning, T_9-Four stem branching at 1 feet + 10% pruning, T_{10}-Four stem branching at 1 feet + 20% pruning, T_{11}-Four stem branching at 2 feet + 10% pruning, T_{12}-Four stem branching at 2 feet + 20% pruning and T_{13}-Control without any training and pruning. Significant differences were observed on plant growth and yield attributes. Among all the treatment, maximum plant height (1.65 m) was recorded in T_1-Single stem branching at 1 feet + 10% pruning followed by T_2-Single stem branching at 1 feet + 20% pruning (1.59) and minimum in control (1.19 m). Canopy spread N-S and E-W found maximum (1.85 and 1.79 m) in treatment T_{10}-Four stem branching at 1 feet + 20% pruning followed by T_9-Four stem branching at 1 feet + 10% pruning (1.74 and 1.71 m) and minimum in control (1.38 and 1.31 m), respectively. Canopy volume was recorded highest (1.98 m^3) in T_9-Four stem branching at 1 feet + 10% pruning followed by T_2-Single stem branching at 1 feet + 20% pruning (1.96 m^3) as compared to minimum canopy volume recorded in T_{13}-Control without any training and pruning (1.01 m^3).

Maximum number of fruits and yield per plant (34.00 and 8.00 kg) was recorded in T_9-Four stem branching at 1 feet + 10% pruning followed by T_{10}-Four stem branching at 1 feet + 20% pruning (31.67 and 7.69 kg) and minimum number of fruits and yield per plant were found in control (15.50 and 2.80 kg), respectively. Fruit weight was ranged from minimum 180.85 g in T_{13}-Control without any training and pruning to maximum 242.68 g in T_{10}-Four stem branching at 1 feet + 20 % pruning (Table 62).

Table 62. Effect of training and pruning on growth and yield of pomegranate

Treatment	Plant height (m)	Canopy spread N-S (m)	Canopy spread E-W (m)	Canopy volume (m^3)	Number of fruits /plant	Fruit weight (g)	Yield (kg/plant)
T_1	1.65	1.40	1.43	1.75	27.89	211.07	5.89
T_2	1.59	1.51	1.54	1.96	25.50	215.79	5.50
T_3	1.55	1.22	1.17	1.17	20.50	197.15	4.04
T_4	1.51	1.34	1.26	1.35	16.67	205.18	3.42
T_5	1.49	1.65	1.59	1.91	30.50	220.18	6.72
T_6	1.45	1.72	1.64	1.87	27.67	225.46	6.24
T_7	1.38	1.45	1.42	1.45	23.50	215.60	5.07
T_8	1.32	1.53	1.48	1.39	19.00	219.10	4.16
T_9	1.47	1.74	1.71	1.98	34.00	235.30	8.00
T_{10}	1.41	1.85	1.79	1.92	31.67	242.68	7.69
T_{11}	1.38	1.62	1.59	1.62	29.33	228.50	6.70
T_{12}	1.33	1.71	1.67	1.58	26.50	231.70	6.14
T_{13}	1.19	1.38	1.31	1.01	15.50	180.85	2.80
CD (5%)	0.08	0.11	0.09	0.06	0.94	3.65	0.86

Flower regulation and identification of suitable *bahar* in pomegranate under hot arid condition

In pomegranate, plants were subjected to flower regulation treatment *i.e.* withholding of irrigation for one month prior to *bahar* and 2 ml/l ethrel (40%) application for defoliation in different bahar/first bahar for standardized flower regulation treatment to reduce cracking and improve yield. There were ten treatment combinations including T_1-*Ambe bahar* (January-February), T_2-Late *ambe bahar* (March-April), T_3-*Mrig bahar* (June-August), T_4-*Hasta bahar* (September-October), T_5- *Ambe* + *Mrig bahar*, T_6-*Ambe* + *Hasta bahar*, T_7-Late *ambe* + *Hasta bahar*, T_8-*Mrig* + *Hasta bahar,* T_9-*Ambe* + *Mrig* + *Hasta bahar* and Control (Natural flowering). Among all the treatments, maximum number of fruits per plant were observed in T_8-*Mrig* + *Hasta bahar* (40.50), followed by T_3-*Mrig bahar* (37.30) and T_4-*Hasta bahar* (35.12) as compared to minimum in control T_{10} (19.25) treatment. Among all the treatments, maximum fruits yield per plant were observed in T_3-*Mrig bahar* (9.00 kg) followed by T_4-*Hasta bahar* (8.97 kg) as compared to minimum in control T_{10} (3.28 kg).

Fruit cracking was varied significantly among different flower regulations treatments. The minimum fruit cracking was observed in T_4-*Hasta bahar* (10.05%) followed by T_8- *Mrig* + *Hasta bahar* (12.25) while maximum fruit cracking was observed in control (27.50%). Fruit juice TSS and maturity index were observed maximum (16.25 °Brix and 45.52) in T_4-*Hasta bahar* followed by T_8-*Mrig* + *Hasta bahar* (15.74 °Brix and 42.54) as against minimum TSS and maturity index recorded in T_1-*Ambe bahar* (12.20 °Brix and 20.44), respectively. Aril colour was varied from light pink to dark red while rind colour varied from light red, red to dark red among different flower regulation treatments (Table 63 & 64).

Table 63. Effect of flower regulation treatments on yield attributes of pomegranate

Treat-ment	Number of fruits/plant	Fruit dia. (cm)	Fruit weight (g)	Fruit set (%)	Fruit yield (kg/plant)	Fruit cracking (%)
T_1	23.18	6.01	190.42	20.25	4.41	18.97
T_2	30.67	6.25	200.90	21.54	6.16	20.25
T_3	37.30	7.09	241.18	23.68	9.00	16.15
T_4	35.12	7.15	255.30	22.15	8.97	10.05
T_5	26.50	5.98	180.12	21.25	4.77	16.22
T_6	30.25	6.05	188.67	20.38	5.71	18.36
T_7	20.33	6.11	198.70	20.47	4.04	15.30
T_8	40.50	6.12	195.15	22.12	7.90	12.25
T_9	31.17	5.57	176.10	19.58	5.49	19.67
T_{10}	19.25	5.50	170.18	19.10	3.28	27.50
CD (5%)	3.22	0.27	6.78	0.37	0.84	2.03

Table 64. Effect of flower regulation treatments on fruit quality of pomegranate

Treatments	TSS (°Brix)	Acidity (%)	Maturity index	Aril colour	Rind colour
T_1	12.20	0.597	20.44	Light pink	Light red
T_2	13.04	0.496	26.29	Light pink	Light red
T_3	15.50	0.382	40.58	Dark red	Dark red
T_4	16.25	0.357	45.52	Dark red	Red
T_5	13.40	0.491	27.29	Light pink & dark red	Light red & dark red
T_6	13.61	0.470	28.96	Light pink & dark red	Light red & red
T_7	13.87	0.428	32.41	Light pink & dark red	Light red & red
T_8	15.74	0.370	42.54	Dark red	Dark red & red
T_9	14.33	0.440	32.57	Light pink & dark red	Light red, red & dark red
T_{10}	12.75	0.510	25.00	Light pink & dark red	Light red, red & dark red
CD (5%)	0.49	0.032	2.02	-	-

Response of date palm cultivar to pollen sources, pollen quality, quantity and suitability under hot arid ecosystem

The healthy, nearly uniform and vigoured four male date palm trees were selected for the study by applying commonly adopted cultural practices in the orchard. Male plants (Ghanami, M1 and M3) were available in field repository and Al-Ain City male was collected from mechanized agriculture state government farm Khara, Bikaner, Rajasthan. The mature male spathes were cut off from tree at spathe cracking stage. The harvested male spathes pollen grains were collected on the clean plastic silpaulin sheet and air dried for 3-4 h. All four selected female (Halawy, Khalash, Barhee and Medzool) tree spathes were pollinated directly with four male by hand pollination. For pollination used the dry pollen grains and dusting with help of cotton plug followed by placed the same cotton plug within the strands of the female spathe. Each spathe was pollinated with an equal amount of pollen grains. The number of days was counted from spathe emergence to opening of male (Ghanami, Al-Ain City M1 and M3) plants, it takes around 29.4 to 37.6 days. The maximum spathe length (50.4 cm), width (17.2 cm), number of spath per plant (27.4), number of strands (172.6), weight of pollen per spath (23.8 g) and pollen yield per plant (667 g) were recorded under the male M1. The remaining pollen grains were stored at refrigerator (4 ^{0}C), deep freezer (-20 °C), ultra deep freezer (-80 °C) and ambient room temperature in sealed air tight vials for assessing the viability of fresh and stored pollen for pollination (Table 65 & 66 and Fig. 52).

Table 65. Flowering parameters of various male date palms

Varieties/elite male	Date of spathe emergence	Date of spathe opening	Days taken for opening	Length of spathe (cm)	Width of spathe (cm)
CIAH/DP/ M01	26-01-2020	02-03-2020	36.4	50.4	17.2
Al-Ain City	27-01-2020	04-03-2020	37.6	36.6	11.2
CIAH/DP/ M03	31-01-2020	25-03-2020	29.4	31.8	14.4
Ghanami	07-02-2020	28-03-2020	32.8	19.4	10.8
SEm±			1.80	1.56	1.08
CD (5%)			5.62	4.86	3.37

Table 66. Yield attributing parameters of various male date palms

Varieties/elite male	No. of spathe/plant	Number of strands/spathe	Weight of pollen/ spathe (g)	Yield of pollen/plant (g)
CIAH/DP/ M01	27.4	172.6	23.8	667
Al-Ain City	20.2	144.4	14.0	288
CIAH/DP/ M03	17.4	145.2	13.8	237
Ghanami	15.4	127.2	12.6	199
SEm±	1.83	7.46	1.17	56.17
CD (5%)	5.71	23.25	3.65	175.01

CIAH/DP/ M01 CIAH/DP/ M03 Ghanami Al-Ain City

Fig. 52. Spathe of male genotypes

The spathe emergence in the date palm female varieties takes place during January to March in western Rajasthan condition but during the years due to climatic influence, it was observed delay about one month as compared to normal period. The spathe of female date palm emerged from the axil of the leaves. The flowering parameters of four female (Halawy, Khalash, Barhee and Medzool) varieties were recorded before pollination by various males (Ghanami, Al-Ain City, M1 and M3). Among the varieties spathe emergence to opening period was ranges 16 to 29 days. The maximum spathe length and width was observed in variety Barhee (39.6 x 8.8 cm), but number of buds per strand (34.4) and length of strands (36.2 cm) were observed in varieties Halawy, Khalash, Barhee and Medjool (Table 67 to 70 and Fig. 53).

Table 67. Flowering parameters of CIAH/DP/M01 date palm cultivar

Varieties	Spathe emergence	Spathe opening	Date of pollination	Length of spathe (cm)	Width of spathe (cm)	No. of buds	Length of strand (cm)
Halawy	04.03.20	20.03.20	21.03.20	29.8	7.0	30.6	27.8
Khalas	02.03.20	19.03.20	19.03.20	31.6	6.8	33.6	36.1
Barhee	27.02.20	21.03.20	22.03.20	39.6	8.2	31.6	32.6
Medzool	02.03.20	20.03.20	21.03.20	27.8	6.4	25.6	27.1
SEm±				2.76	0.38	1.11	0.58
CD (5%)				8.62	1.20	3.48	1.80

Table 68. Flowering parameters of CIAH/DP/M03 date palm cultivar

Varieties	Spathe emergence	Spathe opening	Date of pollination	Length of spathe (cm)	Width of spathe (cm)	No. of Buds	Length of strand (cm)
Halawy	02.03.20	23.03.20	23.03.20	29.4	7.4	30.2	27.2
Khalas	04.03.20	22.03.20	23.03.20	32.0	7.2	34.6	35.7
Barhee	25.02.20	20.03.20	21.03.20	39.2	8.6	32.0	32.4
Medzool	28.02.20	21.03.20	21.03.20	28.2	6.8	25.4	27.6
SEm±				2.52	0.38	0..83	0.85
CD (5%)				7.87	1.20	2.60	2.67

Table 69. Flowering parameters of Ghanami date palm cultivar

Varieties	Spathe emergence	Spathe opening	Date of pollination	Length of spathe (cm)	Width of spathe (cm)	No. of buds	Length of strand (cm)
Halawy	29.02.20	07.03.20	07.03.20	30.0	7.4	29.8	28.0
Khalas	8.03.20	25.03.20	25.03.20	31.8	6.8	32.8	35.8
Barhee	02.03.20	19.03.20	19.03.20	39.4	8.8	31.0	32.4
Medzool	29.02.20	23.03.20	23.03.20	27.8	6.4	25.0	27.6
SEm±				2.61	0.50	1.24	0.80
CD (5%)				8.13	1.56	3.87	2.48

Table 70. Flowering parameters of Al-Ain City date palm cultivar

Varieties	Spathe emergence	Spathe opening	Date of pollination	Length of spathe (cm)	Width of spathe (cm)	No. of buds	Length of strand (cm)
Halawy	27.02.20	04.03.20	04.03.20	29.6	6.8	31.0	28.1
Khalas	4.03.20	20.03.20	25.03.20	32.2	7.0	33.2	36.2
Barhee	05.03.20	22.03.20	22.03.20	39.6	8.4	31.2	32.4
Medzool	26.02.20	25.03.20	25.03.20	27.8	6.6	26.0	27.6
SEm±				2.51	0.42	1.08	0.89
CD (5%)				7.84	1.30	3.36	2.77

Fig. 53. Developmental stages of female date palm spathe

Studies of compatibility and adaptability of Kinnow, sweet orange, lime and lemon scions on different rootstock

In different citrus species, to study the compatibility and adaptability in rootstocks and scion, various combinations (forty two) of scions and rootstocks were made and planted in the field as Kinnow, sweet orange cv. Mosambi and Satgudi were grafted on Pectinifera, Karna Khatta, Rangpur lime, Volkamericana, Rough lemon, Cleopatra, Macrophylla, Sour orange and Carrizo rootstocks; lime (Sai Sarbati and Kagzi lime) and lemon cv. Pant lemon was grafted on Karna Khatta, Rangpur lime, Volkamericana, Rough lemon and Macrophylla rootstocks. All the combinations were transplanted in the field and growing well. The compatibility and adaptability parameters were recorded under field condition.

Studies of compatibility and adaptability of sweet orange cv. Mosambi scions on different rootstocks of citrus

Different rootstocks significantly influenced compatibility index of sweet orange cv. Mosambi under hot arid climatic condition. Maximum plant height of sweet orange was registered (68.33 cm) on Rangpur lime rootstock followed by Karna Khatta (65.11 cm) whereas minimum plant height was recorded in Pectinifera (32.05 cm). Maximum canopy spread (E-W & N-S) was registered (60.17 and 61.74 cm) on Rangpur lime rootstock followed by Karna Khatta (55.64 and 58.09 cm) while minimum canopy spread (EW & NS) was recorded in Pectinifera (28.25 and 28.16 cm), respectively. The highest scion rootstock (SR) ratio was recorded on Karna Khatta (0.95) rootstock followed by Volkameriana (0.92) as compared to minimum recorded on sour orange (0.80) rootstock (Table 71).

Table 71. Effect of rootstocks on growth and compatibility of sweet orange cv. Mosambi

Rootstocks	Plant height (cm)	Canopy spread (E-W) (cm)	Canopy spread (N-S) (cm)	Rootstock diameter (mm)	Scion diameter (mm)	SR ratio
Pectinifera	32.05	28.25	28.16	7.05	6.29	0.89
Karna Khatta	65.11	55.64	58.09	15.47	14.68	0.95
Rangpur lime	68.33	60.17	61.74	12.23	10.15	0.83
Volkameriana	60.36	53.14	57.93	14.51	13.38	0.92
Rough lemon	53.29	41.62	45.37	13.47	11.85	0.88
Cleopatra	41.23	33.54	36.12	12.65	10.37	0.82
Macrophylla	44.38	40.18	34.70	9.08	7.89	0.87
Sour orange	32.85	30.07	28.47	6.81	5.45	0.80
CD (5%)	3.21	4.39	4.08	0.32	0.39	0.02

Studies of compatibility and adaptability of sweet orange cv. Satgudi scions on different rootstocks of citrus

Vegetative growth and compatibility index of sweet orange cv. Satgudi were significantly influenced by different rootstocks under hot arid climatic condition. Maximum plant height of sweet orange was registered (59.34 cm) on Volkameriana rootstock followed by Karna Khatta (55.85 cm) and minimum plant height was recorded in Pectinifera (28.33 cm). Maximum canopy spread (E-W and N-S) was registered (49.52 and 52.08 cm) on Volkameriana rootstock followed by Karna Khatta (48.31 and 46.14 cm) while minimum canopy spread (E-W and N-S) was recorded in Pectinifera (25.71 and 26.38 cm), respectively. The highest scion rootstock (SR) ratio was recorded on Rough lemon (0.95) rootstock followed by Macrophylla (0.91) as compared to minimum recorded on Rangpur lime (0.74) rootstock (Table 72).

Table 72. Effect of rootstocks on growth and compatibility of Sweet orange cv. Satgudi

Rootstocks	Plant height (cm)	Canopy spread (E-W) (cm)	Canopy spread (N-S) (cm)	Rootstock dia. (mm)	Scion dia. (mm)	SR ratio
Pectinifera	28.33	25.71	26.38	7.32	6.11	0.83
Karna Khatta	55.85	48.31	46.14	12.31	10.61	0.86
Rangpur lime	52.32	45.32	40.18	16.51	12.18	0.74
Volkameriana	59.34	49.52	52.08	14.33	12.57	0.88
Rough lemon	45.69	40.31	39.84	13.18	12.48	0.95
Cleopatra	42.38	35.67	33.68	14.87	11.82	0.79
Macrophylla	50.11	44.07	40.55	15.28	13.96	0.91
Sour orange	38.59	33.51	35.99	15.33	12.39	0.81
CD (5%)	3.05	4.11	3.48	0.42	0.49	0.03

Studies of compatibility and adaptability of lemon cv. Pant lemon scions on different rootstocks of citrus

Compatibility index of lemon cv. Pant lemon was significantly influenced by different rootstocks under hot arid climatic condition. Maximum plant height of lemon was registered (72.34 cm) on Volkameriana rootstock followed by Karna Khatta (60.38 cm) and minimum plant height was recorded in Macrophylla (34.25 cm). Maximum canopy spread (E-W and N-S) was registered (68.53 and 64.24 cm) on Volkameriana rootstock followed by Karna Khatta (58.64 and 55.32 cm) while minimum canopy spread (E-W and N-S) was recorded on Macrophylla (30.18 and 29.51 cm), respectively. The highest scion rootstock (SR) ratio was recorded on Rangpur lime (0.92) rootstock followed by Rough lemon (0.89) as compared to minimum recorded on Karna Khatta (0.80) rootstock (Table 73).

Table 73. Effect of rootstocks on growth and compatibility of lemon cv. Pant lemon

Rootstocks	Plant height (cm)	Canopy spread (E-W) (cm)	Canopy spread (N-S) (cm)	Rootstock dia. (mm)	Scion dia. (mm)	SR ratio
Karna Khatta	60.38	58.64	55.32	25.32	20.18	0.80
Rangpur lime	42.84	36.27	39.08	14.09	12.95	0.92
Volkameriana	72.34	68.53	64.24	18.34	16.21	0.88
Rough lemon	37.18	35.41	37.83	12.47	11.08	0.89
Macrophylla	34.25	30.18	29.51	9.35	8.17	0.87
Sour orange	42.31	40.87	37.19	14.35	11.59	0.81
CD (5%)	3.15	3.68	2.57	0.29	0.38	0.02

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

Phenophases of jamun crop occurred at different calendar dates namely panicle emergence on 7 February, flowering on 3 March, fruit set on 5 May and harvesting on 1 July. Unseasonal rain at flowering and fruit set was observed during the reporting year. Weather parameters like temperature, wind velocity and evapo-transpiration gradually increased with the advances of the phenophases from panicle emergence to fruit maturity. Agro meteorological indices of jamun crop were calculated from flowering to fruit maturity, these were heat unit (2450 °C), heat use efficiency (1.0 kg/plant degree days), photo thermal (30.6 ^{0}C) and nycto temperature (25.6 °C). Fruit yield positively correlated to relative humidity and rainfall while, negatively with temperature, wind velocity, sunshine hours and evapo-transpiration (Table 74 to 77).

Table 74. Time of different phenophases in jamun

S. No.	Phenophases	Month /value
1	Panicle emergence	7 February
2	Flowering initiation	3 March
3	End of bloom	1 May
4	Fruit set initiation	5 May
5	Harvest starts	1 July
6	End of Harvesting	27 July
7	Flowering span	25 February -27 April (61 days)
8	Fruiting span	5 May-1 July (57 days)
9	Harvesting span	1July-27 July (28 days)
10	Weather aberration and plant yield	Unseasonal rainfall 6, 11 & 27 March and 20 April, 2020 and yielded 27.5 kg/tree congenial during flowering & fruiting

Table 75. Phenophases wise weather parameters of jamun

Weather parameters	Phenophases						
	Pre flowering	Panicle emergence	Full bloom	Flowering span	Fruit development	Fruit set to maturity span	Harvesting span
Mean temperature (^{0}C)	13.99	15.61	26.42	28.72	34.9	35.43	34.95
Mean RH (%)	61.06	60.63	67.03	76.79	69.58	64.64	79.75
Wind velocity (km/h)	3.46	4.9	5.65	5.94	8.08	8.06	10.32
Sun shine hours	6.62	7.44	5.04	9.67	10.17	10.66	8.49
Total rainfall (mm)	2.7	0	32.8	32.8	21.8	9	12.8
Evapo-transpiration (mm)	2.84	3.84	7.76	8.9	12.15	13.26	10.04

Table 76. Yearly and average utilized heat unit from flowering to fruit maturity

Agro-meteorological indices	Unit	Years 2020
Heat unit (HU)	°C day	2449.85 (over 10 °C) 1784.35 (over 15.5 °C)
Heat use efficiency (HUE)	kg plant^{-1} °C day	0.89-1.25
Heliothermal unit (HTU)	°C day hours	22212.87 (over 10 °C) 16302.02 (15.5 °C)
Hydrothermal unit (HYTU)	°C day %	108430 (over 10 °C) 78213 (15.5 °C)
Hydrothermal use efficiency (HYTUE)	kg plant^{-1} °C %	0.01-0.02
Photothermal temperature (PHT)	°C day	3709 (mean 30.6 °C)
Nyctotemperature (NCT)	°C day	3142 (mean 25.6 °C)

Table 77. Correlation of fruit yield with weather parameters

Weather parameters							
T max (°C)	T min (°C)	RH-1 (%)	RH-II (%)	WV (km/h)	SSH (h)	RF (mm)	Evapo (mm)
-0.08	-0.10	0.36	0.10	-0.18	-0.16	0.27	-0.16

Development of new block of lasoda cv. Thar Bold

A new block of lasoda variety Thar Bold was developed by planting of 6 x 6 m distance. The plant survival was 100% in the field. Budded plants of cultivar Thar Bold along with one row of seedling plants of same cultivar, one row (6 budded plants) of elite type (AHCM/KK/SMH 19) colected from Sikar, one row of elite type (AHCM/KK LP 9) and one row AHCM 22 genotypes were transplanted in the field for evaluation of vegetative growth, flowering and fruiting related attributes. The plants were covered with white polyethylene

sheet having 3-4 holes for protecting from winter frost. All plants of lasoda (Thar Bold and other genotypes) suffered badly in the field due to frost during December month; leaves and tender upper twigs were dried while mature branches and stem were in good condition.

Effect of plant growth regulator and chemicals on fruit drops and sun scald in bael

Among the various treatments combination (grass mulch + NAA 15 ppm + coarse cotton cloth, grass mulch + NAA 15 ppm + kaolin 1% , grass mulch + NAA 15 ppm + ascorbic acid 1000 ppm, grass mulch + NAA 15 ppm + KH_2PO_4 500 ppm, grass mulch + Zn SO_4 1000 ppm + coarse cotton cloth, grass mulch + Zn SO_4 1000 ppm + kaolin 1%, grass mulch + Zn SO_4 1000 ppm + KH_2PO_4 500 ppm, grass mulch + Zn SO_4 1000 ppm + ascorbic acid 1000 ppm and control) to control fruit drop and sunscald, minimum fruit drop (94.27%) and sun scald (19.00%) and the highest fruit retention (5.15%) were recorded with grass mulch + NAA (15 ppm) + course cotton cloth followed by grass mulch + NAA (15 ppm) + ascorbic acid (96.00, 27.34 and 4.00%) and grass mulch + Zn SO_4 (1000 ppm) + coarse cotton cloths (96.50, 26.00 and 3.18), whereas fruit drop and sunscald affected fruits were recorded maximum in control (98.62% and 47.20%) while fruit retention was also recorded minimum (1.97%) in control (Table 78).

Table 78. Effect of PGR, chemicals and fruit cover on sun scald and fruit drop in bael

Treatments	Fruit drop (%)	Fruit retention (%)	Sun scald affected fruits (%)	Fruit weight (kg)	TSS (°Brix)	Acidity (%)	Yield (kg/ plant)
Grass mulch + NAA (15 ppm) + coarse cotton cloth	94.27	5.15	19.00	1.45	37.45	0.28	60.57
Grass mulch + NAA (15 ppm) + kaolin (1%)	98.67	2.52	32.20	1.40	37.23	0.29	50.20
Grass mulch + NAA (15 ppm) + ascorbic acid (1000 ppm)	96.50	3.18	26.00	1.42	36.87	0.31	55.60
Grass mulch + NAA (15 ppm) + KH_2PO_4 (500 ppm)	97.00	2.87	25.12	1.40	36.00	0.30	51.40
Grass mulch + Zn SO_4 (1000 ppm) + coarse cotton cloth	96.30	2.78	26.00	1.44	36.65	0.28	54.64
Grass mul ch + Zn SO_4 (1000 ppm) + kaolin (1%)	97.80	2.13	27.24	1.43	36.00	0.31	51.79
Grass mulch + Zn SO_4 (1000 ppm) + KH_2PO_4 (500 ppm)	97.70	2.10	28.17	1.43	37.00	0.32	50.70
Grass mulch + Zn SO_4 (1000 ppm) + ascorbic acid (1000 ppm)	97.23	2.42	37.12	1.45	35.69	0.30	52.10
Control	98.62	1.97	47.20	1.50	37.00	0.31	42.60
CD (5%)	3.23	0.25	0.26	0.13	2.41	0.02	5.62

Efficacy of canopy management on growth, yield and quality of bael (Goma Yashi)

Various pruning treatments were imposed during 2019, observations related to growth, flowering and fruiting were recorded. The maximum number of shoots (3.65) was recorded with treatment T_3 (3 m plant height + 25 per cent Annual Growth Extension (AGE). However the length of shoot (44.67 cm) was recorded maximum in T_5 (3 m plant height + 50

per cent AGE). Average yield per plant was recorded highest with 3 m plant height + 25% AGE (68.59 kg) followed by 2.5 m plant height + 25% AGE (65.50 kg), whereas the lowest yield per plant was observed with 2.5 m height + 75% AGE among the different combination of plant height and pruning intensity. Fruit size and TSS was recorded maximum in the plants height maintained at 3 m which were pruned at 25 per cent AGE (Table 79 and Fig. 54 & 55).

Table 79. Efficacy of canopy management on growth, yield and quality of bael

Treatments	Plant spread (m)	No. of shoots	Length of shoots (cm)	Fruit retention (no.)	Fruit weight (kg)	Yield kg/tree	TSS (^{0}Brix)	Acidity (%)
T1- 2.5 m plant height + 25% AGE	3.76	3.15	45.30	38.23	1.42	65.50	36.24	0.29
T2- 2.5 m plant height + 50% AGE	3.55	3.53	47.00	35.25	1.45	51.25	36.94	0.27
T3- 2.5 m plant height + 75% AGE	3.40	2.10	45.49	30.31	1.42	47.20	36.53	0.28
T4- 3 m plant height + 25% AGE	4.10	3.90	40.23	42.10	1.40	61.19	37.12	0.30
T5- 3 m plant height + 50% AGE	3.60	2.67	49.27	39.05	1.41	55.27	37.00	0.29
T6 3 m plant height + 75% AGE	3.65	2.25	46.30	32.75	1.40	68.59	36.87	0.30
CD (5%)	0.33	0.22	0.41	0.31	NS	5.49	N S	N S

Fig. 54. Field view of canopy management in bael cv. Goma Yashi

Fig. 55. Bud emergence after pruning

Dynamics of productivity and economics of Goma Yashi bael under high density

Based on potentiality of Goma Yashi bael, a field trial on high density planting (5 m x 5 m), accommodating 400 plants/ha was initiated in 2007 to find out its efficacy to maximize the yield per unit area. *Deshi* rootstock were sown directly on the field and *in-situ* patch budding was performed from the scion shoot of single mother plant of Goma Yashi variety in 2008. Uniform cultural practices were performed in all the plants. Fruit setting started from 2nd year, but economic yield was harvested after 5th year of budding under rainfed semi-arid conditions. Results of study revealed that the fruit setting fruit retention showed linear increase as the age of tree progressed. However, after 8th year canopy management is required for proper aeration, light interception and proper intercultural operations in the orchard. Bael tree respond to pruning well for which pruning (25 per cent of AGE) during May, when the plants were in leafless condition, was performed uniformly to

all the tree 9th and 10th year, which help in maintaining the proper canopy and improving the fruit quality. The yield per plant was recorded 0.57 kg (2nd year) to 59.27 kg (10th year) and yield per ha was recorded 2.28 q/ha (second year) to 237.28 (10th year) under rainfed semi-arid condition (Fig. 56). For calculating the economics, the total yield was calculated Rs. 10/kg to find out the gross income. Gross income Rs.10/kg fruit was obtained Rs. 2280.00 (2nd year) and Rs. 237080.00 (10th year) under rainfed semi-arid conditions (Fig. 57). Net profit of Rs. 187080.00 was observed under rainfed semi-arid conditions of western India.

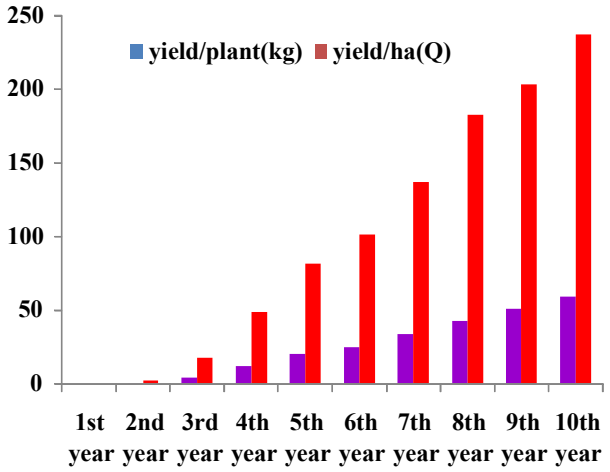


Fig. 56. Yield increment in Goma Yashi under semi-arid condition

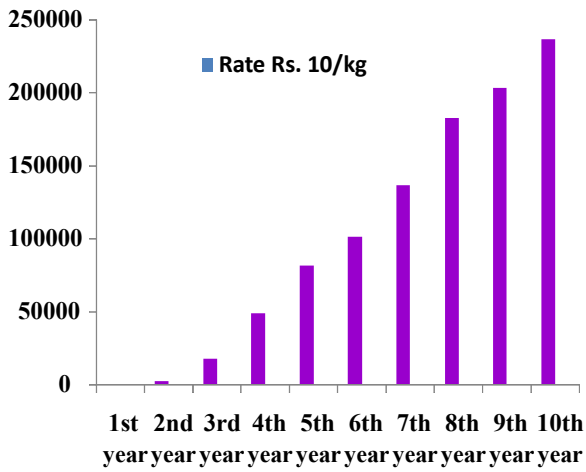


Fig. 57. Gross income of Goma Yashi (Rs/ha)

Effect of mulching and integrated nutrient management on growth and yield of bael

Among different combination of mulches, biofertilizer and fertilizer, plant height (3.91 m) was recorded maximum in standard dose of NPK followed by grass mulch + FYM + neem cake + 50% recommended dose of NPK + *Azotobactor* + VAM culture; grass mulch + FYM + 25% recommended dose of NPK + *Azotobactor* + PSB culture; and it was recorded minimum in FYM (20 kg/plant, whereas plant spread (3.87 m), stem girth (30.65) and number of fruit retention (5.23 fruits/plant) was also recorded maximum with grass mulch + FYM + neem cake + 50% recommended dose of NPK + *Azotobactor* + VAM culture under rainfed semi-arid conditions (Table 80).

Table 80. Effect of manures, bio-fertilizers and fertilizers on bael cv. Goma Yashi

Treatments	Plant height (m)	Plant spread (m)	Stem girth (cm)	Yield/ plant (kg)	Fruit weight (kg)	TSS (°Brix)	Acidity (%)
Standard dose of NPK	3.91	3.85	24.00	08.00	1.42	36.50	0.32
FYM (5 kg/plant) increase 5 kg every year up to 10 years	3.40	3.55	25.17	09.19	1.40	37.50	0.30
Grass mulch + FYM + 50% recommended dose of NPK+ *Azotobactor* + PSB culture	3.78	3.70	27.17	10.24	1.41	36.75	0.34
Grass mulch + FYM + 25% recommended dose of NPK + *Azotobactor* + PSB culture	3.81	3.65	28.83	09.15	1.43	37.00	0.31
Grass mulch + FYM + neem cake + 50% recommended dose of NPK + *Azotobactor* + VAM culture	3.87	3.87	30.65	15.23	1.44	37.50	0.32

Treatments	Plant height (m)	Plant spread (m)	Stem girth (cm)	Yield/ plant (kg)	Fruit weight (kg)	TSS (°Brix)	Acidity (%)
Grass mulch + FYM + neem cake + 25% recommended dose of NPK + *Azotobactor* + VAM culture	3.97	3.80	28.20	13.67		37.75	0.31
Grass mulch + FYM + neem cake + *Azotobactor* + PSB + VAM culture	3.50	3.60	25.60	12.27	1.41	38.00	0.30
CD (5%)	0.31	0.22	2.03	0.91	NS	N S	NS

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

Effect of pruning on plant growth, flowering and fruit quality of mango cv. Kesar

For conducting the pruning trial in mango, planting of 200 plants of Kesar mango under high density (5 x 5 m) has been done in 0.5 ha area. Treatments were imposed after harvesting of the fruits. Maximum fruit yield (42.10 kg/plant), TSS (20.20^{0}Brix) was recorded in 3.60 m plant height + 25% AGE. Fruit yield was recorded minimum in control (26.40 kg/plant).

Effect of rootstocks on growth, yield and fruit quality of sweet orange cv. Satgudi

Experiment has been conducted on 4 rootstocks *i.e.* Rangpur lime, Rough lemon, Cleopatra mandarin, Carizzo citrange. Satgudi was used as scion variety. Maximum plant growth and root stock girth was recorded in Rangpur lime closely followed by Rough lemon. Highest fruit yield was also recorded in Rangpur lime. TSS and juice content was also found highest in Rangpur lime (Table 81).

Table 81. Effect of rootstocks on fruit yield and quality of sweet orange cv. Satgudi

Treatments	Yield (kg/plant)	Fruit weight (g)	Juice (%)	TSS (°Brix)	Acidity (%)	Total sugar (%)	Vitamin C (mg/100 g)
Rangpur lime	15.20	170.40	43.18	12.34	1.39	5.80	59.93
Rough lemon	9.20	160.70	39.40	11.25	1.46	5.60	52.40
Cleopatra mandarin	8.20	155.30	38.10	11.15	1.45	5.50	51.10
Carizzo Citrange	7.20	152.40	37.12	11.10	1.47	5.20	49.40
CD (5%)	0.91	2.11	1.10	0.10	0.02	0.11	0.44

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

Standardization of pit size for plant growth

Maximum plant height (325 cm) was recorded in Khalas and Barhee cultivar with 1 x 1 x 1 m pit size while minimum plant height (150 cm) in Khuneizi cultivar with 0.5 x 0.5 x 0.5 m pit size. The maximum leaf emergence was recorded in cultivar Barhee and Khalas cultivar in the bigger size pit while minimum leaves were emerged in cultivar Khuneizi with small pit size and same trend was also recorded in plant spread. In cultivar Khalas, 28% plants have been flowered and first emergence was observed on 10 March, 2020 and last spathe emergence was recorded on 20 March, 2020. In Barhee and Medjool cultivars, only 20% plants have been flowered first time. In Barhee, first emergence was recorded on 20 March, 2020 and in Medjool flowering started on 28 March, 2020. The Ghanami cultivar (male) spathe emerged on 10 March, 2020 and pollens were collected and used for pollination in all female cultivars. Fruiting in some plants have been set during the report period. The effect of pit size was recorded only on the growth performance while on reproductive phase pit size did not show any effect on emergence of spathe. 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 6 m and 8 x 8 m were not been observed and survival, plant height and spread were not differed significantly in both the spacing.

Standardization of crop geometry

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 6 m and 8 x 8 m have been recorded and observed that in 6 m spaced side difference between canopy was in the range of 1.5-2.0 m while in 8 m spaced difference between canopy was in the range of 3.25-4.0 m in different cultivars. In cultivar Khalas and Barhee cultivars, 8-10 new leaves were emerged while in Medjool, it was 6-8 and minimum leave emergence *i.e.* 3-4 was in Khuneizi cultivar. In cultivar Khalas, Barhee and Medjool, 8-10, 2-3 and 5-6 suckers were emerged, respectively while in Khuneizi 1-2 suckers were emerged. In Khalas and Barhee in some plants spathe has been emerged in the month of March. In Khalas, 25% plants spathe emerged in the 3rd week of February while in Barhee 18% plants spathe emerged in last week of March while in Medjool, 15% plants spathe emerged on 7-10 March. Among all the cultivars, the overall performance was graded as >Khalas > Barhee > Medjool > Khuneizi (Table 82).

Table 82. Growth parameters of different tissue cultured varieties of date palm

Varieties	Plant height (cm)	East x West (cm)	North x South (cm)	No. of leaves	No. of spathe	No. of strand	Number of fruit per strand at pea stage
Khalash	325	270	250	17.5	3.5	10.5	10.0
Bharhee	275	245	240	17.6	2.5	10.2	12.5
Medzool	210	260	270	16.8	2.0	8.5	8.0
Khunezi	150	115	125	10.4	0	0	--

Evaluation of fruit based diversified cropping models for arid region

The experiment comprises of eight different cropping models *viz*., aonla-ber-cluster bean-fennel (M-1), aonla-bael-cluster bean-coriander (M-2), aonla-*khejri*-cluster bean-ajowain (M-3), aonla-drumstick-custer bean-dill (M-4), aonla-*khejri*-grass (*L. sindicus*) (M-5), aonla-Mosambi-cluster bean-*mateera* (M-6), aonla-Kinnow-cluster bean-chickpea (M-7) and aonla-mulberry-*kachri*-mustard (M-8). Observations on growth and development was recorded in already 11 year old established plants of aonla, ber, bael, *khejri* and drumstick grown in association with aonla in the different cropping models. Ground storey crops were sown as per the treatments during *kharif* and *rabi* season. Higher plant height of aonla was found in sole aonla (5.0 m) followed by aonla ber (4.3 m) while minimum plant height of aonla in aonla + karonda (3.3 m) followed by aonla + moringa (3.6). Maximum plant girth of aonla was recorded in aonla + ber (50.6 cm) cropping system followed by aonla + bael (45.4 cm) aonla + *khejri* (43.3 cm) and while minimum plant girth was observed in sole aonla (36.9 cm) (Fig. 58 & 59).

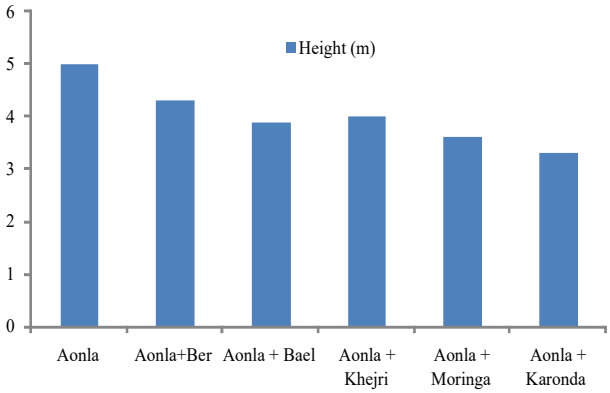


Fig.58. Plant height in different fruit based diversified cropping models for arid region

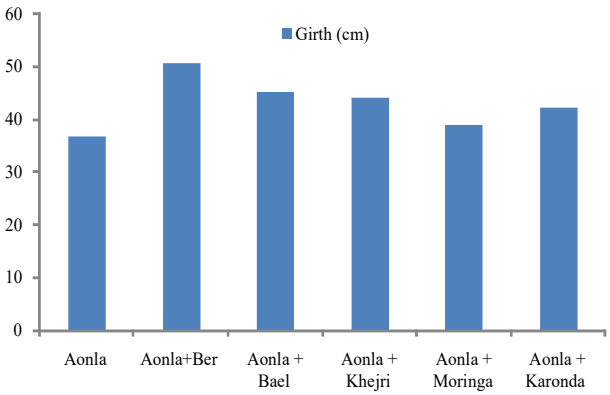


Fig.59. Plant girth in different fruit based diversified cropping models for arid region

The average yield of aonla varied considerably in different cropping model systems with highest being recorded in aonla-khejri (73.9 kg/plant) followed by aonla-ber (70.2 kg/plant) and aonla-karonda (68.6 kg/plant). While the lowest was recorded in aonla-moringa (61.3 kg/plant) (Fig. 60 to 62).

The average yield of bael was recorded 16-41 kg per tree, while a single fruit weighed around 1.62 kg with maximum and minimum fruit weights recorded 3.96 and 0.4 kg, respectively. The average yield of karonda was recorded 13.32 kg/plant planted in between aonla plants. Likewise, the yield of ber cv. Seb was recorded 46.73 kg/plant in model M-1.

Fig. 60. Profuse fruiting in aonla

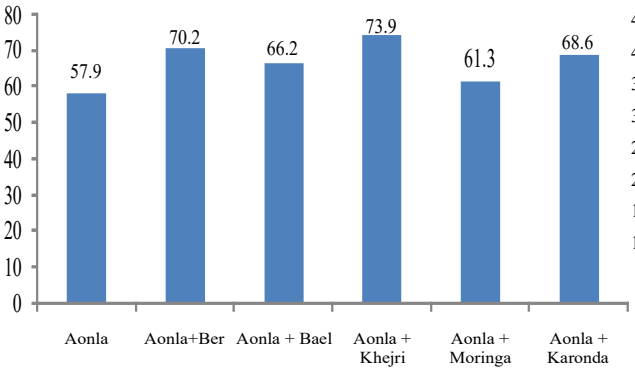


Fig. 61. Aonla yield (kg/ha) in fruit based diversified cropping models in arid region.

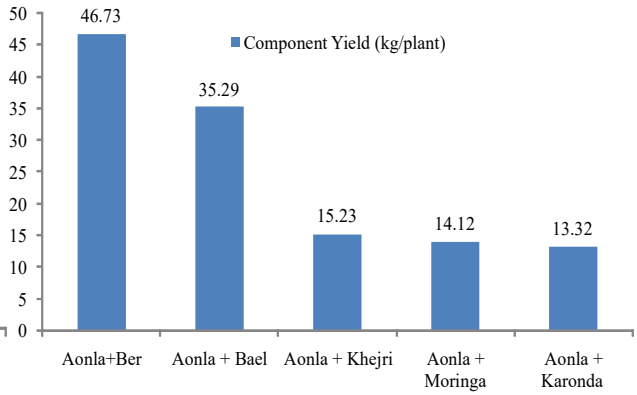


Fig. 62. Component crop yields in fruit based diversified cropping models for arid region.

Water requirement of fruit based diversified cropping models for arid region

The average water use efficiency varied considerably in different cropping model systems. Water requirement (l/kg fruit) of aonla under different models *viz*., aonla, aonla + ber, aonla + bael, aonla + *khejri*, aonla + drumstick and aonla + karonda were 24.89, 20.51, 21.76, 19.48, 23.48 and 20.99 l/kg fruit, respectively. Water requirement of componenet crop of ber, bael, *khejri* karonda and drumstick was 14.82, 30.83, 12.99, 77.05 and 44.55 l water/kg fruit. Lower water requirement (l /kg fruit) was recorded in aonla-*khejri* followed by aonla-ber (Table 83 & 84).

Table 83. Aonla yield and component crop yield in different fruit based diversified cropping models for arid region

Treatment	Aonla yield (kg/plant)	Price (Rs./kg)	Aonla plant/ha	Component plant/ha	Component crop yield (Rs./ha)	Price (Rs./kg)
Aonla	57.9	10	156	0	0	0
Aonla + ber	70.2	10	156	40	42.52	10
Aonla + bael	66.2	10	156	40	32.11	20
Aonla + *khejri*	73.9	10	156	40	13.86	90
Aonla + drumstick	61.3	10	156	40	12.85	15
Aonla + karonda	68.6	10	156	40	12.12	20

Table 84. Water requirement of fruit based diversified cropping models for arid region

Treatment	No of irrigation	Water applied (l/plant)	Aonla yield/ plant	Total Water applied (l/plant	Water requirement (l/kg fruit)	No of irrigation for component crop	Water applied (l/plant)	Water applied(l/ plant)	Yield of component /plant	Water requirement (l/kg fruit)
Aonla	16	90	57.9	1440	24.89	-	-	-	-	-
Aonla + ber	16	90	70.2	1440	20.51	7	90.00	630	42.52	14.82
Aonla + bael	16	90	66.2	1440	21.76	11	90.00	990	32.11	30.83
Aonla + *khejri*	16	90	73.9	1440	19.48	2	90.00	180	13.86	12.99
Aonla + drumstick	16	90	61.3	1440	23.48	11	90.00	990	12.85	77.05
Aonla + karonda	16	90	68.6	1440	20.99	6	90.00	540	12.12	44.55

Average Rs. 10/kg price for aonla and Rs. 10, 20, 90, 15 and 20 have taken for ber, bael, *khejri*, drumstick and karonda, respectively.

Net return from fruit based cropping system

Integration of annual crops with fruit trees yields multiple outputs that ensure production and income generation in a sustainable manner. Natural resources (land, solar radiation, water, soil) as well as socio-economic inputs (labour, credit, power and market infrastructure) are efficiently utilized. Incorporation of fruit trees into the cropping system is more remunerative. It increases the resilience of the system over time. It enables to maximize system productivity on annual basis, utilize resources with high efficiency through due consideration of various interactions and direct, residual and cumulative effects occurring in soil-plant-atmosphere continuum, intensify input use vis-à-vis quality of environment and impart sustainability of farm resources. Net return from fruit based cropping system viz., aonla, aonla + ber, aonla + bael, aonla + *khejri*, aonla + drumstick and aonla + karonda were 60251, 81516, 83946, 120183, 58363 and 71744 Rs./ha, respectively. The maximum net return was recored from aonla + khejri followed by aonla + bael and aonla + ber (Table 85).

Table 85. Net return from fruit based cropping system

Treatment	Return from Aonla (Rs/ha)	Return from component crops (Rs./ha)	Total return (Rs./ha)	Cost of cultivation (Rs. 000/ha)	Net return (Rs./ha)	B:C ratio
Aonla	90251	0	90251	30	60251	2.0
Aonla + ber	109506	17010	126516	45	81516	1.8
Aonla + bael	103255	25691	128946	45	83946	1.9
Aonla + *khejri*	115290	49893	165183	45	120183	2.7
Aonla + drumstick	95654	7710	103363	45	58363	1.3
Aonla + karonda	107048	9697	116744	45	71744	1.6

Carbon sequestration in soil (t C/ha)

Soils contain one of the largest carbon (C) pools in the biosphere with the greatest potential of C sequestration to mitigate climate change impacts. The present study aimed at comparing C sequestration potential of various fruit based diversified cropping models for arid region. Soil samples from the layers of 0-15, 15-30, 30-45 and 45-60 cm depths were collected and analysed for soil physico-chemical properties. Results revealed that the highest C sequestration potential was in the aonla + *khejri*, aonla + ber and aonla + bael and the lowest in aonla + karonda. The respective values in case of carbon sequestration in soil (t C/ha) were, 4.26, 12.01, 10.28, 6.15, 20.54 and 8.94 in the aonla + karonda, aonla + ber, aonla + bael, aonla + morianga, aonla + khejri, respectively (Table 86 & 87).

Table 86. Carbon sequestration in soil (t C/ha) of arid region

Cropping system	0-15 cm	15-30 cm	30-45 cm	45-60 cm	Mean
Initial status	0.47	0.41	0.37	0.33	0.39
Aonla + karonda	5.12	4.38	4.02	3.53	4.26
Aonla + ber	14.43	12.35	11.31	9.95	12.01
Aonla + bael	12.35	10.57	9.68	8.52	10.28
Aonla + moringa	7.39	6.32	5.79	5.10	6.15
Aonla + *khejri*	24.68	21.12	19.35	17.03	20.54
Mean	10.74	9.19	8.42	7.41	8.94

Table 87. Component responsible for carbon sequestration in soil of arid region

S. No.	Management practices	Effects
1.	Reduced tillage/no tillage	Reduced C loss
2.	Erosion control	Reduced C loss
3.	Addition of organic amendments	Increase C input
4.	Use of cover crops	Reduced C loss/increase C input

Performance and evaluation of onion varieties under hot arid conditions

Different varieties of onion *viz*. Bhima Shubhra, Bhima Raj, Bhima Supar, Bhima Kiran, Bhima Shakti, Bhima Safed, Bhima Shweta, Bhima Red, Bhima Dark Red from ICAR-DOGR and RO-252 from RARI, Durgapura were evaluated during *rabi* season of 2019-20 under hot arid condition to identify the suitable variety and develop its production technology under hot arid agro-ecosystem (Fig. 63).

Fig. 63. Evaluation of onion varieties under hot arid condition

A wide range of diversity was observed among the varieties with respect to growth and yield contributing traits such as polar diameter, equatorial diameter and bulb weight. The observations were recorded on plant growth attributes revealed that maximum plant height at harvest and number of leaves was recorded in variety Bhima Shakti whereas, minimum plant height and number of leaves was recorded in variety Bhima Shubhra. Similarly, the highest leaf length, leaf diameter, psedoustem length and psedoustem diameter was recorded by variety RO-252, Bhima Light Red, Bhima Shubhra and Bhima Shakti, respectively. The lowest leaf length, leaf diameter, psedoustem length and psedoustem diameter was recorded by variety Bhima Shweta, Bhima Shakti, Bhima Dark & Light Red and Bhima Kiran, respectively. The data recorded on bulb yield and yield attributes revealed that the variety Bhima Shakti registered maximum polar and equatorial diameter, whereas the lowest was recorded by Bhima Super and Bhima Light Red, respectively. Similarly, the highest bulb weight and TSS was recorded by variety Bhima Red, while the lowest was recorded by Bhima Light Red and Bhima Super, respectively. The highest bulb yield was obtained from variety Bhima Red (44.85 t/ha) followed by Bhima Kiran (41.47 t/ha) and Bhima Shakti (41.00 t/ha), whereas the lowest was obtained from Bhima Shubhra (19.14 t/ha). No incidence of any pest and disease was observed to any of the variety under field conditions. Based on the performance evaluation, it can be inferred that onion has the potential for cultivatioin under hot arid condition with good yield and quality (Fig. 64 & 65).

Fig. 64. Variability in bulb size, shap and colour among varieties

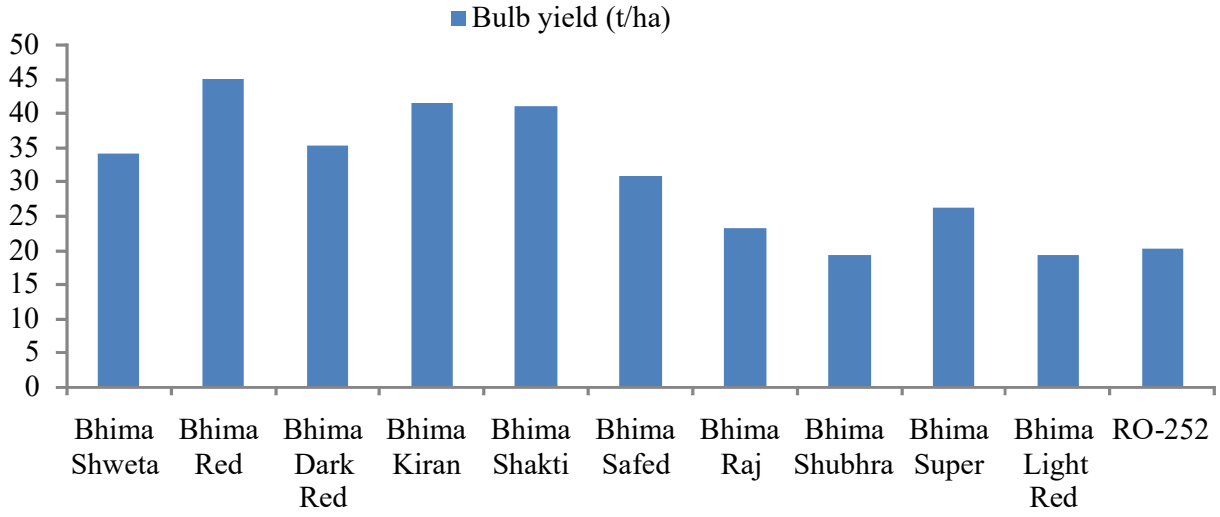


Fig. 65. Yield performance of onion varieties under hot arid conditions

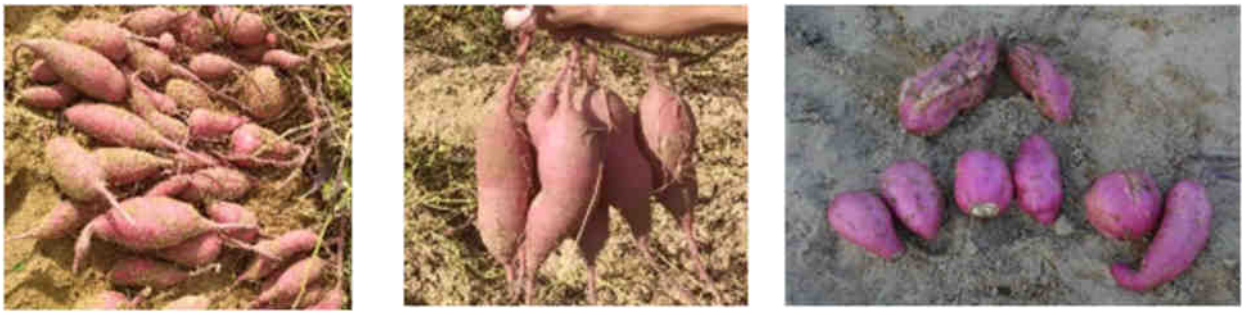
Performance of sweet potato varieties/ germplasm in arid regions

Eleven variety/germplasm were procured from MPUAT, Udaipur and two local lines were collected from Bikaner district (Table 88).

Out of the 13 germplasm, evaluated six cultivars namely Co-3-4, Sree Rethna and Local-2 performed well. The highest tuber yield was recorded in Co-3-4 (312 q/ha) followed by Sree Rethna (307 q/ha), Local -1 (270 q/ha) and Local-2 (232 q/ha). In case of Co-3-4 about 50% breakages of tubers was observed and in case Sree Rethna 4%, TSP 10, 15-20% breakage, TSR, 10-20% breakage and Local 1 and Local 2, 5-10% breakage was observed. Sree Rethna beared tubers in cluster and near and around the main stem with attractive pulp colour. These observations suggest that Co-3-4, Sree Rethna, Local -1 and Local-2 were high yielders (Fig. 66).

Table 88. Performance of sweet potato varieties/germplasm in arid regions

Variety	Tuber length (cm)	Tuber dia. (cm)	Tuber weight (g)	Tuber dry weight (g)	TSS (°Brix)
TSP 1	13.5	18.50	274	15	11.45
TSP 2	18.3	11.00	53.3	15	8.56
TSP 3	-	-	-	-	-
TSP 4	28	19.00	-	14	6.7
TSP 7	13.3	13.66	164	16	8.36
TSP 8	-	-	-	-	-
TSP 9	16	12.00	156	20	6.9
TSP 10	16.3	19.33	291	23	6.73
TSR	17.3	10.33	-	21	10.06
Co-3-4	19.3	24.66	792.33	27	7.33
Sree Rethna	16.3	16.66	297.33	15	12.7
Local-2	32	9.33	167	13	8.3
Local-1	17.6	8.33	111.66	13	8.73



Sree Rethna | Cluster bearing of Sree Rethna | Breakage of tubers

Fig. 66. Genotypes of sweet ptato

Maintenance of *khejri* based native crop production site

Annual plant growth and total bio-mass harvest component was studied in native crop-plant species of horticultural significance. *Phog* was studied in response to training-pruning/lopping for monsoon support bio-mass harvest including vegetable use *phogla*. The 10 years data of *phog* with reference to propagation, growth, training-pruning or lopping and bio-mass harvest were compiled. Boundary side and naturally perpetuated *kheep* shrubs were studied for growth, flowering and tender pod (*khipoli*) harvesting. With good management practices, *kheep* shrubs exhibited prolonged period of flowering and tender pod harvesting. The seedlings of native crop-plant species such as *ker*, *jharber*, *rohida*, lasoda, *kumat* and *khejri* were observed as inter-crop/boundary side plantation and studied with HBCPSMA concept to promote desert horticulture under rainfed situation.

Standardization of package and practices in *Phog*

Phog (*Calligonum polygonoides*) is multiple-use desert flora of horticultural significance. It is a drought and abiotic stresses tolerating perennial shrub of sand-dunes eco-system and well-known for its energy rich fuel-wood, leaf-fodder and flower-buds (*phogla*). This is an endangered plant in hot arid region, and thus ICAR-CIAH initiated its conservation and promotion with horticultural production system since year 1996. In nature, it is easily perpetuated by seed but self-sown plants wipe-out by the animal grazing and tractor-ploughing and thus, protection is needed for requisite growth. Freshly harvested seeds gave 72–78% germination and 40-45 days old seedlings became ready for planting in August is best. Nursery raised seedlings survived 65% whereas self-sown saplings re-planting gave 52% field establishment. For conservation of germplasm, hard-wood cutting gave 18% rooting and 24% survival. Adoption of good management practices in initial 24 months can give highest results for orcharding. Seedlings of CIAH Selection-1 took faster growth and shrubs well-shaped in 4-5 year and from this age May pruning and November lopping is recommended for the highest bio-mass. Commercial harvest starts at 6-7 year age and fresh yield of total produce is 14.85 kg/plant/year. Under rainfed and low temperature situations, it shed leaves in December and behaves deciduous. Plant re-sprouted with on-set of spring season, took floriferous and lush-green growth in summer. Day-night temperature play critical role in flower bud development and it is from middle of March to first week of April, period of *phogla* harvesting (0.725 kg/plant). Plants took quick growth, huge flowering and seed formation in May month, and this is the period for bio-mass harvest through light pruning (2.65 kg fodder and 2.88 kg fuel-wood yield). Plants re-sprouted in June and lopping for fodder (3.16 kg/plant) is done in November. This *phog* crop-plant management practices may helps in higher bio-mass harvest, eco-restoration and conservation of native diversity (Fig. 67 & 68).

Fig. 67. Growth of *phog* seedling plant of 10 years age-group under evaluation

Fig. 68. Fresh *sangri* of *khejri* selection-2

PROPAGATION STUDIES IN HORTICULTURAL CROPS

Propagation studies on Phalsa

An experiment was conducted in the month of July 2020 to determine the effect of different concentrations of IBA on rooting of phalsa cuttings. Highest percentage of success (52.10 %) was recorded in 2000 ppm IBA, it was closely followed by 1000 ppm, 500 ppm and 150 ppm concentrations of IBA. Other parameters like length of sprout, number of leaves per plant and girth of sprout was also noted highest in 2000 ppm IBA (Table 89 & 90).

Table 89. Effect of IBA on semi hard wood cutting of Phalsa cv. Thar Pragati

Treatments*	Survival (%)	Length of sprout (cm)	No of leaves per plant	No of sprouts per plant	Girth of sprout (cm)	No of primary roots	No of secondary roots
100 ppm	37.00	55.12	10.20	2.00	1.30	10.10	25.00
150 ppm	38.34	57.10	11.40	2.50	1.40	11.20	26.10
500 ppm	39.21	58.23	10.42	2.68	1.50	12.00	26.50
1000 ppm	40.12	59.20	10.20	2.80	1.55	12.50	27.20
2000 ppm	50.20	62.30	12.10	3.00	1.70	15.30	28.10
3000 ppm	30.12	42.30	8.30	2.00	1.30	8.20	22.10
4000 ppm	28.00	37.10	7.10	1.90	1.20	7.10	18.00
5000 ppm	26.00	31.00	7.00	1.80	1.15	7.00	17.00
Control	22.12	28.21	5.20	1.60	1.00	5.12	15.00
CD (5%)	1.21	1.10	0.51	0.11	0.10	0.53	1.11

*Data recorded 90 days after treatment

Table 90. Effect of IBA on semi hard wood cutting of phalsa cv. Thar Pragati

Treatments*	Survival (%)	Length of sprout (cm)	No of leaves per plant	No of sprouts per plant	Girth of sprout (cm)	No of primary roots	No of secondary roots
100 ppm	38.10	68.20	12.12	2.00	1.50	12.00	27.10
150 ppm	40.30	70.11	13.00	2.50	1.60	12.50	28.30
500 ppm	42.20	72.32	13.20	2.80	1.65	13.00	28.60
1000 ppm	44.20	73.14	14.32	2.90	1.70	13.50	29.30
2000 ppm	52.10	76.30	15.21	3.90	1.90	16.30	32.20
3000 ppm	32.21	55.30	10.23	2.20	1.45	9.60	24.50

Treatments*	Survival (%)	Length of sprout (cm)	No of leaves per plant	No of sprouts per plant	Girth of sprout (cm)	No of primary roots	No of secondary roots
4000 ppm	30.11	50.10	9.12	2.10	1.40	8.50	21.00
5000 ppm	28.30	42.31	9.00	2.00	1.30	8.20	20.11
Control	24.20	40.20	7.00	1.70	1.20	6.20	17.00
CD (5%)	1.20	1.11	0.50	0.12	0.11	0.54	1.12

*Data recorded 150 days after treatment

Multiplication of *ker* [*Capparis deciduas* Edgew (Forssk.)] through seeds

Fruit of *ker* were harvested at red ripe stage and observations were recorded on fruit weight, fruit size, fruit diameter, number of fruits per cluster and number of seeds per fruit *etc.* Seeds were extracted by mashing pulp with sand and then washed in running tap water several times. Extracted seeds were dried at room temperature and immediately sown in protrays filled with vermiculite, cocopeat and perlite (1:1:1) media for quick, early and maximum germination. Seeds were sown at three different times *viz*., immediate after extraction, three and six months after storage at room temperature for studying germination per cent and seed longevity in green house condition attached to biotechnology laboratory of Institute. Average fruit weight and diameter at ripening were recorded 4.08 g and 1.87 cm, respectively. Average number of fruits per bunch and seeds per fruit were observed 5.3 and 23.27, respectively. After seed sowing watering to media was given twice in a week. Maximum average germination (64.53%) of *ker* seeds was noted when seeds were sown immediate after extraction while it was 45.53% when stored for three months and least germination (35.67%) was observed at six months of storage at room temperature (Table 91).

Table 91. Fruits, seeds and germination study in thornless *ker* AHCD-1

S. No.	Fruit weight at ripening (g)	Fruit dia. at ripening (cm)	Number of fruits /bunch	Number of seeds /fruit	Germination (%)		
					Fresh seed	Three months storage at room temperature	Six months storage at room temperature
1	4.77	2.03	3.3	25.00	66.67	46.67	36.67
2	4.03	1.94	6.0	24.33	63.00	45.33	34.00
3	3.98	1.74	4.3	23.00	63.33	45.00	35.33
4	4.26	1.70	5.7	24.00	65.00	47.00	36.00
5	3.37	1.93	7.0	20.00	64.67	43.67	36.33
Mean	4.08	1.87	5.3	23.27	64.53	45.53	35.67

Growth parameters of *ker* seedlings

Seedlings were shifted in polybags filled with soil, clay and FYM (2:1:1) after 75 days after seeds sowing. There were two treatments applied for recording seedling growth parameters. In one, only water was given to seedlings twice in a week and in another 1/4th MS solution weekly was given with water. Observations were taken during shifting, 90 and 180 days after seedling shifting (DAS). In first set of treatments, average height, number of leaf and root length of seedlings during shifting was 5.07 cm, 5.23 and 8.18 cm, respectively. In second set, average height, number of leaf and root length of seedlings during shifting was 5.18 cm, 5.20 and 8.09 cm, respectively. After 90 and 180 DAS, average height, number of branches, number of leaf per seedling in first set was 12.07, 20.28 cm, 4.27, 7.37 and 19.33, 38.43 respectively. While in second set weekly treated with 1/4th MS solution, enhanced growth characteristics were observed as compared to first set and recorded average height (15.48, 26.90 cm), number of branches (5.40, 9.43) and number of leaf per seedling (23.37, 2.53), respectively after 90 and 180 DAS. Plant survival (66.00%) was found better in treatment having 1/4th MS solution as compared to normal treatment (58.67%) at 180 DAS (Table 92).

Table 92. Seedling parameters of thornless *ker* AHCD-1

Treatment	Seedling height during shifting (cm)	Seedling root length during shifting (cm)	Number of leaf per seedling during shifting	Seedling height 90 DAS (cm)	Number of branches per seedling at 90 DAS	Number of leaf per seedling at 90 DAS	Seedling height at 180 D AS (cm)	Number of branches per seedling at 180 DAS	Number of leaf per seedling at 180 DAS	Plant survival rate (%) at 180 DAS
A (soil+clay+FYM)										
1	5.12	8.04	5.10	12.23	4.60	21.20	22.17	7.30	37.50	58.00
2	4.93	8.45	5.10	11.96	4.10	18.60	20.07	7.10	39.10	60.00
3	5.17	8.05	5.50	12.01	4.10	17.60	18.61	7.70	38.70	58.00
Mean	5.07	8.18	5.23	12.07	4.27	19.33	20.28	7.37	38.43	58.67
B (soil+clay+FYM weekly treated with ¼ strength MS solution)										
1	5.28	8.54	5.40	14.79	5.10	22.50	26.83	9.40	54.50	66.00
2	5.26	7.67	5.00	15.98	5.90	23.60	27.15	9.60	52.90	68.00
3	4.99	8.05	5.20	15.68	5.20	24.00	26.73	9.30	50.20	46.00
Mean	5.18	8.09	5.20	15.48	5.40	23.37	26.90	9.43	52.53	66.00

Standardization of seed and seedling standards of thornless *ker* AHCD-1

Ker crop is very hard to propagate and prepare planting materials by any means of plant multiplication. Therefore, experiments were conducted to prepare planting materials of thornless *ker* AHCD-1 (IC-0634593) through seeds, cuttings and root suckers.

Development of seed and seedling standards of thornless *ker* AHCD-1

On the basis of seed and seedling growth experiment, it can be recommended that seedlings from *ker* can be ready for field plantation within six months if treated with 1/4th MS solution at weekly intervals. Therefore, seed and seedling standards of *ker* were formulated for getting quality planting materials. For getting genuine planting material of *ker* one can follow these standards *viz*., (1) fruits should be harvested at fully ripe pink/red colour stage, (2) having ≥3.0 g fruit weight and ≥2.0 cm size, (3) seed should be sown immediate after extraction giving >60% germination, (4) seedlings should be shifted into polybags after attaining height >5.0 cm with 4-7 fully expanded leaves and this attained in about 60-75 days after sowing, (5) seedling plants ready for field planting in about six months from DAS having 25-30 cm height and 6-13 branches (Table 93 and Fig. 69).

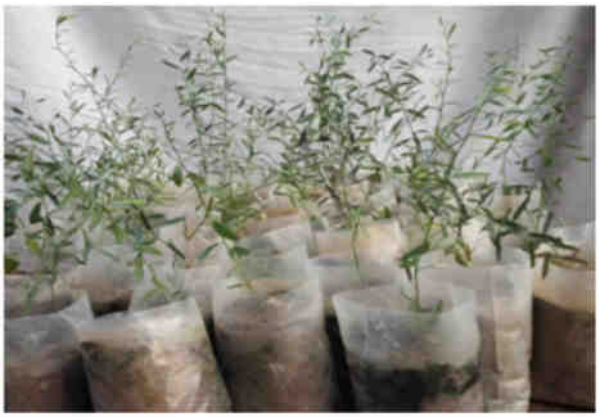


Fig. 69. *Ker* seedling ready for transplanting

Table 93. Seed and seedling standards of thornless *ker* AHCD-1

S. No.	Character	Standard
1	Fruit harvesting stage	Fully ripe at pink/red colour stage
2	Fruit size	≥2.0 cm
3	Fruit weight	≥3.0 g
4	Seed longevity (at room temperature)	1-3 months
5	Seed sowing	Freshly extracted
6	Seed germination	>60 %
7	Age of seedling suitable for shifting in polybags	60-75 days old with 4-6 leaves
8	Seedling height during shifting	>5.0 cm
9	Seedling root length during shifting	>8.0 cm
10	Number of leaf per seedling during shifting	4-7
11	Seedling ready for planting	Six months treated with 1/4th MS solution and 9 months in normal condition
12	Plant height after six months	25-30 cm
13	Number of branches per plant after six months	6-13
14	Plant survival rate after six months	>60%

Multiplication of *ker* through semi-hardwood stem cuttings

An experiment was conducted last year 2018-19 for multiply *ker* through stem cuttings. For the purpose three types of cuttings *viz*., hardwood cutting, semi-hardwood cutting and soft-wood cutting were used at three different time periods in three types of potting media and mixes. Maximum success was obtained only in semi-hardwood stem cuttings when planting was done during September month with clay+vermiculite+clay media. Same experiment was repeated during 2019-20 on semi-hardwood stem cuttings with three layers of clay+vermiculite+clay media. Cuttings were taken during September month and planted in pots containing above media and observations were recorded on weekly basis. Thus, average sprout percentage on semi-hardwood stem cuttings was observed 41.13% (36.00-46.47.70%) while well rooted success cuttings recorded 45.95%. After one year, average plant height and number of success sprouts were noted 47.40 cm and 3.60, respectively.

On the findings of the experimental results obtained from both the years (2018-20) data on stem cuttings, planting material standards of *ker* 'AHCD-1' was developed which require some prerequisites for production of quality planting material such as (1) semi-hard wood stem cuttings with 30-35 cm of length should be planted during September month, (2) potting media and mixes should be (i) sand and/ or (ii) three layered clay + vermiculite + clay, (3) planting should be done under mist chamber/green house condition for better and early sprouting, (4) sprouting should be completed within 10-15 days from planting of cuttings with sprout and rooting success rate of ≥ 35 %, (5) after plant survival, plants with more than two branches having length of ≥ 20 cm will be good for planting and it attained after one year of planting of cuttings with total plant height ≥ 40 cm (Table 94).

Table 94. Planting material standards of thornless *ker* AHCD-1

SN	Characters	Standards
1.	Planting material	Stem cuttings
2.	Type of cuttings	Semi-hard wood cuttings
3.	Length of cuttings	30-35 cm
4.	Diameter of cuttings	10-14 mm
5.	Time of planting of cuttings	September
6.	Potting media and mixes	(1) Sand and (2) three layered clay + vermiculite + clay
7.	Potting medium	Plastic pots (size 9 and 12 inch)
8.	Planting condition for sprouting of cuttings	Mist chamber/ green house
9.	Sprouting period	Second to third weeks after planting
10.	Days to sprout	10-15 days
11.	Sprouting rate	50-60 %
	Sprout success (%)	
12.	Sprouts lengths after one year (cm)	≥20
13.	Rooting success (%)	≥35
14.	Plant survival rate (%)	≥35
15.	Plant height after one year (cm)	≥40
16.	Number of branches per plant after one year	≥2
17.	Plants ready for transplantation	After one year
18.	Incidence of disease/ pest and disorders	Free from all major diseases and insects No any nutrient deficiency symptoms.
19.	Aftercare/ precautions	1. After successful sprouts under mist chamber/ green house, sprouted cuttings always remain untouched up to 6 months.

SN	Characters	Standards
		2. Irrigate sprouted plants twice every day (morning and evening). 3. After 6 months of sprouting, cuttings started developing roots. Therefore, proper care should be done to sprouted cuttings up to six months for well development of root-shoot. 4. Always irrigate plants by misting or watering cane. No direct watering to pots by other means because it disturbs the intactness of cuttings.

Propagation studies in *pilu* (*Salvadora oleoides* Decne.)

An experiment was undertaken for studying sprouting, rooting and plant success per cent on *pilu* cuttings during September month under green house condition. Hundred cuttings of pilu were planted in media containing soil, cocopeat, vermicopost (2:1:1). Fifty cuttings were selected from sprouts arising from trunk near to ground level and fifty from above periphery of the plant. The length of cuttings was 30-35 cm with pencil thickness having 2-3 leaves. Cuttings were putted keeping 2/3rd portion below in media. Watering to cuttings was given twice in a week. After two weeks, seventeen cuttings (34.00%) were sprouted, out of which presently eleven (22.00%) surviving well under green house condition in first condition (cuttings taken from sprouts arising from trunk near to ground level). In second case, where cuttings were selected from plant, none cutting sprouted and all fifty cuttings were dried after one month.

Grafting studies in drumstick

Different drumstick rootstocks and scions varieties were used for grafting during 25 June to 25 September, 2020 to get true to type plant. Thar Harsha showed significantly highest grafting success (55.3 per cent) during the month of July followed by August and September.

Standardization of time of patch budding in Manila tamarind

Patch budding was done at monthly interval. Maximum success per cent (82.00) was recorded in March, closely followed by April and May. Maximum length of sprout, girth of sprout was also recorded when patch budding was done in the month of March.

Protected cultivation of vegetables under hot arid conditions

Standardization of sowing date and covering material in watermelon

Watermelon was sown on four different date of sowing *i.e.* 20 December, 30 December,10 January under tunnel and 10 February under open condition to standardize the sowing date and covering material under tunnel for early season harvest. Two types of covering material *i.e.* biodegradable plastic sheet of 25 micron and non-woven cloth (25 gsm) was used. The covering was completely removed after gradual hardening of the plants during second week of February when the outside temperature increased. It was found that germination was earlier in biodegradable plastic sheet of 25 micron than non-woven cloth (25 gsm) because the temperature inside the tunnel with polythene cover was comparatively higher than the non-woven cloth. The crop raised under tunnel (20 December with polythene covering) attained the harvestable maturity on 8 March in comparison to open field sowing (second week of February), which came in harvesting during first week of May which was 61 days later than the tunnel (Fig. 70). Tunnel facilitated the early harvest of crop which earn higher market price in off-season than the normal season.

Data recorded on fruit and yield attributes revealed that number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare were significantly influenced by the sowing date and covering material. Number of fruits per plant was ranged from 2.64 to 3.78. Fruit diameter was ranged from 15.4 to 18.3 cm. The mean weight of fruit was ranged from 2.28 to 2.85 g. The fruit yield was ranged from 5.72 to 8.61 kg per plant and 156.78 to

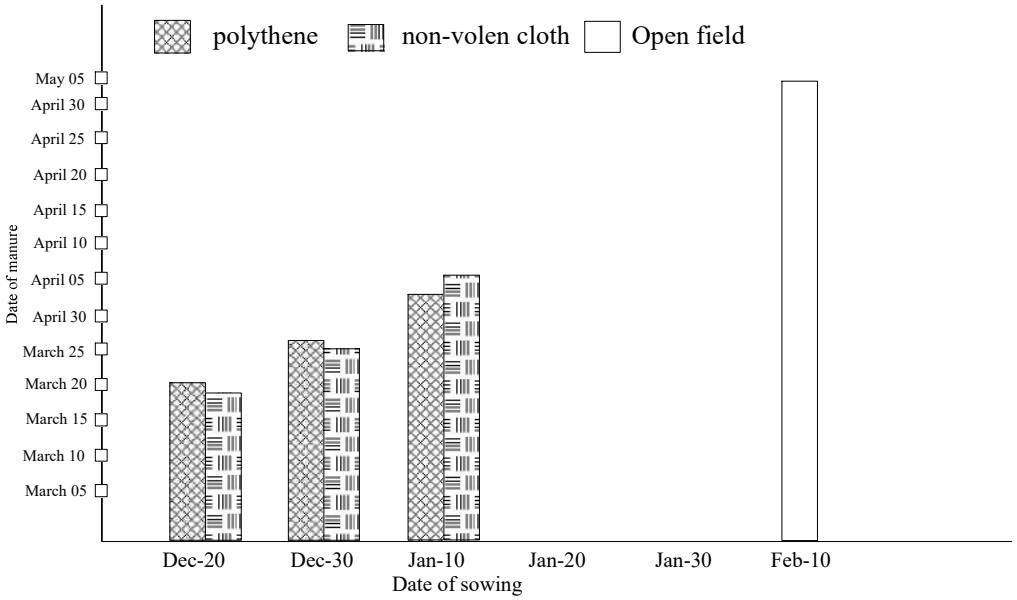


Fig. 70. Effect of sowing time on harvest of watermelon under tunnel and open field conditions

256.32 q per ha. The sowing on 10 January with polythene covering recorded maximum fruit yield (256.32 q/ha) followed by sowing on the same date with non-woven covering (232.64 q/ha) and minimum was recorded in sowing under open condition (156.78 q/ha). Higher yield under tunnel than open field condition was also supported by fruiting duration as it was observed that the treatment having the highest yield had 26 days of fruiting duration in comparison to open field condition which had 16 days of fruiting duration only. With the use of tunnels, it is possible to harvest warm season crops up to 50-60 days earlier in the spring and extend the growing season. This is where low tunnel made the difference in comparison to open field because the produce harvested during first week of March from low tunnel is sold at Rs. 15-30 per kg against Rs. 05-10 per kg from the produce harvested during first week of May from open field. Net income and cost benefit ratio of sowing under low tunnel was significantly higher than the sowing under open field condition and the highest economics (B:C ratio of 2.00) was achieved by sowing the crop on 10th January under tunnel with non-woven cloth followed by polythene sheet.

Performance studies on tomato under protected condition

To understand growth, fruiting and quality of tomato under protected condition, the genotype AHSL-1 was evaluated with varying environments (open drip, open mini-sprinkler and shade net) during spring-summer season of 2020. Observations were recorded on growth and yield parameters of the crop. The plant growth and fruit yield parameters except branches per plant, fruit length and diameter were significantly influenced by the varying environments. The maximum plant height at 90 DAP and number of branches per plant was observed under shade net and open mini-sprinkler, respectively and minimum was recorded under open drip environment. The other plant growth attributes as leaf width, leaflet length and petiole length were found maximum under shade net condition followed by open mini-sprinkler and minimum under open drip condition. Leaf length was reported maximum under shade net followed by open drip and minimum under open mini-sprinkler. Numbers of clusters per plant were found maximum under open mini-sprinkler followed by open drip and minimum under shade net condition. Numbers of fruits per cluster were found maximum under shade net condition followed by open mini-sprinkler and minimum under open drip. The ripe fruits were medium in size and reddish in colour. The fruit yield per plant was ranged from 1.89 to 3.68 kg per plant under varying environments. The highest fruit yield per plant was recorded under open mini-sprinkler followed by shade net and the lowest was recorded under open drip environment. The other fruit yield attributes as number of fruits per plant, fruit length, fruit diameter and average fruit weight followed the similar trend. Based on performance studies, the genotype has the potential for cultivation under hot arid environment with further improvement (Table 95 & 96 and Fig. 71).

Table 95. Growth parameters of tomato under different growing situations

Environment	Plant height at 90 DAP (cm)	No. of branches per plant	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	No. of leaflets	Leaflet length (cm)	Leaflet width (cm)
Open drip	44.66	3.5	13.33	11.77	2.98	9.11	5.42	2.78
Open mini - sprinkler	51.53	3.88	12.84	12.22	3.46	7.27	5.5	2.8
Shade net	70.14	3.62	17.71	18.43	4.76	8.23	7.49	3.7
CD (5%)	9.45	NS	2.53	1.96	0.53	1.12	0.58	0.54

Table 96. Fruit yield parameters of tomato under different growing situations

Environment	No. of clusters /plant (cm)	No. of fruits /cluster	No. of fruits /plant	Fruit length at marketable stage (cm)	Fruit diameter marketable stage (cm)	Average fruit weight at marketable stage (g)	Fruit yield /plant (kg)	TSS (°Brix)
Open drip	21.66	2.27	44.44	3.77	4.25	39.75	1.89	5.26
Open mini - sprinkler	30.55	2.63	70.23	4.41	4.9	58.42	3.68	4.75
Shade net	17.37	3.58	48.42	4.12	4.62	45.92	2.14	4.38
CD (5%)	3.61	0.41	1.78	NS	NS	1.67	0.17	0.08

Fig. 71. Improved tomato genotype AHSL-1

Performance studies on brinjal under protected condition

To understand growth, fruiting and quality in brinjal under protected condition, the genotype AHB-03 (CIAH-22) was evaluated with varying environments (open drip, open mini-sprinkler and shade net) during spring-summer season of 2020. The plant growth and fruit yield parameters except leaf length, width, petiole length, fruit length, diameter and weight were significantly influenced by the varying environments. The plant growth attributes as plant height at 90 DAS and numbers of branches per plant were found maximum under shade net condition followed by open mini-sprinkler and minimum under open drip. Similarly, leaf length was recorded maximum under shade net followed by open drip and minimum under open mini-sprinkler. The other plant growth attributes as leaf width and petiole length were observed maximum under open drip followed by shade net and minimum under open mini-sprinkler. The genotype has thorns on leaf as well as on fruit calyx in the range of 5-8 and 12-20, respectively under varying production situations. The genotype has the ability to tolerate high temperature as there was continuous fruiting during hot summer months (temperature up to 46 °C). Numbers of fruits per plant were found maximum under open mini-

sprinkler followed by shade net and minimum under open drip. Both fruit length and fruit diameter at marketable stage were recorded maximum under open drip followed by open mini-sprinkler and minimum under shade net. The fruit yield per plant was ranged from 2.18 to 3.72 kg per plant under varying environments. The highest fruit yield per plant was recorded under open mini-sprinkler followed by shade net and the lowest was recorded under open drip environment. The average fruit weight followed the similar trend (Table 97 & 98).

Table 97. Growth and fruit yield parameters of brinjal under different growing situations

Environment	Plant height at 90 DAP (cm)	No. of branches / plant	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	No. of thorns/leaf
Open drip	43.06	3.0	21.31	15.94	6.13	5.55
Open mini-sprinkler	60.00	3.6	18.83	14.93	5.35	8.00
Shade net	60.10	4.9	21.63	15.83	5.87	4.87
CD (5%)	9.67	0.38	NS	NS	NS	0.20

Table 98. Growth and fruit yield parameters of brinjal under different growing situations

Environment	No. of thorns on calyx/fruit	No. of fruits /plant	Fruit length at marketable stage (cm)	Fruit diameter at marketable stage (cm)	Average fruit weight at marketable stage (g)	Fruit yield /plant (kg)
Open drip	20	16.82	8.33	7.48	144.56	2.18
Open mini-sprinkler	14.75	27.58	8.07	7.44	155.84	3.72
Shade net	12.28	21.35	7.56	7.19	148.42	2.85
CD (5%)	3.31	3.79	NS	NS	NS	0.45

Performance studies on chilli under protected condition

To understand growth, fruiting and quality of chilli under protected condition, the genotype mathania type slection-1 was evaluated with varying environments during spring-summer season of 2020. The plants attained 48.1, 61.2 and 67.5 cm height at 90 DAP under open drip, open sprinkler and low cost protective shade net condition, respectively. No. of branches per plant were 2.5, 2.9 and 3.4 under open drip, open sprinkler and lowcost protective shade net condition, respectively. Leaf length was 10.11, 13.54 and 12.1 cm and leaf width was 4.84, 6.21 and 5.72 cm whereas, leaf petiole length was 4.84, 5.72 and 4.84 cm under open drip, open sprinkler and low cost protective shade net condition, respectively. There was seasonal difference in performance of the genotype with respect to plant growth, flowering and fruit set. Flowering occurred under all the three environments during both rainy and summer season but fruit set during summer was lower than rainy season. The genotype had light green fruits with typical fruit shape. The immature fruits at marketable stage were 16.25 cm in length and 1.52 cm in diameter.

INTEGRATED NUTRIENT AND WATER MANAGEMENT

Nutrient management in chironji, custard apple, jamun and tamarind

Leaf sampling survey was carried out in custard apple, chironji and Jamun. The nutrients were estimated and from them norms for Diagnosis Recommendation Integrated System (DRIS) were calculated and categorised in to deficient, low, optimum, high and toxic according to standard deviation. The nutrient concentrations in the range with mean $\pm$ 4/3 SD are optimum, < (mean - 8/3 SD) are deficient, (mean - 8/3 SD) to (mean - 4/3 SD) are low, (mean + 4/3 SD) to (mean + 8/3 SD) are high

and > (mean + 8/3 SD) are toxic. These can be used for calculating DRIS indices in the corresponding fruit crops for efficient diagnosis of required element and nutrient management. DRIS indices were calculated at different months to apply fertilizers for above crops (Table 99 to 101).

Table 99. DRIS norms in custard apple collected from Gujarat and Chittorgarh area of Rajasthan

Nutrient	Deficient	Low	Optimum	High	Toxic
Nitrogen	<1.40	1.40-1.96	1.96-3.06	3.06-3.62	>3.62
Phosphorus	<0.10	0.10-0.13	0.13-0.17	0.17-0.20	>0.20
Potassium	<0.39	0.39-0.59	0.59-0.99	0.99-1.19	>1.19
Calcium	<1.08	1.08-1.48	1.48-2.26	2.26-2.66	>2.66
Magnesium	<0.22	0.22-0.69	0.69-1.64	1.64-2.11	>2.11
Sulphur	<0.21	0.21-0.29	0.29-0.45	0.45-0.53	>0.53
Iron	<25	25-126	126-327	327-429	>429
Manganese	<204	204-243	243-323	323-363	>363
Zinc	<29	29-38	38-56	56-65	>65
Copper	<14	14-21	21-36	36-44	>44

Table 100. DRIS norms in chironji collected from Gujarat

Nutrient	Deficient	Low	Optimum	High	Toxic
Nitrogen	<1.44	1.44-2.50	2.50-4.64	4.64-5.70	>5.7
Phosphorus	<0.06	0.06-0.08	0.08-0.14	0.14-0.16	>0.16
Potassium	<0.19	0.19-0.34	0.34-0.62	0.62-0.77	>0.77
Calcium	<0.59	0.59-1.19	1.19-2.41	2.41-3.01	>3.01
Magnesium	<0.34	0.34-0.60	0.60-1.10	1.10-1.36	>1.36
Sulphur	<0.05	0.05-0.11	0.11-0.25	0.25-0.31	>0.31

Table 101. DRIS norms in jamun collected from Gujarat

Nutrient	Deficient	Low	Optimum	High	Toxic
Nitrogen	<1.03	1.03-2.14	2.14-4.36	4.36-5.47	>5.47
Phosphorus	<0.04	0.04-0.06	0.06-0.11	0.11-0.13	>0.13
Potassium	<0.26	0.26-0.46	0.46-0.88	0.88-1.08	>1.08
Calcium	<0.48	0.48-0.84	0.84-1.56	1.56-1.92	>1.92
Magnesium	<0.54	0.54-0.87	0.87-1.53	1.53-1.86	>1.86
Sulphur	<0.04	0.04-0.09	0.09-0.17	0.17-0.22	>0.22

Nutrients management in vegetables of hot arid region of Rajasthan

Kachri (AHK-119) production under different combinations of nutrients

The application of organic and inorganic sources of nutrients significantly increased growth parameters and yield of *kachri* as compared to control. The maximum leaves no./plant, shoot length (cm), root length (cm) and fresh weight of plant (g) were recorded 9.57, 16.84, 14.15 and 8.76, respectively when 50% NPK from inorganic fertilizers and 15 t/ha FYM was applied whereas, the minimum leaves no./plant, shoot length (cm), root length (cm) and fresh weight of plant (g) were recorded in control where fertilizer and FYM were not applied (Table 102).

Table 102. Effect of organic and inorganic source of nutrient on performance of *kachri*

Treatments	Leaves no./plant	Shoot length (cm)	Root length (cm)	Fresh weight of plant (g)
Control	7.05	11.05	8.56	7.39
100% (I)	8.9	13.165	8.98	8.43
75% (I) + 7.5 t/ha FYM	7.72	15.07	9.45	8.06
50% (I) + 15 t/ha FYM	9.57	16.84	14.15	8.76
25% (I) + 22.5 t/ha FYM	15.95	32.12	19.43	14.53
30 t/ha FYM	20.65	26.33	16.29	16.26
Mean	2.42	3.46	2.51	1.67
CD (5%)	2.41	4.68	4.78	2.45

The vine length (cm), no. of branches, fruits/plant and fruit production/plant (g/plant) were observed in above treatment in which organic and inorganic sources at equal proportion (application of 50% NPK from inorganic fertilizers and 15 t/ha FYM) were 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 (Table 103 & 104).

Table 103. Effect of organic and inorganic source of nutrient on performance of growth parametrs of *kachri*

Treatments	Vine length (cm)	No. of vine	No. of male/plant	No. of female/plant
Control	17.2	3.65	6.6	300.5
100% (I)	24.65	5.75	9.1	378.5
75% (I) + 7.5 t/ha FYM	26.95	5.70	11.5	454.1
50% (I) + 15 t/ha FYM	29.95	6.50	13.7	557.7
25% (I) + 22.5 t/ha FYM	35.35	5.25	11	445.6
30 t/ha FYM	35.6	6.50	12.3	435.6
Mean	28.3	5.55	10.9	428.5
CD (5%)	5.14	1.36	4.17	78.56

Table 104. Effect of organic and inorganic source of nutrient on yield traits of *kachri*

Treatments	Yield (q/ha)	Weight of fruit	DM (%)	Dry matter yield
Control	44.62	25.54	8.90	5.11
100% (I)	86.63	29.48	9.89	10.00
75% (I) +7.5 t/ha FYM	98.12	30.45	9.67	11.00
50% (I) + 15 t/ha FYM	104.12	32.55	9.86	11.20
25% (I) + 22.5 t/ha FYM	91.90	28.57	10.82	10.51
30 t/ha FYM	88.39	31.66	10.80	10.67
Mean	85.63	29.71	9.99	9.75
CD (5%)	17.26	1.97	0.84	2.75

The yield of *kachri* under different treatments *i.e.* control, 100% (I), 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 44.62, 86.63, 98.12, 104.12, 91.90 and 88.39 q/ha.

Micronutrient application in *mateera*

An experiment was conducted for application of micronutrients in *mateera*. Application of micronutrient such as Zn, Fe, Mn and Cu 15 kg/ha each increased the planting with number of fruit/ha (Table 105).

Table 105. Micronutrient application in *mateera* (Mean of two year)

Treatments	No. fruit/ ha at 40 DAS	No. of fruit/ ha at 50 DAS	% increase number of fruits at 40 DAS	% increase number of fruits at 50 DAS
Full recommended NPK through chemical fertilizer (T1)	2005	2253	0	0
T1 + Zinc sulphate fertilizer 15 kg/ha	3101	3195	80	72
T1 + Iron sulphate fertilizer 15 kg/ha	2978	3067	76	69
T1 + Manganese fertilizer 15 kg/ha	2818	2782	72	61
T1 + Cupper sulphate fertilizer 15 kg/ha	2350	2407	62	54
T1 + Zn, Fe, Mn and Cu 15 kg/ha each	3105	3229	80	71
T1 + Zn + Fe 15 kg/ha	3094	3242	79	74

Effect of boron application on performance of *mateera* under drip irrigation

Different treatments of boron were applied in native crops of *mateera* and results revealed that application of 100 ppm boron as foliar application at 25, 35 and 45 days increased number of fruit/ha (Table 106).

Table 106. Effect of boron application on performance of *mateera*

Treatments	No. of fruit/ha at 40 DAS	No. of fruit/ha at 50 DAS	% increase in number of fruits at 40 DAS	% increase in number of fruits at 50 DAS
Control	2769.5	3855.0	-	-
50 ppm boron foliar appli cation at 25, 35 and 45 days	3402	5000	123	130
100 ppm boron foliar application at 25, 35 and 45 days	3406	5550	123	144
2 kg/ha borax soil application at sowing	3469	3955	125	103
4 kg/ha borax soil application at sowing	3222	4517	116	117
6 kg/ha borax soil application at sowing	3403	5085	123	132

Judicious management of saline water with amendments for higher productivity of kachri and snapmelon under hot arid agroecosystem

Effect of salinity levels and amendments on yield of *kachri* (*Cucumis callosus*)

The field experiment was conducted at ICAR-CIAH, Research farm to investigate the effect of different level of salinity ($0.5EC_{IW}$ and $4EC_{IW}$) with the combination of amendments on *kachri* crop performance. The soil was sandy, pH 8.3, low in organic carbon (0.11%) and available nitrogen (110 kg/ha), medium in available phosphorus (12 kg/ha) and high in available potassium K (320 kg/ha).

The application of saline water with amendments increased yield of *kachri* as compared to control. The data revealed that with the two salinity level, the highest yield was observed with the treatment of gypsum 4 t/ha + $4EC_{IW}$ (dSm^{-1}) (50.00 q/ha) followed by vermicompost 10 t/ha + $4EC_{IW}$ (dSm^{-1}) (45.83 q/ha) and FYM 15 t/ha + $4EC_{IW}$ (dSm^{-1}) (42.66 q/ha) and 36.66 q/ha yield of *kachri* in control. In the salinity level of 0.5EC, the highest yield was observed with the treatment of FYM 15 t/ha + $4EC_{IW}$ (dSm^{-1}) (69.83 q/ha) followed by vermicompost 10 t/ha + $4EC_{IW}$ (dSm^{-1}) (64.67 q/ha), gypsum 5 t/ha+ $4EC_{IW}$ (dSm^{-1}) (58.00 q/ha) and $4EC_{IW}$ (dSm^{-1}) (42.00 q/ha). Maximum per cent yield response was observed in 0.5EC irrigation water applied, where treatment of IW 0.5EC + FYM 15 t/ha was applied (68.8%) followed by IW 5EC + vermicompost 10 t/ha was (63.7) and IW 5EC + gypsum 5 t/ha (55.0%) as compared to control.

The maximum per cent yield response was observed in IW 4EC + gypsum 5 t/ha was (49.00%) followed by IW 4EC + vermicompost 10 t/ha was (45.83%), IW4EC + FYM 15 t/ha was applied (41.66%) as compared to control. The treatment of IW 4EC + gypsum 5 t/ha was found good for yield as well as yield response of *kachri* crop production under arid region. It was may be due to sandy nature of soil because sandy soil filtered the salt due to large pore size in deeper soil zone (Fig. 72 & 73).

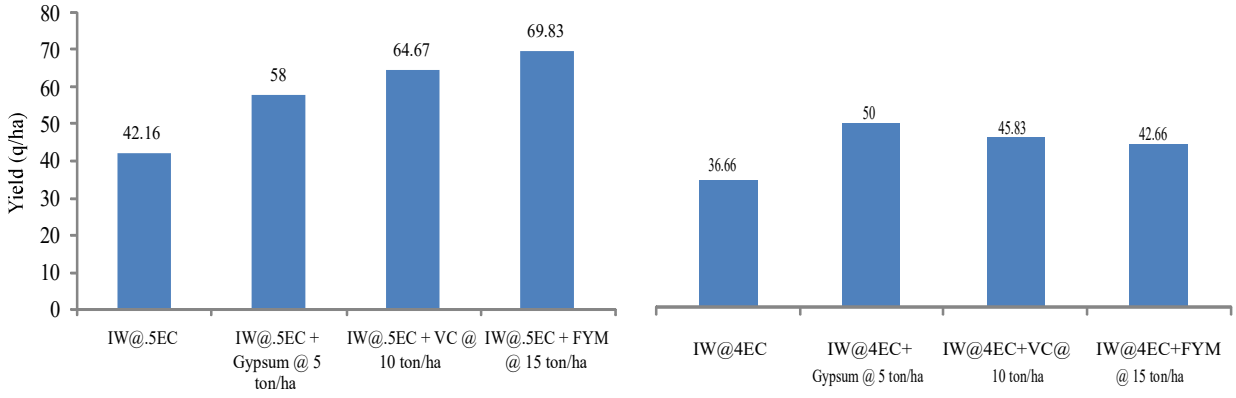


Fig. 72. Yield of *kachri* under different salinity level of irrigation water with amendments

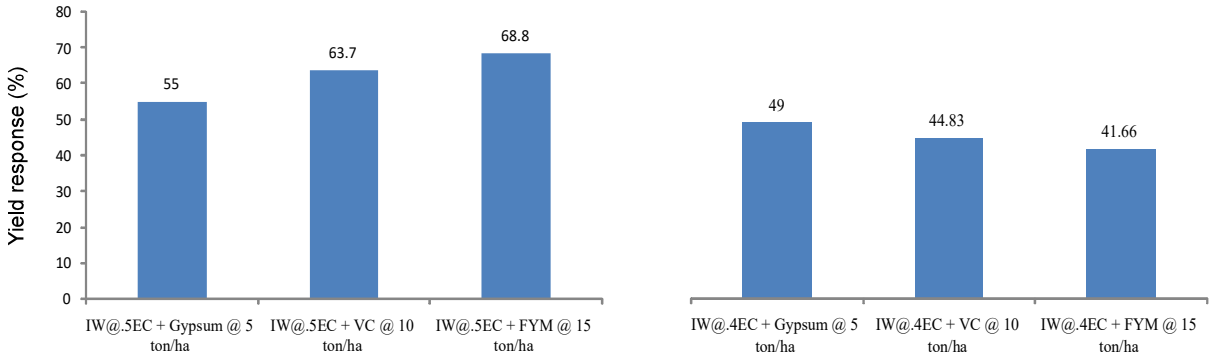


Fig. 73. Per cent yield response of *kachri* fruit under different salinity level of irrigation water

Effect of different salinity level of irrigation water on growth and yield of *kachri*

The data revealed that the treatment IW 0.5EC + FYM 15 t/ha was recorded maximum fruit weight (81.67 g), fruit length (5.48 cm), diameter (7.02 cm) and fruit volume 81.7 ml) followed by IW 0.5EC + VC 10 t/ha , IW 0.5EC + gypsum 5 t/ha and IW 0.5EC (control) while, the treatment IW 4EC + gypsum 5 t/ha registered for maximum fruit weight (73.33 g), fruit length (5.75 cm) fruit diameter (6.75 cm) and fruit volume (73.33 ml) followed by , and IW 4EC (control). The treatment IW 4EC + gypsum 5 t/ha is registered for maximum fruit weight, length, diameter and fruit volume. The combination of FYM and vermicompost with 4EC saline water were found good treatment for *kachri* fruit yield under saline water irrigation. It was observed that maximum number of vine (12), number of leaf/vine (16), vine length (1.95 m), leaf length (7.67 cm), leaf width (10.75 cm), number of male flowers (25) and number of female flowers (10) were recorded in IW 0.5EC + FYM 15 t/ha. While maximum number of vine (13), number of leaf/vine (15), vine length (1.93 m), leaf length (7.33 cm), leaf width (10.7 cm), number of male flower (22) and number of female flower (10) were recorded with the application of IW 4EC + gypsum 5 t/ha (Table 107 & 108).

Table 107. Effect of different salinity level of irrigation water on of *kachri* fruit attributes

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Fruit volume (ml)	
	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})
Control	62.00	58.35	5.01	4.12	6.03	4.52	75.0	67.50
Gypsum 5 t/ha	72.50	73.33	5.42	5.75	6.63	6.92	70.0	73.33
VC 10 t/ha	75.40	67.56	5.45	4.93	6.69	6.75	72.5	65.00
FYM 15 t/ha	81.67	63.33	5.48	4.82	7.02	6.58	81.7	63.33
Mean	72.89	65.64	5.34	4.91	6.59	6.19	74.79	67.29
SD	8.21	6.36	0.22	0.67	0.41	1.12	5.02	4.38

Table 108. Growth parameter of *kachri* under different level of salinity of irrigation water

Treatment	Number of vine	Number of leaf /vine	Vine length (m)	Leaf length (cm)	Leaf width (cm)	Number of male flower	Number of female flower
Salinity level ($0.5EC_{IW}$ dSm^{-1})							
IW 0.5EC (control)	6	10	1.56	6	8.00	13	5
IW 0.5EC + gypsum 5 t/ha	11	17	1.68	7.33	9.00	16	9
IW 0.5EC + VC 10 t/ha	10	16	1.78	7.5	9.33	24	8
IW 0.5EC + FYM 15 t/ha	12	16	1.95	7.67	10.75	25	10
Mean	9.75	14.75	1.74	7.13	9.27	19.50	8.00
SD	2.63	3.20	0.16	0.76	1.14	5.92	2.16
Salinity level ($4EC_{IW}$ dSm^{-1})							
IW 4EC (control)	6	11	1.58	6.17	8.17	15	5
IW 4EC + gypsum 5 t/ha	13	15	1.93	7.33	10.17	22	10
IW 4EC + VC 10 t/ha	8	16	1.77	6.83	8.83	19	9
IW 0.5EC + FYM 15 t/ha	11	14	1.73	6.73	9	18	8
Mean	9.50	14.00	1.75	6.77	9.04	18.50	8.00
SD	3.11	2.16	0.14	0.48	0.83	2.89	2.16

Effect of different salinity level of irrigation water on *kachri*

It was observed that in both salinity level, the leaf area were high in gypsum amendment with saline water application that was highest leaf area (60.34 cm^2) in $0.5EC_{IW}$ + gypsum 5 t/ha and followed by other treatments. With the $4EC_{IW}$ the result on the leaf area was significantly influenced by treatments levels with their combination and maximum leaf area (52.97 cm^2) were found with the treatment of IW 4EC + gypsum 5 t/ha.

The highest LAI value for *kachri* crop was (0.81) was observed under the treatment of IW 0.5EC + FYM 15 t/ha which was at par with other treatments. While, with the application of $4EC_{IW}$, the mean maximum LAI was recorded (0.75) in treatment of IW + gypsum 5 t/ha. Data revealed that the treatment IW 0.5EC + gypsum was recorded maximum DM% (12.39) and TSS (4.78 °Brix) were recorded with the treatment of IW 0.5EC + FYM 15 t/ha. Similarly with the second salinity level, maximum DM (12.80%) was observed in IW 4EC + gypsum 5 t/ha and TSS (4.09 °Brix) were recorded with the treatment of IW 4EC + FYM 15 t/ha. The maximum TSS 4.78% and 4.09% were observed under the treatment of IW 0.5EC + FYM 15 t/ha and IW 4EC + FYM 15 t/ha, respectively (Table 109).

Table 109. Effect of different salinity level of irrigation water on of *kachari*

Treatments	LA (cm^2)		LAI		TSS (°Brix)		DM (%)	
	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})
Control	34.59	32.67	0.58	0.42	3.74	3.62	9.00	8.60
Gypsum 5 t/ha	60.34	52.97	0.77	0.75	4.39	3.91	12.18	12.80
VC 10 t/ha	51.17	42.42	0.68	0.62	4.02	3.94	11.21	12.30
FYM 15 t/ha	45.17	43.15	0.81	0.45	4.78	4.09	12.39	12.20
SEm±	5.30	5.27	0.11	0.11	N/A	N/A	0.3	0.3
CD (5%)	1.60	1.59	0.03	0.02	0.30	0.136	0.1	0.1

Effect of different salinity level of irrigation water on light interception on above and below canopy of *kachri*

The light interception was measured between 10-12 AM by canopy analyzer (LP80) under natural radiation at ICAR-CIAH, Bikaner. The effect of salinity levels and their combination with various amendment of light interception on above canopy was found to be statistically non significant. It is evident from data that different levels of salinity showed significant effect on below canopy light interception. Further the lowest light interception (215 µ mol $m^{-2}S^{-1}$ and 179.00 µ mol $m^{-2}S^{-1}$) was observed in IW 0.5EC and IW 4EC respectively and the highest light interception below canopy (674.00 µ mol $m^{-2}S^{-1}$ and 441.05 µ mol $m^{-2}S^{-1}$) was observed in IW 0.5EC + gypsum 5 t/ha and IW 4EC + gypsum 5 t/ha, respectively (Table 110).

Table 110. Light interception in *kachri* under different salinity level with amendments

Treatments	Light interception above canopy (µ mol $m^{-2}S^{-1}$)		Light interception below canopy (µ mol $m^{-2}S^{-1}$)	
	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})
Control	1771.0	1670.5	215	179.00
Gypsum (5 t/ha)	1804.2	1857.5	674.00	441.05
VC (10 t/ha)	1797.0	1823.5	426.33	203.50
FYM (15 t/ha)	1806.3	1707	475.33	259.00
SEm±	21.12	46.35	57.37	54.18
CD (5%)	NS	NS	190.01	179

Biochemical parameter of *kachri* under different salinity level of irrigation water

The total phenolic values of kachri fruits was recorded 3.27±0.108 mg GAE/g DW to 5.10±0.144 mg GAE/g DW and 3.16±0.144 mg GAE/g DW to 4.24±0.144 mg GAE/g DW in *IW* 0.5EC and IW 4EC with various amendment, respectively. The total flavonoides content of kachri fruit was recorded 0.312±0.013 to 0.50±0.022 mg Cat. E/g DW and 0.221±0.009 to 0.343±0.013 mg Cat. E/g DW under IW 0.5EC and IW 4EC with various amendments, respectively. The total TAA of kachri fruit various treatment from (8.32±0.201 mg AAE/g to 9.11±0.371 mg AAE/g DW) and 6.68±0.262 mg AAE/g to 8.94±2.485 mg AAE/g DW under IW 0.5EC and IW 4EC with various amendment, respectively. It was observed that the phenolic values, flavonoides and total antioxidant properties were highest in salt stress condition with 4ECIW but after application of amendment with saline water, data showed the phenolic values, flavonoides and total antioxidant properties were in decline pattern in salt stress condition (Fig. 74)

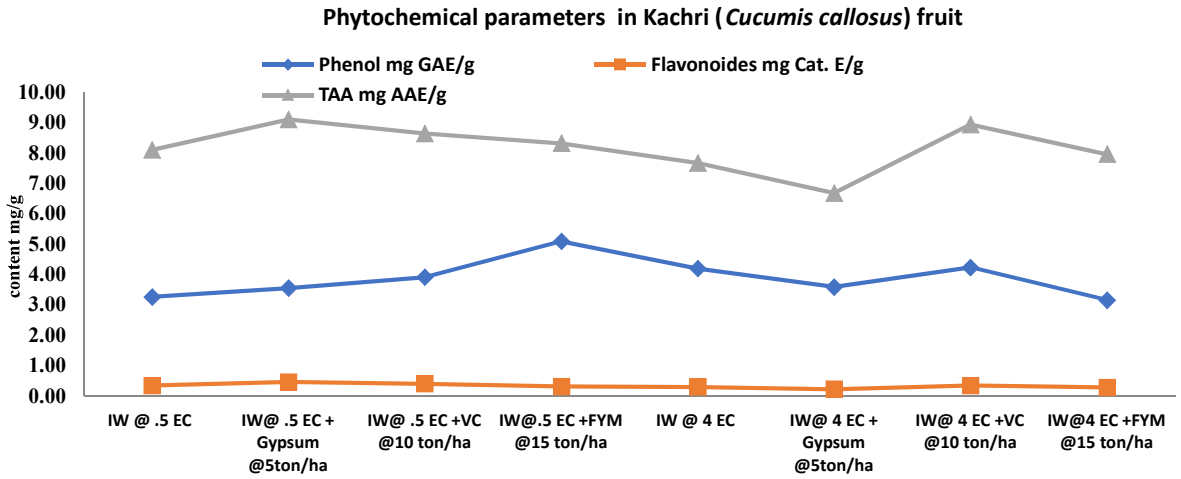


Fig. 74. Biochemical parameters of *kachri* fruit under different saline water with amendment

Effect of different salinity level of irrigation water on of snapmelon yield

The data revealed that with the application of saline water with amendments increased yield of snapmelon as compared to control and the highest yield was observed under the treatment of IW 4EC (dSm^{-1}) + FYM 15 t/ha was (185 q/ha) followed by irrigation water 4EC (dSm^{-1}) + vermicompost 10 t/ha (170.60 q/ha), IW 4EC (dSm^{-1}) + gypsum 4 t/ha (168.86 q/ha) and 136.77 q/ha yield of snapmelon in control IW4EC (dSm^{-1}) treatment and with the salinity level of 0.5EC (dSm^{-1}) the highest yield was observed with the treatment of IW 0.5EC (dSm^{-1}) vermicompost 10 t/ha + $4EC_{IW}$ was (198.56 q/ha) and followed by gypsum 5 t/ha + $4EC_{IW}$ dSm^{-1}) that was (188.88 q/ha) and 0.5EC + FYM 15 t/ha (dSm^{-1}) (180.67 q/ha) and 152.90 q/ha in control treatment. Further, the maximum per cent yield response was observed where IW 0.5EC (dSm^{-1}) + vermicompost 10 t/ha was applied (29.88%) followed by IW0.5 EC (dSm^{-1}) + gypsum 5 t/ha (18.30.0%) and IW.5 EC (dSm^{-1}) + FYM 15 t/ha (18.16%) as compared to control. The maximum per cent yield response in saline water was observed, where the treatment of IW4EC (dSm^{-1}) + FYM 15 t/ha was (35.27%) followed by IW4EC (dSm^{-1}) vermicompost 10 t/ha (24.46%) and IW 4EC (dSm^{-1}) + gypsum 4 t/ha (23.46%) and yield of snapmelon was compared to control (Fig. 75 & 76).

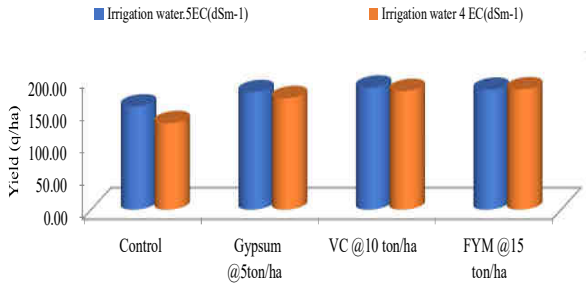


Fig. 75. Yield of *snapmelon* fruit under different salinity level of irrigation water with amendments

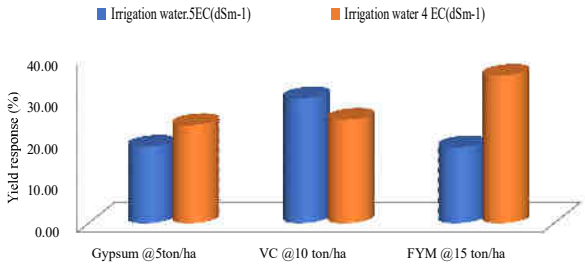


Fig. 76. Yield response of snapmelon fruit under different salinity level of irrigation water

Effect of different salinity level of irrigation water on snapmelon

The treatment IW 4EC (dSm^{-1}) + gypsum 5 t/ha is registered for maximum fruit weight length and diameter. While combitation of FYM and vermicopost with 4EC saline water were also good treatment for snapmelon fruit yield under saline water irrigation. The treatment IW 0.5EC (dSm^{-1}) + was recorded maximum fruit weight (374.17 g), fruit length

(17.13 cm), diameter (21.11 cm) and followed by IW 0.5EC (dSm^{-1}) + gypsum 5 t/ha, IW 0.5EC (dSm^{-1}) + FYM 15 t/ha and IW 0.5EC (dSm^{-1}) (control) while with the salinity level ($4EC_{IW}$), the treatment IW 4 EC (dSm^{-1}) + gypsum 5 t/ha registered for maximum fruit weight (349.58 g), fruit length (13.7 cm), fruit diameter (21.56 cm) and followed by IW 4EC (dSm^{-1}) + VC 10 t/ha, IW 5 EC (dSm^{-1}) + FYM 15 t/ha and IW 4EC (dSm^{-1}) (control) (Table 111).

Table 111. Effect of different salinity level of irrigation water on *snapmelon*

Treatments	Fruit weigh (g)		Fruit length (cm)		Fruit diameter (cm)	
	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})
Control	263.77	254.56	13.02	10.7	19.07	19.03
Gypsum 5 t/ha	362.72	349.58	16.88	13.4	19.64	21.56
VC 10 t/ha	374.17	341.11	17.13	13.7	21.11	20.76
FYM 15 t/ha	340.14	305.89	13.24	11.4	20.91	19.79
SEm±	17.663	11.457	0.779	0.177	0.734	0.585
CD (5%)	62.308	40.417	2.747	0.623	N/A	N/A

Effect of different salinity level on growth parameter of snapmelon

It was observed that maximum number of vine (14), number of leaf/vine (23), vine length (2.95 m), leaf length (6.83 cm), leaf width (8.67 cm), number of male flowers (27) and number of female flowers (12) in with the application of IW 0.5EC + FYM 15 t/ha. While maximum number of vine (15), number of leaf/vine (19), vine length (2.93 m), leaf length (7.33), leaf width (10.7), number of male flower (25) and number of female flowers (11) were recorded with the application of IW 4EC + gypsum 5 t/ha (Table 112).

Table 112. Effect of salinity levels of irrigation water on growth parameter of snapmelon

Treatment	Number of vine/plant	Number of leaf /vine	Vine length	Leaf length	Leaf width	Number of male flower	Number of female flower
Salinity level ($0.5EC_{IW}$ dSm^{-1})							
IW 0.5EC (Control)	8	12	2.13	6.33	7.67	12	5
IW 0.5EC + gypsum 5 t/ha	11	14	2.68	6.00	8.17	17	8
IW 0.5EC + VC 10 t/ha	13	20	2.78	5.23	7.07	24	9
IW 0.5EC + FYM 15 t/ha	14	23	2.95	6.83	8.67	27	12
Mean	11.50	14.67	2.64	6.10	7.89	20.00	8.50
SD	3.87	0.35	1.29	0.68	6.78	2.89	23.71
Salinity level ($4EC_{IW}$ dSm^{-1})							
IW 4EC (Control)	6	9	1.58	6.3	7.7	14	6
IW 4EC + Gypsum 5 t/ha	15	19	2.93	7.3	9.1	25	11
IW 4EC + VC 10 t/ha	10	16	2.77	8.4	10.0	21	9
IW 5EC + FYM 15 t/ha	13	17	2.73	7.0	8.7	21	8
Mean	11.00	15.25	2.50	7.26	8.86	20.25	8.50
SD	3.92	4.35	0.62	0.85	0.97	4.57	2.08

The data presented in Table 113 showed that saline water irrigation had significant on leaf area. The treatment of VC 10 t/ha with 0.5EC and 4EC level were recorded maximum leaf area (59.10 and 58.92 cm), leaf area index (0.59 and 0.59) while maximum TSS (5.17 and 5.35) were recorded in treatment of FYM 15 t/ha with 0.5EC and 4EC level, respectively and the dry matter percentage were recorded maximum in treatment of gypsum 5 t/ha in both salinity level *i.e.* 0.5EC and 4EC.

Light interception on above and below canopy of snapmelon

The light interception was measured between 10-12 AM by canopy analyzer (LP80) under natural radiation at ICAR-CIAH, Bikaner. The effect of salinity levels and their combination with various amendment of light interception on above canopy was found to be statistically non significant. It is evident from data that different levels of salinity showed significant effect on below canopy light interception. Further the lowest light interception (247.50 µ mol $m^{-2}S^{-1}$ and 281.50 µ mol $m^{-2}S^{-1}$) was observed in IW 0.5 EC and IW 4EC, respectively and the highest light interception below canopy (356.50 µ mol $m^{-2}S^{-1}$ and 396.00 µ mol $m^{-2}S^{-1}$) was observed in IW 0.5EC + gypsum 5 t/ha and IW 4EC + gypsum 5 t/ha, respectively (Table 114 to 116).

Table 114. Light interception of snapmelon under different salinity level with amendments

Treatments	Light interception above canopy (µ mol $m^{-2}S^{-1}$)		Light interception below canopy (µ mol $m^{-2}S^{-1}$)	
	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})	Irrigation water 0.5EC (dSm^{-1})	Irrigation water 4EC (dSm^{-1})
Control	1744	1753.33	247.5	281.5
Gypsum 5 t/ha	1771	1858.00	299	298.5
VC 10 t/ha	1852.5	1767.50	355.5	305.5
FYM 15 t/ha	1739.5	1810.50	256.5	396
SEm±	16.73	32.78	38.29	29.54
CD (5%)	59.01	N/A	N/A	N/A

Table 115. Net return and B:C of Snapmelon under salinity level at 0.5EC (dSm^{-1})

Treatment	Yield (q/ha)	Marketable price (Rs)	Cost of cultivation (Rs)	Gross income (Rs)	Net Income (Rs)	B:C ratio
Control	157.19	314380.0	18500	314380.0	295880.0	1.06
Gypsum 5 t/ha	178.93	357866.7	108500	357866.7	249366.7	1.44
VC 10 t/ha	185.87	371733.3	43500	371733.3	328233.3	1.13
FYM 15 t/ha	182.63	365266.7	38500	365266.7	326766.7	1.12

Table 116. Net return and B: C of snapmelon under salinity level at 4EC (dSm^{-1})

Treatment	Yield (q/ha)	Marketable price (Rs)	Cost of cultivation (Rs)	Gross income (Rs)	Net Income (Rs)	B:C ratio
Control	131.87	263733.3	18500	263733.3	245233.3	1.08
Gypsum 5 t/ha	169.90	339800.0	108500	339800.0	231300.0	1.47
VC 10 t/ha	180.67	361333.3	43500	361333.3	317833.3	1.14
FYM 15 t/ha	183.33	366666.7	38500	366666.7	328166.7	1.12

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 10 x 10 m 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 (4.70 m), plant spread East-West (3.80 m), North-South (3.60 m) and scion girth (68.80 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 (47.00 kg/plant), TSS (20.70 °Brix) was also recorded in T-6, closely followed by T-8.

Standardization of irrigation scheduling in date palm

The irrigation treatments were deployed on the basis of evapotranspiration considering the open pan evaporation data. The plant to plant spacing (6 x 8 m), pan factor (0.75), crop factor (0.60) was taken into account to calculate the water requirement of the treatment. The water requirements of different treatments were calculated and said amount was applied through drip system. The amount of water was given on third day. The results revealed that 100 and 75% of ETc gave maximum plant height (350 cm), spread (2.00 x 180 cm) in cultivar Barhee and Khalas. In Khalas cultivar, maximum spathes per plant (5) were recorded in 1.00 ETc irrigation level and minimum (2) in 50% ETc irrigation level. The maximum moisture (5.50%) was recorded at 45 cm depth after 8 h of the irrigation.

The treatments were applied in the month of October 2020 and plant height, spread, spathe emergence were recorded in different treatments in different cultivars. Growth data revealed that maximum plant height (1.50 m), spread (1.25 x 1.30 m) after six month was recorded in T8 treatment in Barhee cultivar where NPK (800 g each) along with 50 kg FYM were applied. All plants are in vegetative phase.

PHYSIOLOGICAL, BIOCHEMICAL AND BIOTECHNOLOGICAL INTERVENTIONS

DNA fingerprinting of watermelon cultivars using functional molecular markers

For DNA fingerprinting of watermelon cultivars, sixteen ScoT (Start codon Targeted polymorphism) and 25 CBDP (CAAT Box-Derived Polymorphism) markers were used for profiling on genomic DNA of watermelon cultivars. Leaf samples were collected at seedling stage and DNA was isolated from the pooled sample. Consequently, eleven ScoT and 16 CBDP markers produced varietal specific bands and differentiated each cultivar (Fig. 77).

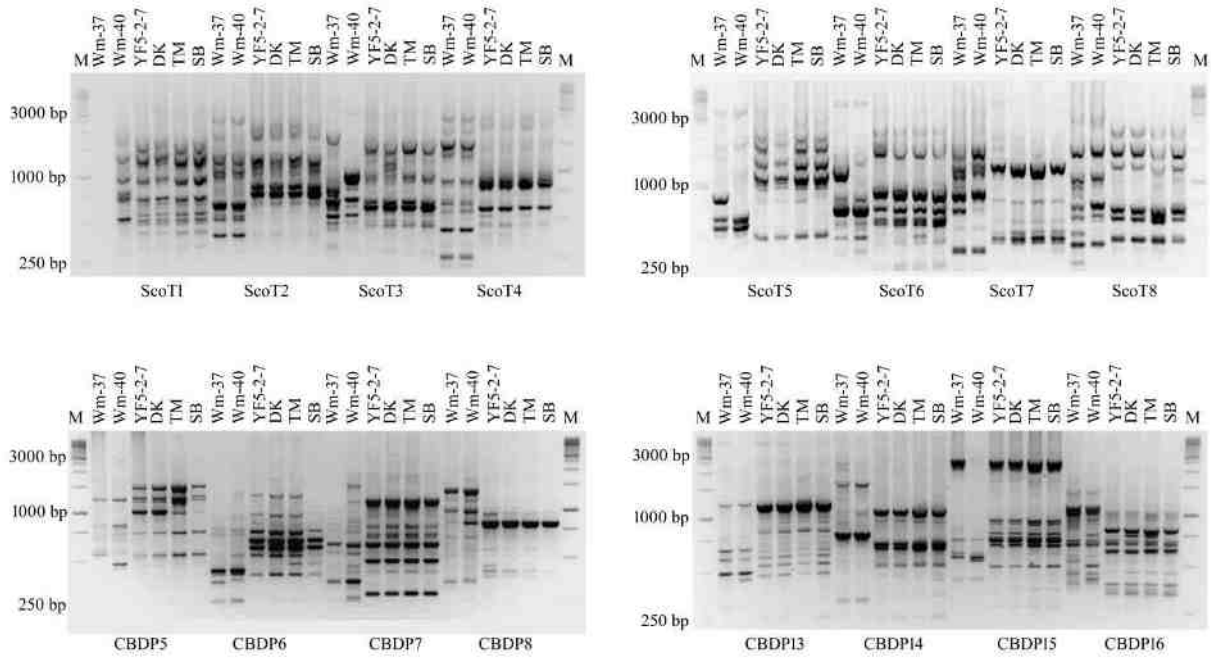


Fig. 77. PCR profiling of ScoT and CBDP markers on genomic DNA of watermelon cultivars

Identification and characterization of RBOH genes from watermelon genome

To identify the Respiratory Burst Oxidase Homologs (RBOH) genes in watermelon, the BLASTp search was performed against the genomic database of watermelon using *Arabidopsis* RBOH protein as a query. Consequently, nine putative RBOH

genes were identified in watermelon. Based on the species belong and their chromosomal position, the RBOH genes were named as ClaRBOH genes and nomenclatured as ClaRBOH01 to ClaRBOH09, respectively (Table 117).

Table 117. RBOH genes of watermelon

S. No.	Gene Name	Locus ID	Gene family
1.	Respiratory burst oxidase homolog protein A	Cla97C01G002330	ClaRBOH01
2.	Respiratory burst oxidase-like protein	Cla97C02G046480	ClaRBOH02
3.	Respiratory burst oxidase-like protein	Cla97C02G046490	ClaRBOH03
4.	Respiratory burst oxidase-like protein	Cla97C03G052820	ClaRBOH04
5.	Respiratory burst oxidase, putative	Cla97C03G067430	ClaRBOH05
6.	Respiratory burst oxidase-like protein F	Cla97C06G125190	ClaRBOH06
7.	Respiratory burst oxidase homolog protein A-like	Cla97C07G134970	ClaRBOH07
8.	Respiratory burst oxidase-like protein	Cla97C10G195960	ClaRBOH08
9.	Respiratory burst oxidase protein E	Cla97C11G206420	ClaRBOH09

For assessing the sequence conservation among the ClaRBOH genes, multiple sequence alignment (MSA) was carried out using amino acid sequences of ClaRBOH proteins. The MSA analysis revealed the significant peptide sequence conservation along with conserved domains among the ClaRBOH proteins. The evolutionary relationship among the ClaRBOH genes and RBOH genes of other cucurbits and *Arabidopsis* was demonstrated by phylogenetic analysis in MEGA 7.0 software. The phylogenetic tree constructed with deduced amino acid sequences of ClaRBOH genes classified them into 4 major groups. The ClaRBOH genes showed close proximity with bottle gourd RBOH genes (Fig. 78).

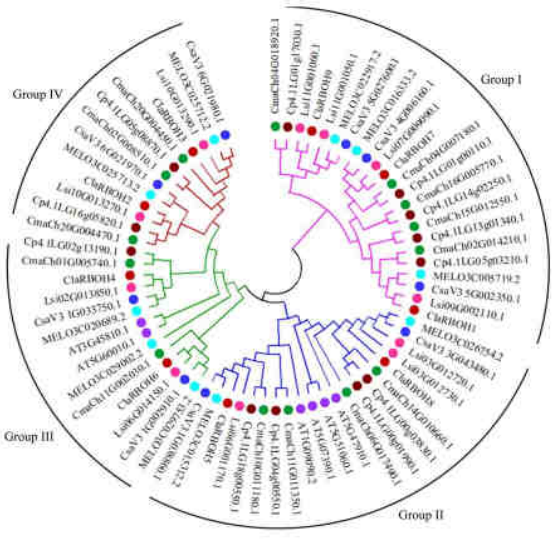


Fig. 78. Phylogenetic tree of ClaRBOH genes of watermelon

To validate the tissue-specific expressivity governed by ClaRBOH genes, the RNAseq data sets pertaining to different tissues and environmental conditions (osmotic and salt stress) were analysed using SRA Blast tool of NCBI. During the *in silico* gene expression analysis, the ClaRBOH genes clustered the tissues and conditions into 6 major groups and ClaRBOH genes itself clustered into two major groups. The ClaRBOH06 and ClaRBOH08 were found most up-regulated in their expression in major group II comparatively (Fig. 79).

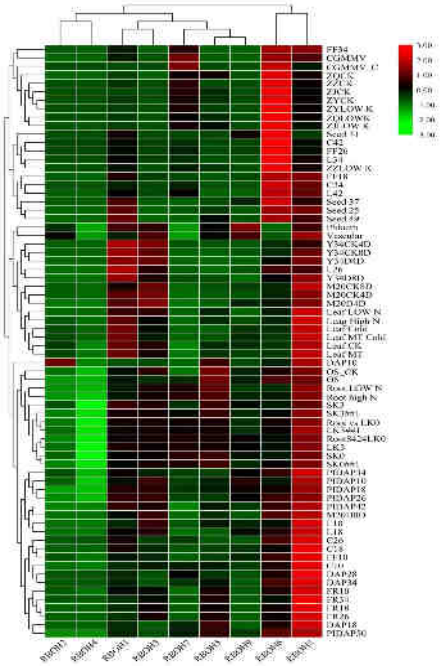


Fig. 79. *In silico* gene expression of ClaRBOH genes in watermelon

Biochemical mechanism of abiotic stress tolerance in arid horticulture crops

The effect of concurrent abiotic stresses (drough, low & high tempreature) was studied on tannin, proline, malondialdehyde (MDA), chlorophyll, soluble protein content and specific activities of superoxide dismutase (SOD), peroxidase (POD) and catalase enzymes in *khejri* (*Prosopis cineraria*) leaves (wild and Thar shobha). The *khejri* leaves samples were collected on tenth of each month between 10-11 am in ice-box and grounded in liquid nitrogen. The grounded samples were stored at deep freezer (-80 °C) condition till further use for analysis. A significant difference was observed in all the metabolites/enzymes studied in response to different concurrent stresses and the trend of these compounds/ enzymes during the study is presented in Fig. 80.

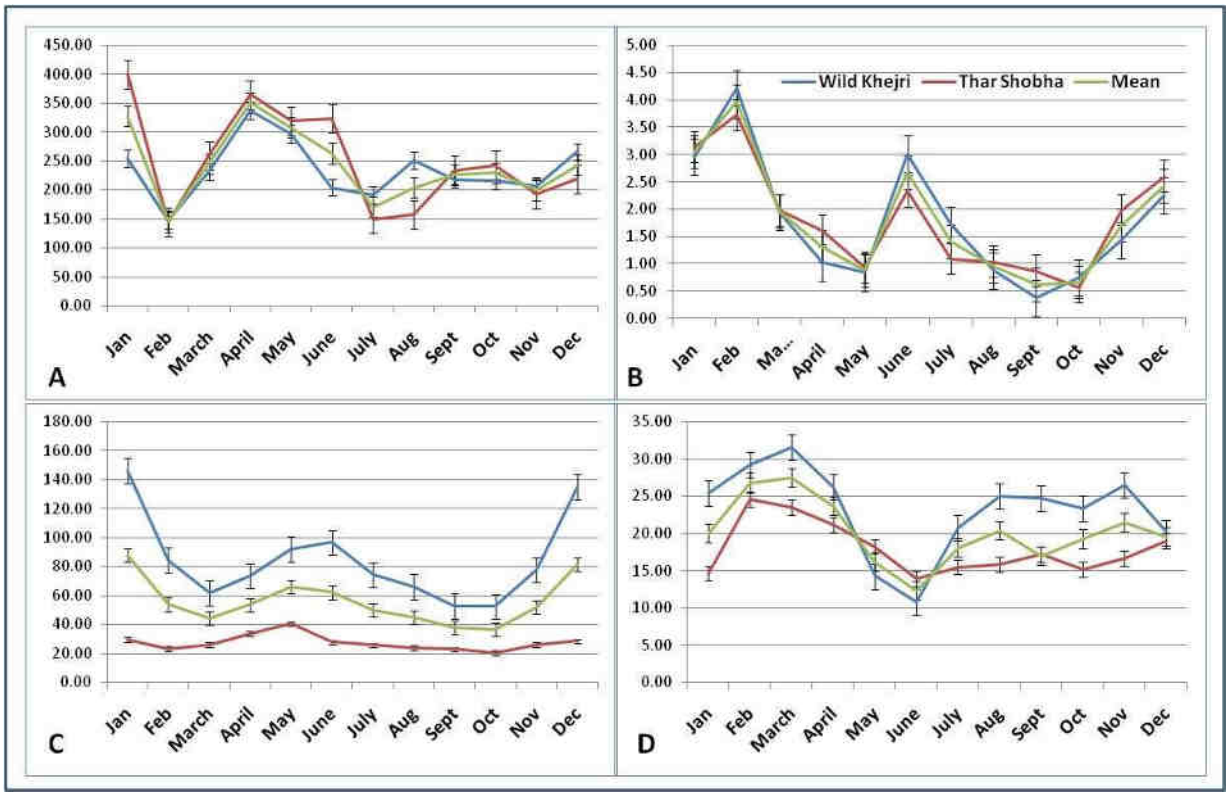


Fig. 80. Effect of abiotic stresses on tannin (A), proline (B), MDA (C) and Chl content (D) in *khejri*

The graphical representation of tannin, proline and MDA content showed that the accumulation of these compounds increased under sever stresses conditions like heat and cold irrespective of the variety. Tannin content accumulation was highest during May-June and December-January while proline content was highest during January-February and June months. Likewise, MDA content was also responded well towards different stresses but the trend is very smooth rather than quick like in tannin and proline content. Unlike these above discussed metabolites, chlorophyll content and soluble protein content behaved differently towards concurrent abiotic stresses. The leaf chlorophyll and soluble protein content were highest during March and lowest during May-June in both the varieties. The leaf chlorophyll content was impacted by both the concurrent stresses (Heat and cold) while soluble protein content was more impacted by heat stress than cold stress. Lower values of chlorophyll and soluble protein content showed that under stress condition, plants reduced its metabolic activities to sustain under adverse conditions.

The expression pattern of antioxidant enzymes like SOD, peroxidase and catalase was also studies in *khejri* leaves under concurrent abiotic stresses and observed a significant different in all the enzymes under different

conditions in both varieties. SOD responded very well under both heat and cold stresses and maximum activity was observed during May-June and December-January. While, peroxidase and catalase behaved differently under concurrent abiotic stresses. The peroxidase activity was more vulnerable to heat stress (May-June) than cold stress and maximum activity was observed during May-June. The catalase enzyme found more vulnerable towards cold stress and maximum activity was observed during December-January. Under heat stress, the catalase activity was slightly higher than mansoon season but lower than March-April. The expression pattern of these enzymes under concurrent abiotic stresses might be one of the defense components in *khejri* plant which make it tolerant towards multiple abiotic stresses (Fig. 81).

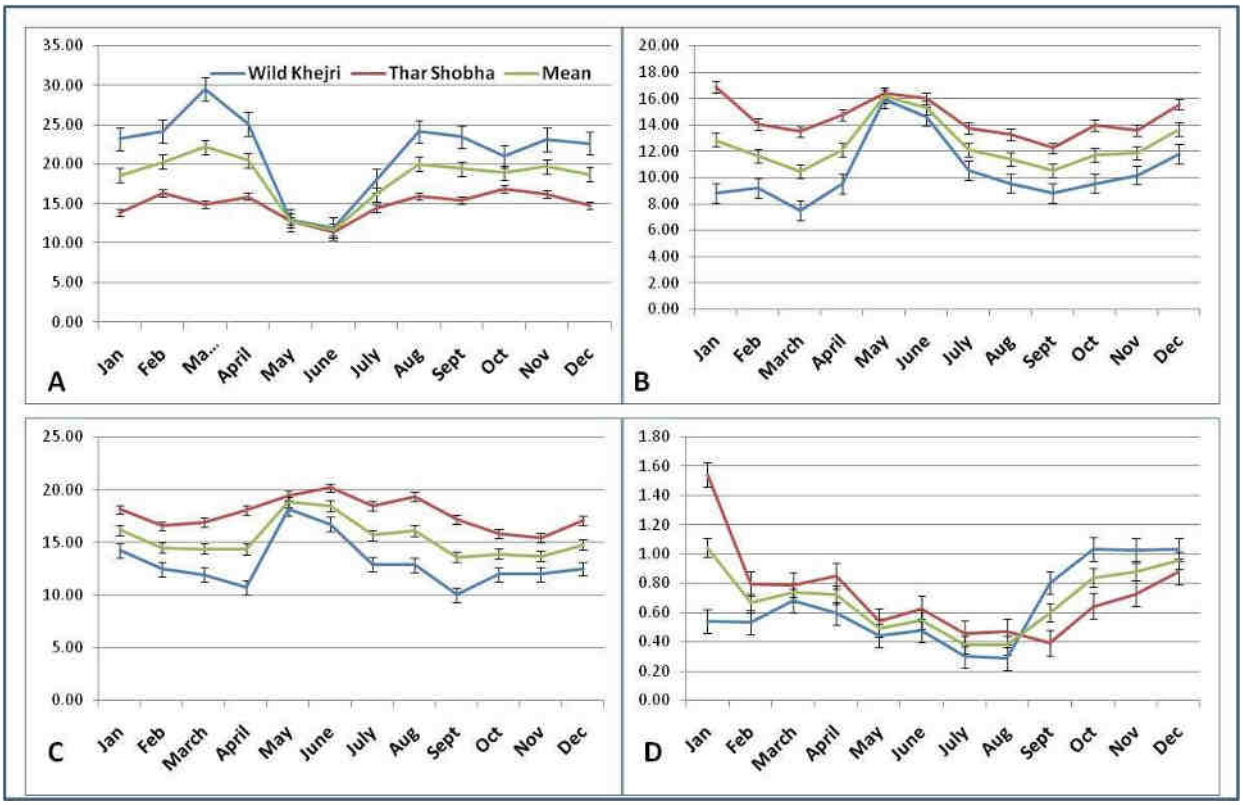


Fig. 81. Effect of abiotic stresses on protein (A), SOD (B), peroxidase (C) and catalase (D) activities in *khejri*

Development of functional foods and nutraceutically rich value added products from arid horticultural crops

During the reporting period (2020), various samples of arid fruits viz. mulberry, ber, bael, cactus pear, aonla have been collected and stored for biochemical analysis. Nutritional analysis of 30 ber cultivars available in the Institute field gene bank was done. Samples of ber and kinnow from different geographical locations being collected and stored at -80 °C for nutraceutical analysis. Developed fortified extruded products using the khokha (dried khejri pods) powder supplementing the basic ingredient of rice flour in varying proportions. Also tried bio-fortification of aonla candy with karonda extract for improving their color appeal and nutritional potential.

Nutraceutical profiling of ber germplasm

An attempt was made to study the nutraceutical profile of 30 different germplasm available within the Institute field gene bank. Among the different cultivars studied, maximum total soluble solids was observed in the cultivar Tikdi (28.1 °Brix) with lowest being in Seb (10.52 °Brix). The titratable acidity (%) was maximum in the cultivar Kathaphal

(1.09%) with lowest acidity in cv. Mundia (0.16%). Vitamin C/Ascorbic acid content were found to be maximum in the ber cv. Thar Malti (54.12 mg/100g FW) while it was minimum in the cv. Thai ber (16.40 mg/100 g FW) (Table 118).

Table 118. Nutraceutical potential of different ber germplasm

Variety	TSS (°Brix)	TA (%)	Vit C (mg/100 g)	Phenols (mg GAE/100 g)	Flavonoids (mg CTE/100 g)	CUPRAC (mg AAE/100 g)	PMA (mg AAE/100 g)
Sanaur-05	23.1	0.48	45.1	290.71	11.06	265.53	315.95
Gola	23.1	0.48	47.56	308.65	16.04	503.26	313.67
Umran	22.8	0.48	47.56	222.52	7.80	237.74	247.76
Mundia	21.7	0.16	37.72	283.53	10.41	342.71	268.21
Rashmi	20.7	0.48	24.6	244.05	9.97	296.40	275.03
Chuhara	26.9	0.48	35.26	269.18	9.32	290.23	286.40
Narma	20.4	0.32	33.62	269.18	6.50	185.25	275.03
Safeda Sel	24.6	0.48	41.82	455.80	20.60	632.94	390.96
Tikdi	28.1	0.81	33.62	513.23	36.64	750.26	445.51
Jogia	21.4	0.32	26.24	287.12	11.71	253.18	290.94
Mehroon	24.3	0.81	37.72	427.09	21.68	611.33	404.59
Dharaki No. 1	18.9	0.81	37.72	455.80	20.38	598.98	370.50
Lakhan	24.5	0.58	19.68	488.10	28.40	765.70	415.96
Banarsi Kadaka	16.7	0.39	20.5	229.70	9.11	419.90	225.03
Kathaphal	26.7	1.09	30.34	376.85	18.86	555.75	359.13
Ilaitchi	23	0.35	22.14	265.59	7.59	240.83	252.30
Kismiss	20.6	0.74	21.32	330.19	12.79	441.51	320.49
Gularvasi	23.4	0.32	17.22	272.76	10.19	314.93	384.14
Kala Gola	18.4	0.55	24.6	326.60	14.53	398.29	340.95
Safed Rohtak	20.4	0.48	22.14	427.09	11.92	287.14	347.77
Chuhara Bawal	22.8	0.48	34.44	330.19	12.14	392.11	379.59
ZG-3	21.4	0.39	28.7	258.41	8.24	237.74	275.03
Thar Sevika	25.5	0.58	25.42	305.07	10.84	330.36	356.86
Thar Bhubraj	24.3	0.45	18.86	315.83	8.24	234.65	290.94
Thar Malti	25.3	0.97	54.12	523.99	37.51	1077.54	518.24
Thai Ber	15.4	0.52	16.4	190.22	12.36	290.23	215.94
Kaithli	13.42	0.29	26.24	262.00	11.06	290.23	265.94
Seb	10.52	0.35	31.98	265.59	12.79	308.75	313.67
Banarsi Pavindi	13.64	0.58	24.6	251.23	9.97	247.00	386.41
Z. rotundifolia	31.8	3.38	35.26	811.11	27.53	812.01	543.25

Total phenolic content was noted high in the cv. Thar Malti (523.99 mg GAE/100 g FW) and lowest in the cv. Thai ber (190.22 mg GAE/100 FW). Total flavonoids were found maximum in the cv. Thar Malti (37.51 mg/100 g FW) and minimum in the cv. Narma (6.5 mg/100 g FW). Study of total antioxidant activity (TAA) by CUPRAC and PMA methods exhibited highest values for Thar Malti (1077.54 and 518.24 mg AAE/100 g FW), respectively. However, the *Z. rotundifolia* species possessed greater acidity (3.38%), TSS (31.8 °Brix), phenols (811 mg GAE/100 g FW), and total antioxidant activity (PMA) (543.25 mg AAE/ 100 g FW) compared to *Z. mauritiana* species.

PLANT PROTECTION

Management of *Fusarium* wilt in muskmelon under field conditions

A trial was conducted for management of *Fusarium* wilt caused by fungal pathogen *Fusarium acuminatum* in muskmelon (*Cucumis melo* L.) variety 'RM-50' through botanicals and

inorganic salts under field conditions. The seeds of muskmelon crop were sown on 26 February, 2020 in the field. Eleven treatments such as neem leaf extract 5%, neem leaf extract 10%,, tumba fruit extract 5%, tumba fruit extract 10%, aak leaf extract 5%, aak leaf extract 10%, neem seed kernel extract (NSKE) 5%, salicylic acid 500 ppm and borax 500 ppm, carbendazim (0.1%) and control (without spray) were taken in the field trial against this disease. Per cent disease index and per cent disease reduction were also calculated. In case of *Fusarium* wilt, minimum per cent disease index was found 17.38% while maximum per cent disease index was 41.26% under field conditions. Among 11 treatments, carbendazim (0.1%) was found the most efficient treatment against *Fusarium* wilt with minimum per cent disease index of 17.38% and 57.87 per cent disease reduction, followed by neem leaf extract 10% with per cent disease index of 24.12% and 41.54% disease reduction. Next best treatments were tumba fruit extract (10%) and aak leaf extract (10%) with per cent disease index of 26.45% and 29.13% as well as 35.89% and 29.39% disease reduction, respectively. It was also revealed that neem leaf extract, tumba fruit extract and aak leaf extract (10% concentration of each) were statistically at par with another. Least effective inorganic salts were borax 500 ppm and salicylic acid 500 ppm having 38.74% and 39.86% PDI as well as 6.11% and 3.39 per cent disease reduction, respectively. These two salts were also statistically at par with each other. Maximum disease index (41.26%) was found in case of control (Table 119).

Table 119. Management of *Fusarium* wilt in muskmelon during summer season of 2020

Treatments	Doses	Per cent disease index (%)	Per cent disease reduction (%)
Neem leaf extract	5%	31.54 (34.08)	23.56
Neem leaf extract	10%	24.12 (29.34)	41.54
Tumba fruit extract	5%	34.48 (35.91)	16.43
Tumba fruit extract	10%	26.45 (30.87)	35.89
NSKE	5%	32.72 (34.86)	20.69
Aak leaf extract	5%	36.17 (36.94)	12.34
Aak leaf extract	10%	29.13 (32.54)	29.39
Borax	500 ppm	38.74 (38.46)	6.11
Salicylic acid	500 ppm	39.86 (39.12)	3.39
Carbendazim	0.1%	17.38 (24.51)	57.87
Control	-	41.26 (39.94)	-

Occurrence of disease severity of *Alternaria* leaf spot in date palm

Date palm (*Phoenix dactylifera* L.) is infected by many important diseases. Out of which, *Alternaria* leaf spot caused by *Alternaria alternata* (Fr.) Keissler is moderate to severe disease in date palm growing areas under hot arid region. This disease was appeared from the month of August to November, 2020 under field conditions at date palm block of the Institute. Severity of this disease was found from 0.0 to 22.30% in some date palm varieties (Khalas, Zahidi, Chip-chap, Halawy, Medini and Medzool). Symptoms were observed as small light/dark gray to black circular spots. Later on, these spots increased in size and become irregular and black to straw colored and coalesced. The diseased leaves turned light yellow and defoliated under severe conditions (Fig. 82).

Fig. 82. *Alternaria* leaf spot of date palm leaves

Collection, isolation and characterization of *Rhizobium* sp. from cluster bean

Twenty *Rhizobium* isolates were isolated from collected root nodules. All twenty isolates were acid producers and fast growers. Ability of the isolates to grow at different acidic pH range such as 3.5, 4.5, 5.5, 6.5 and alkaline pH 7.5, 8.5 and 9.5 were studied. No isolates could grow at pH 9.5 and 3.5. Three isolates could grow at pH 4.5 and 7 isolates at pH 5.5. Ability of the isolates to grow at different salt concentration that is 1%, 2%, 3%, 4%, 5% and 6% NaCl were also studied (Table 120). Six isolates were showing growth at 2% NaCl and all isolates were able to grow at 1% NaCl. No isolate could grow above 2% NaCl salt concentration. Ability of isolates to grow at different temperature at 10, 28 and 37 °C was determined. No isolate was able to grow at 10 °C, whereas 16 isolates could grow at 37 °C and all isolates could grow at 28 °C. CLB11, CLB16 strains of *Rhizobium* spp. isolated from cluster bean could grow well at higher temperature of 37 ^{0}C, alkaline pH of 8.5 and higher salt concentration of 2% NaCl.

Table 120. Morphological and physiological characterization of *Rhizobium* in cluster bean

Strain code	Location	Type of crop	Temperature sensitivity	pH sensitivity	Salt sensitivity
CLB01	Lunkaransar	Rainfed crop	Grow at 28 °C, 37 °C	Grow at pH 5.5, 6.5, 7.5 8.5	Grow at 1% NaCl
CLB02	Lunkaransar	Rainfed crop	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5 8.5,	Grow at1% NaCl
CLB03	Kolayat	Rainfed crop	Grow at 28 °C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CLB04	CIAH	Rainfed crop	Grow at 28 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB05	CIAH	Rainfed crop	Grow at 28 °C, 37 °C	Grow at pH 5,5, 6.5, 7.5 8.5	Grow at 1% NaCl
CLB06	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 4.5, 5.5, 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CLB07	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 4.5, 5.5,6.5, 7.5, 8.5	Grow at 1% , 2% NaCl
CLB08	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5,	Grow at 1% NaCl
CLB09	CIAH	Irrigated	Grow at 28 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB10	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB11	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 4.5, 5.5, 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CLB12	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% , 2% NaCl
CLB13	CIAH	Irrigated	Grow at 28 °C	Grow at pH 6.5, 7.,5 8.5	Grow at 1% NaCl
CLB14	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB15	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB16	CIAH	Irrigated	Grow at 28°C, 37°C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CLB17	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB18	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB19	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CLB20	CIAH	Irrigated	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl

Collection, isolation and characterization of *Rhizobium* sp. from cowpea

Twenty *Rhizobium* isolates were isolated from collected root nodules. All twenty isolates were acid producers and fast growers. Ability of the isolates to grow at different acidic pH range such as 3.5, 4.5, 5.5, 6.5 and alkaline

pH 7.5, 8.5 and 9.5 were studied (Table 121). All twenty isolates could grow at pH 6.5, 7.5 8.5. No isolates could grow at pH 9.5, 4.5 and 3.5. Five isolates could grow at pH 5.5. Ability of the isolates to grow at different salt concentration that is 1%, 2%, 3%, 4%, 5% and 6% NaCl were studied. Five isolates were showing growth at 2% NaCl and all isolates were able to grow at only 1% NaCl. No isolate could grow above 2% NaCl salt concentration. Ability of isolates to grow at different temperature was also determined at 10, 28 and 37 °C. No isolate was able to grow at 10 °C, 18 isolates could grow at 37 °C and all isolates could grow at 28 °C. CWP05, CWP04, CWP08, CW11 strains of *Rhizobium* spp. isolated from cowpea could grow well at higher temperature 37 °C, alkaline pH of 8.5 and higher salt concentration 2% NaCl.

Table 121. Morphological and physiological characterization of *Rhizobium* in cowpea

Under irrigated situation at ICAR-CIAH, Bikaner			
Strain code	**Temperature sensitivity**	**pH sensitivity**	**Salt sensitivity**
CWP01	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP02	Grow at 28 °C, 37 °C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP03	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP04	Grow at 28 °C, 37 °C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CWP05	Grow at 28 °C, 37 °C	Grow at pH5.5, 6.5, 7.5, 8.5	Grow at 1% ,2% NaCl
CWP06	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP07	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP08	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CWP09	Grow at 28 °C, 37 °C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP10	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP11	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CWP12	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP13	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1%, 2% NaCl
CWP14	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP15	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP16	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP17	Grow at 28°C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP18	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP19	Grow at 28 °C, 37 °C	Grow at pH 6.5, 7.5, 8.5	Grow at 1% NaCl
CWP20	Grow at 28 °C, 37 °C	Grow at pH 5.5, 6.5, 7.5, 8.5	Grow at 1% NaCl

Root borer in bael under semi-arid condition

Under rainfed semi-arid conditions at CHES, Godhra, Gujarat root borer was observed in the month of December, 2020. Root borers (grub), *Acanthophorus* spp. (2/plant of 100-110 mm length) were observed at a depth of one feet indicating possible association with the drying of bael plants. It is first report from rainfed semi-arid conditions of western India (Fig. 83).

Fig. 83. Dried plant of bael and grub with root tunnelling by larvae

Insect pest and diseases of potato

Leaf miner and aphid were observed insect pest, whose damage was very negligible. Low aphid population was observed till third week of February and after third week population was increased due to rains in last week of February, aphid population decreased in March first week. No aphid transmitted virus diseases symptoms were observed. Brown spot of potato was observed with per cent disease incidence of 1-20% varying from variety to variety. Early spot of potato appeared during last week of February, per cent disease incidence was 1-12% varying from variety to variety. Characterization of brown spot of organism *Alternaria alternata* was also done. *Alternaria alternate* is reported for first time in Rajasthan on potato.

Characterization of potato brown spot causing *Alternaria alternata*

In field, symptoms were not observed on petiole and stem unlike early spot diseases. Diseases progression is slow and not as aggressive as early spot**.** Spots were not typical concentric ring type and were mostly not surrounded by yellow hallow. Also spots size is small and dark compared to the early spot. Early leaf spot symptoms are mostly seen in lower leaves whereas brown leaf spot are also in middle leaves**.** Later, smaller spots coalesce to form larger necrotic areas and dry completely. Isolation of the pathogen from infected leaf was carried out on PDA media at 25 **°C.** Pathogenecity test was carried was out on potato variety Kufri Jyoti to prove Koch postulates. Fungus grew rapidly and colony size reaches a diameter of 3-9 cm after incubation at 25 **°C** for 7 days on PDA. The colonies were flat, woolly and were covered by greyish white at the beginning which later darkens after spore production and with greenish black or with light border. The reverse side is typically brown to black due to pigmentetion. *Alternaria solani* colonies were cottony in texture and had slow growth and did not readily sporulate. Conidia were born in chains and has no beak or very short beak unlike *Alterneria solani* were pale brown to light brown in color, surface is smooth to verruculose, both vertical and transverse septet and obclavate. Brown spot caused by *Alternaria alternata* as not been so far reported from Rajasthan and it's a first report (Fig. 84).

Fig. 84. Upper surface and chains of conidia of *Alternaria alternata* colony

POST HARVEST MANAGEMENT

Development of fortified extruded products using dried ripe *khejri* pods (*khokha*)

The tender pods of *khejri* are eaten green or dried after boiling, locally called as *sangri* used in preparation of curries and pickles. The tender pods, if not harvested in time, they mature, ripe and get dried on the tree itself. The dried ripe pods are referred to as *khokha* and tastes sweet. These pods possess 45–55% carbohydrate, 9–14% crude protein, 6–16% sugar and 1.0–3.4% reducing sugars. The pods and leaves are favorite feed for animals especially goats, ship, camel, *etc*.

Thus, to find an alternate use to these nutrient rich *khokha* pods, an attempt was made to supplement the traditional ingredient rice flour with dried *khokha* powder along with maize flour in the preparation of extruded products. In addition to the varying proportions of the *khokha* powder supplementation, the other variable factors include temperature of the extruder and the screw speed which are being optimized for getting the best acceptable product. The design used was Response Surface Methodology (RSM) with the following

combination of treatments (Table 122 and Fig. 85). Among various treatment combinations, the sensory appeal was greater in the treatments T_8 and T_{10}.

Table 122. Treatment combinations of response surface methodology (RSM) design

Treatment	Temp (°C)	Screw speed	*Khejri* powder	Corn flour	Rice flour
T_1	100	30	200	250	550
T_2	100	31.5	100	250	650
T_3	100	33	200	250	550
T_4	110	30	300	250	450
T_5	110	30	100	250	650
T_6	110	31.5	300	250	450
T_7	110	31.5	200	250	550
T_8	110	33	100	250	650
T_9	110	33	300	250	450
T_{10}	120	31.5	100	250	650
T_{11}	120	31.5	300	250	450
T_{12}	120	30	200	250	550
T_{13}	120	33	200	250	550
T_{14}	110	31.5	0	650	350

Fig. 85. Extrudates developed of rice flour with *khokha* powder under RSM

Biofortification of aonla candy using karonda extract

An attempt was made to standardize the quantity of karonda extract to be impregnated for getting the desirable color improvement and nutritional replenishment. The treatment of impregnation with karonda extract had significant effect on the quality and acceptability of the aonla candy. The anthocyanin pigmentation increased with increasing percentage of the karonda extract. There is no significant difference among the treatments in terms of product recovery. The titratable acidity was highest in the control

candy compared to other treatments as well as fresh aonla fruit. The ascorbic acid content (mg/100 g) was highest in fresh aonla fruits as compared to the candy; however, among various treatments candy impregnated with 2% karonda extract exhibited highest ascorbic acid content among the treatments (Fig. 86 to 88)
.

Fig. 86. Biofortified aonla candy prepared through impregnation of karonda extract

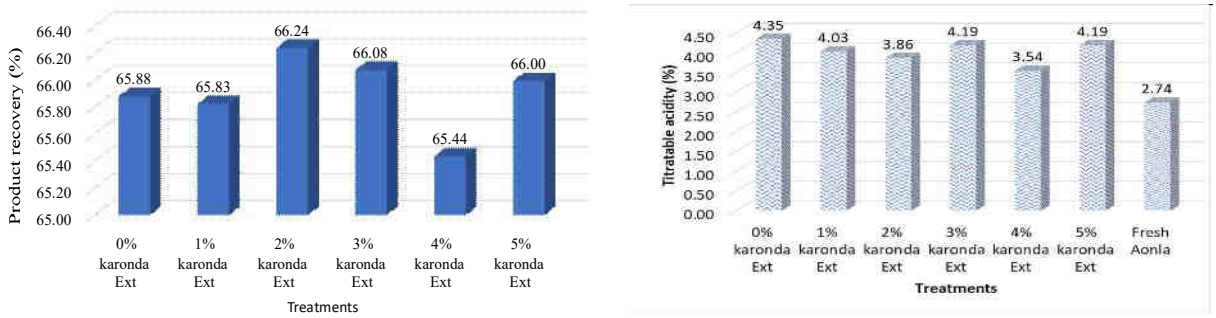


Fig. 87. Representation of product recovery (%) and acidity (%) as effected by different treatments

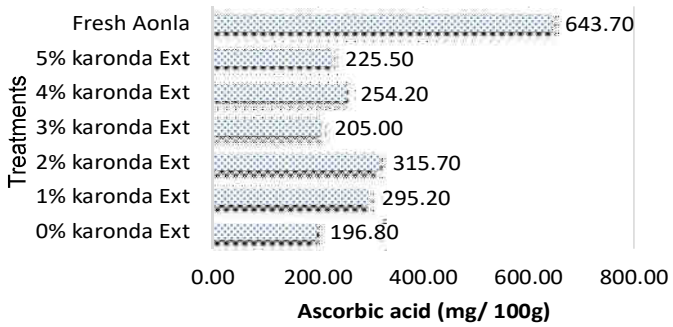


Fig. 88. Comparision of ascorbic acid of fortified candies with aonla candy and fresh aonla fruit

Storage studies in mulberry fruits

Storability of the mulberry fruits both red type (Thar Lohit) and green type (Thar Harit) was worked out by storing them at two different temperatures *i.e.* ambient conditions (32 ± 2 °C and 30 ± 2% RH) and refrigerated storage (4 ± 2 °C and 30 ± 2% RH). Fruits stored under ambient conditions could last for only 3 days compared to those stored under refrigerated conditions which lasted up to 8 days. Among the two cultivars, Thar Harit exhibited a greater physiological loss in weight (PLW) compared to Thar Lohit at both the storage conditions. There was no significant variation in the total soluble solids (TSS) of both the cultivars during the entire storage period (Fig. 89 & 90).

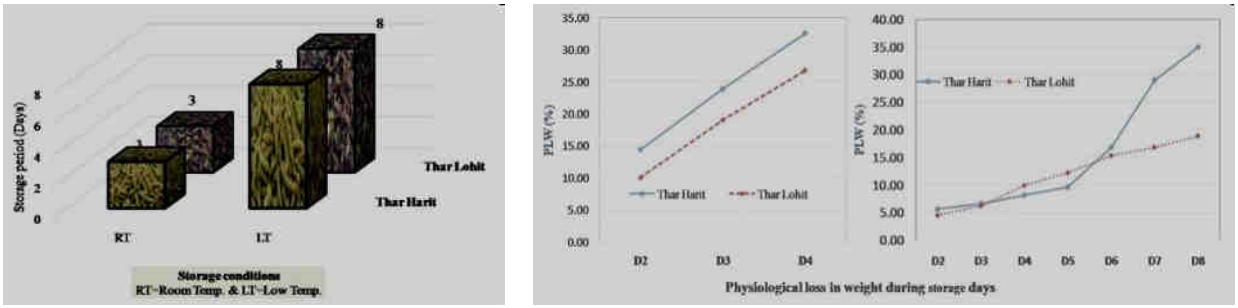


Fig. 89. Storage studies and PLW in mulberry cvs. Thar Harit and Thar Lohit

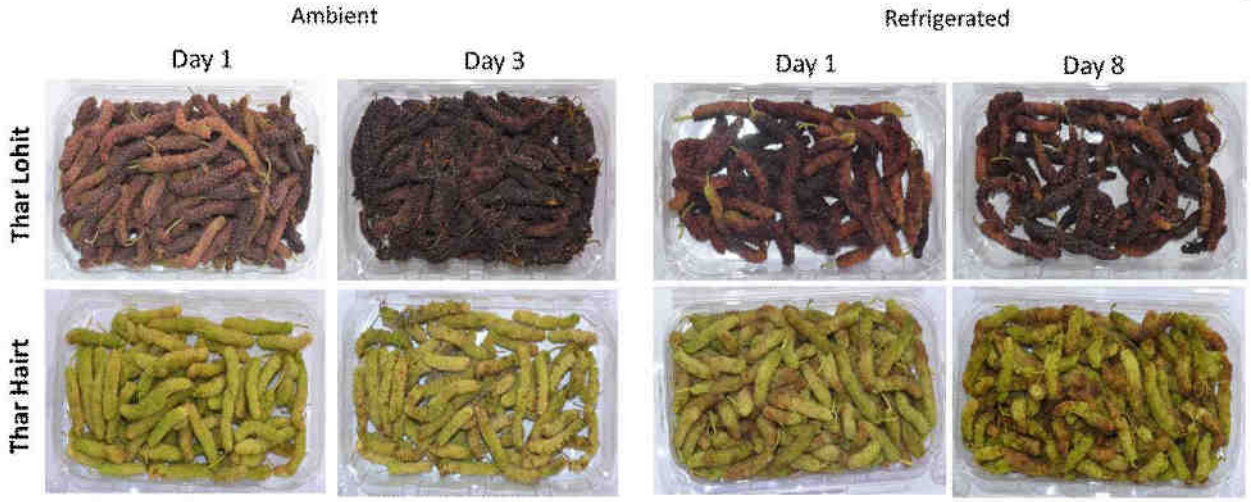


Fig. 90. Storage of mulberry fruits at ambient and refrigerated conditions

Standardization of drying method for cluster bean

Looking into the importance of dehydrated cluster bean, a method has been standardized for dehydration of green pods. Tender pods were harvested at 10-12 days after setting. Pods separated from the cluster, washed with clean water, blanched at 90 °C for five minutes, immediately immersed in cold water to prevent overcooking. Thereafter, pods kept in perforated stainless steel trays and dried at room temperature for 48 h. Trays were covered with perforated plastic net to protect from rodents, birds and other foreign material. Average dried product recovery was 19.77% of fresh weight (Fig. 91).

Fig. 91. Fresh, dehydrated and rehydrated pod of cluster bean

Effect of blanching on drying and rehydration characteristics of cluster bean

The blanching time was standardized for cluster bean green pods. Pods were blanched for 3, 4, 5, 6 and 7 minute's time in boiling water (90 °C). Blanching of green pods for five minutes was found ideal for retaining colour, texture and sufficient reconstitution capacity in dried product. Rapid moisture loss was observed in blanched pods compared to unblanched (control) pods. In blanched pods, eighty per cent moisture loss was achieved within 68 h while unblanched pods took 180 h for same quantum of moisture loss (Fig. 92). Fast removal of moisture from blanched pods may be due to loosening of water from tissues and opening of surface pores by the process of heat treatment.

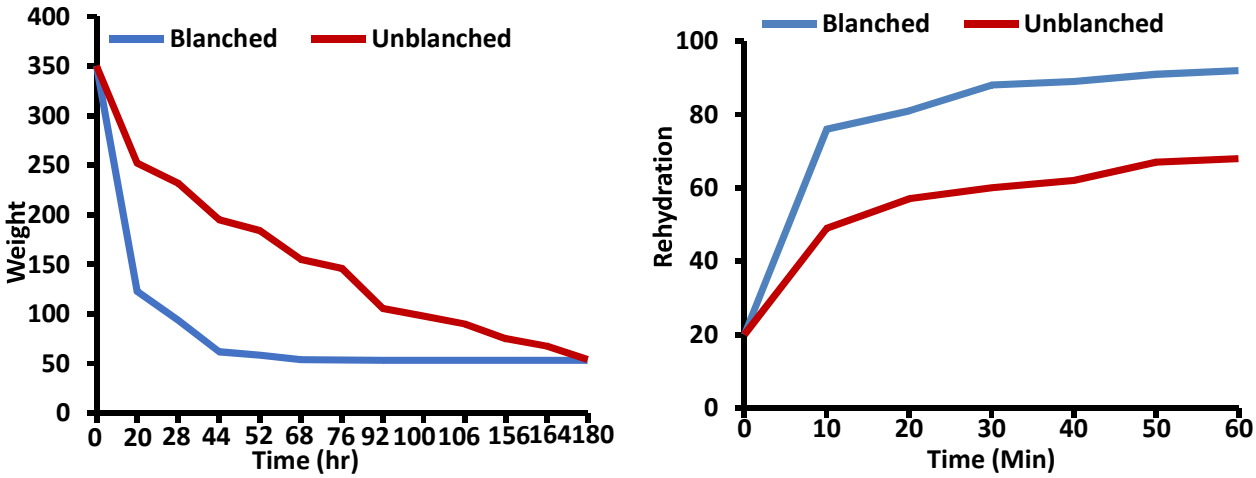


Fig. 92. Drying and rehydration kinetics of blanched and unblanched pods of cluster bean

Blanched pods absorb water more rapidly as compared to unblanched during rehydration. Blanched pods absorb water four times of its initial weight during 60 min. rehydration period and dried pods regained fresh pods like texture, structure and shape. However, unblanched pods does not reconstitute properly during rehydration process. Hence, it is concluded from the study that blanching process is essential prior to drying/dehydration of cluster bean green pods and 5 minutes blanching in boiling water found ideal.

Protocol standardized for making bael candy

An attempt was made to standardize a protocol for making candy from unripe fruits of bael var. NB-9. Raw fruits were sliced into size of 4 x 2 cm (L x W) and seeds and fruit rind were separated. Slices were blanched in boiling water for 15 minutes then dipped in 60 °Brix sugar syrup for 24 h. Then slices were removed from the syrup and sugar concentration was enhanced to 70 °Brix and again slices dipped in syrup. This process was repeated for 3 times till the stability of syrup °Brix. Removed slices from syrup, washed with hot water (50 °C) to remove adhered sugar from surface. Slices were dried in cabinet dehydrator for 8 h at 50 °C temperatures. Removed from the dehydrator and kept for 3 h at room temperature for conditioning. Candy got 8.60 score out of 9 point hedonic scale during sensory evaluation. Candy was packed in food grade plastic containers for further storage study (Fig. 93)

Fig. 93. Bael candy and fresh fruit

TECHNOLOGICAL IMPACT ASSESSMENT

Date palm cultivation in Rajasthan

During 2020, a survey was conducted and the preliminary information including secondary data/information about the adoption,

area and production under improved variety of date palm from different districts of Rajasthan were collected. The collected data were analyzed to draw the impact of the same in hot arid region of Rajasthan (Table 123).

Table 123. Area (ha) and production (metric ton) of date palm in hot arid region

District	Year										
	2016		2017		2018		2019		2020		
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Rank
Bikaner	218	223	232	288	265	356	280	4120	320	4530	I
Jaisalmer	190	2534	190	2770	191	2805	193	2910	196	3171	II
Ganganagar	145	2010	150	2130	158	2430	161	2601	170	2980	III
Hunumangarh	122	790	124	807	127	955	128	980	130	1100	V
Barmer	66	455	74	589	80	730	112	1030	140	1155	IV
Nagaur	31	315	36	390	37	418	39	430	40	440	IX
Jodhpur	30	300	32	320	33	340	35	370	37	390	X
Jalore	12	140	36	400	67	667	102	780	110	1070	VI
Churu	10	110	23	220	37	290	54	410	84	650	VII
Pali	9	100	11	125	22	260	53	470	64	510	VIII
Sirohi	6	65	12	125	22	240	26	255	31	270	XI
Jhunjhunu	4	40	6	60	8	85	11	88	12	116	XII
Sikar	-	-	-	-	5	-	5	-	6	30	XIII
Jaipur	-	-	-	-	3	-	4	-	5	20	XIV
Total	843	6859	926	7936	1055	9220	1203	10324	1345	16432	

Pomegranate cultivation in Rajasthan

The preliminary information under improved variety of pomegranate from different districts of Rajasthan were collected to understand the trend in adoption, area and production of pomegranate in hot arid region of Rajasthan. The initial data/information is being presented as below in Table 124.

Table 124. Area (ha) and production (metric ton) of pomegranate in hot arid region

Districts	Year								Rank
	2016-17		2017-18		2018-19		2019-20		
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	
Barmer	6120	10560	6408	10749	7020	12660	7206	12880	I
Jalore	2690	35304	2777	3443	2838	4540	3023	4136	II
Bhilwara	456	1129	496	1293	526	1060	590	1344	IV
Jodhpur	220	304	230	333	260	435	304	486	VI
Jaisalmer	196	260	211	346	240	354	280	458	VII
Bikaner	630	880	890	1324	1170	1655	1524	2238	III
Pali	130	208	152	243	183	292	234	375	X
Sirohi	140	224	156	250	188	300	235	376	IX
Chittorgarh	98	690	106	870	134	890	190	1304	V
Nagaur	45	80	48	91	96	155	124	198	XIV
Rajsamand	30	48	34	76	62	123	80	168	XVI
Jaipur	62	121	70	135	80	147	105	192	XV
Dausa	30	69	32	72	55	88	60	176	XVII
Sikar	55	88	64	107	80	128	240	384	VIII
Churu	35	58	45	68	56	72	58	78	XVIII
Udaipur	65	132	80	148	102	214	130	296	XII
Ganganagar	52	122	65	160	108	274	110	254	XIII
Hanumangarh	65	115	78	164	122	256	126	297	XI
Total	11119	50392	11942	19872	13320	23643	14619	25640	

Ber cultivation in Rajasthan

During the survey, the preliminary data about the present status with respect to trend in adoption, area and production of ber in different districts of Rajasthan were collected and documented. The initial data/information are presented in Table 125.

Table 125. Area (ha) and production (metric ton) of ber in hot arid region

Distt.	Year										
	2005-06		2010-11		2015-16		2018-19		2019-20		Rank
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	
Bikaner	105	880	210	2002	330	35690	377	3860	435	4480	I
Jaisalmer	43	220	62	690	82	790	109	1088	148	1543	X
Pali	103	878	248	1990	301	3440	366	3640	380	3967	III
Jodhpur	141	1410	160	1690	198	1688	250	2160	304	3080	IV
Nagaur	65	430	105	810	182	1809	232	2060	262	2270	VII
Barmer	215	2180	236	2280	326	5760	335	6761	380	3990	II
Ganaganagar	12	131	28	260	48	467	68	441	87	898	XIII
Hanumangarh	11	98	25	240	46	410	66	590	80	860	XIV
Jaipur	90	1010	122	1690	130	1520	138	1840	150	2256	VIII
Sikar	122	1234	193	2345	233	2730	265	3480	295	2980	V
Churu	23	189	32	256	35	280	35	341	44	455	XV
Sirohi	38	398	44	425	56	565	77	758	98	988	X
Jalore	34	380	90	810	134	1530	188	2010	257	2420	VI
Udaipur	123	1410	145	1295	156	1520	167	1821	190	1950	XII
Bharatpur	70	1005	92	1108	134	1598	164	1635	180	2088	IX
Total	1195	11853	1792	17891	2391	59797	2837	32485	3290	34225	

Impact assessment of *kachri* cultivation in Rajasthan

An extensive survey was conducted in hot arid region of western Rajasthan to collect the data/information from farmers/stakeholders and secondary sources to assess the adoption and area under improved variety of *kachri* (AHK-119). The data reveals that this improved variety of *kachri* (AHK-119) has been adopted on maximum area in Bikaner district with first rank followed by Nagaur, Jodhpur, Sikar and Pali (Table 126).

Table 126. Area (ha) and production (metric ton) of *kachri* (AHK-119) in Rajasthan

District	2007	2009	2010	2011	2012	2014	2015	2016	2017	2018	2019	2020	Rank
Barmer	32	36	105	62	92	122	103	122	145	154	161	186	VI
Bikaner	630	472	1280	1087	1465	1480	1405	1505	1720	1789	1823	1866	I
Churu	32	29	58	52	62	80	72	84	96	101	110	134	IX
Ganganagar	10	9	36	28	33	35	28	35	41	47	58	76	XII
Hanumangarh	11	11	28	25	31	36	30	34	46	52	58	76	XI
Jaisalmer	19	18	52	68	78	68	52	72	86	98	112	132	VII
Jalor	17	24	64	59	71	71	62	83	85	96	108	119	X
Jhunjhunu	40	20	55	64	74	89	78	89	137	141	148	178	VIII
Jodhpur	50	36	104	94	131	152	141	152	181	195	213	238	III
Nagaur	348	267	688	572	774	1035	902	925	1081	1056	1098	1104	II
Pali	39	20	42	68	79	89	74	92	110	134	154	177	V
Sikar	48	25	78	74	95	108	110	122	137	148	167	186	IV
Total	1277	967	2590	2253	2985	3365	3057	3315	3865	4011	4043	4472	

The area and production of AHK-119 increased tremendously on large scale during 2007 to 2020. The area under AHK-119 was 2057 ha and production was 18.30 thousand tons in 2007 which increased >7 thousand ha and >60 thousand tons in the year of 2020 in Rajasthan. The gross return from AHK-119 variety of *kachri* alone was Rs. 28.19 crores in 2007 which increased to more than Rs. >86 crores in 2020 (Table 127).

Table 127. Area (ha) and production (thousand ton) of *kachri* in Rajasthan

Years	Area under improved variety*	Area under local variety**	Total area	Prod^{n}. under improved variety	Prod^{n}. under local variety	Total Production
2007	2057	2381	4438	18.30	15.24	33.54
2008	1716	1890	3606	15.27	12.10	27.37
2009	1489	1475	2964	13.25	9.44	22.69
2010	4028	2551	6579	35.85	16.32	52.18
2011	2843	2030	4873	25.30	12.99	38.29
2012	3415	3077	6492	30.39	19.69	50.09
2013	2981	2048	5029	26.53	13.11	39.64
2014	4505	2471	6976	40.10	15.81	55.91
2015	3832	2023	5855	34.11	12.95	47.05
2016	3878	2822	6700	34.51	18.06	52.57
2017	6093	2884	8977	54.22	18.46	72.68
2018	6625	2908	9533	57.33	18.88	76.21
2019	6815	2940	9755	58.42	19.34	77.76
2020	7123	2901	1024	60.03	19.11	79.14

Impact of adoption of *kachri* variety AHK-119 in terms of income and employment generation in hot arid regions

The adoption and production of improved variety of *kachri* had highly positive impact on employment generation and wages earning/income of the farmers/clients in the hot arid regions of the country (Table 128).

Table 128. Impact of *kachri* cv. AHK-119 in terms of income and employment generation

Year	Total area	No. of labour (man days/ ha/season)	Labour wage (Rs./day)	Total employment (man days) generated (lakh/year)	Value of labour income (wages) generation (Rs. crore/year)
2007	2057	84	164	1.73	2.83
2008	1716	84	176	1.44	2.54
2009	1489	84	180	1.25	2.25
2010	4028	84	188	3.38	6.36
2011	2843	84	211	2.39	5.04
2012	3415	84	219	2.87	6.28
2013	2981	84	240	2.50	6.01
2014	4505	84	267	3.78	10.10
2015	3832	84	281	3.22	9.05
2016	3878	84	313	3.26	10.20
2017	6093	84	322	5.12	16.48
2018	6625	84	340	5.56	18.90
2019	6815	84	350	5.72	20.02
2020	7123	84	350	5.98	20.93
Total				48.20	136.99

Impact assessment of snapmelon cultivation in Rajasthan

An extensive survey was conducted in hot arid region of western Rajasthan to collect the data/information from farmers/stakeholders and secondary sources to assess the adoption and area under improved variety of snapmelon (AHS-82). The data showed that this improved variety (AHS-82) has been adopted on maximum area in Bikaner district with first rank followed by Nagaur, Sikar Pali and Jaisalmer (Table 129).

Table 129. Area (ha) under snapmelon variety AHS-82 in hot arid region of Rajasthan

Distt.	2007	2009	2010	2011	2012	2014	2015	2016	2017	2018	2019	2020	Rank
Barmer	24	49	60	27	48	84	69	92	96	102	114	123	VIII
Bikaner	310	766	678	475	708	1021	1105	1083	1206	1234	1256	1293	I
Churu	29	57	82	55	46	56	63	72	61	68	76	88	IX
Ganganagar	8	19	26	15	22	32	27	37	57	66	75	78	XI
Hanumangarh	9	23		11	28	29	44	31	35	44	53	66	XII
Jaisalmer	15	49	46	31	57	41	52	69	89	98	113	136	V
Jalore	30	33	39	23	48	39	46	32	55	65	76	79	X
Jhunjhunu	35	41	33	33	46	49	51	66	105	112	123	134	VI
Jodhpur	22	54	50	37	62	75	82	63	110	117	124	128	VII
Nagaur	222	389	320	231	308	422	309	388	527	534	557	576	II
Pali	44	56	39	28	48	66	58	69	103	116	126	144	IV
Sikar	37	42	54	32	55	44	49	88	104	121	130	145	III
Total	785	1578	1427	998	1476	1958	1955	2090	2549	2677	2823	2990	

The area under this variety (AHS-82) was 969 ha and production was 14.34 thousand tons in 2007 which estimated to increase 4340 thousand ha and 58.09 thousand tons, respectively in the year of 2020. The gross return from this improved variety (AHS-82) alone was Rs. 11.76 crores in 2007 which increased to Rs. >50 crores in 2020 (Table 130).

Table 130. Area (ha) and production (thousand ton) of snapmelon (AHS-82 and local variety) under hot arid region of the India

Year	Area under AHS-82*	Area under Local Var. **	Total area	Prod. under AHS-82	Prod. under local var.	Total Prod. tones
2007	969	1268	2237	14.34	13.31	27.65
2008	1202	1030	2232	17.79	10.82	28.61
2009	2245	1289	3534	33.23	13.53	46.76
2010	1993	1876	3869	29.49	19.69	49.19
2011	1315	1387	2702	19.46	14.56	34.02
2012	2489	1849	4338	36.84	19.42	56.25
2013	2231	1427	3658	33.03	14.98	48.00
2014	2252	1974	4226	33.34	20.72	54.06
2015	3278	1867	5145	48.51	19.60	68.12
2016	3470	1902	5372	51.36	19.97	71.33
2017	3562	1987	5549	52.72	20.86	73.58
2018	3815	2017	5832	54.21	21.11	75.32
2019	4120	2036	6156	56.06	22.23	78.29
2020	4340	1990	6330	58.09	21.88	79.97

Impact of snapmelon (AHS-82) in terms employment generation and wages earning/income

The data showed that adoption and production of improved variety of snapmelon had highly positive impact on employment generation and wages earning/income of the farmers /clients in the hot arid regions of the country (Table 131).

Table 131. Impact of snapmelon cv. AHS-82 in terms of employment generation in hot arid region

Year	Area	Labour engaged/ ha/season	Labour wage (Rs. /day)	Total employ ment (man days) gererated (lakh/year)	Concealed income labour wages (Rs. crores/year)
2007	969	71	164	0.69	1.13
2008	1202	71	176	0.85	1.50
2009	2245	71	180	1.59	2.87
2010	1993	71	188	1.42	2.66
2011	1315	71	211	0.93	1.97
2012	2489	71	219	1.77	3.87
2013	2231	71	240	1.58	3.80
2014	2252	71	267	1.60	4.27
2015	3278	71	281	2.33	6.54
2016	3470	71	313	2.46	7.71
2017	3562	71	322	2.53	8.14
2018	3815	71	340	2.71	9.21
2019	4120	71	350	2.92	10.22
2020	4340	71	350	3.08	10.78
			Total	**26.46**	**73.67**

4. EXTERNALLY FUNDED PROJECTS

1. DUS Centre on date palm

Funding agency: PPV& FRA, New Delhi

A total of 42 date palm varieties were maintained in field repository and evaluated for morphological, flowering and fruiting characters as per DUS guideline. The observations on spathe emergence/opening were recorded in 37 varieties. The spathe emergence was started from second week of January in male and second week of February in female completed in middle of March. Delay in emergence of spathe was observed in few varieties during the year which may be due to change in climatic condition. Out of 42 varieties, fruiting characters were recorded in 37 varieties because, poor fruit set & fruits were dropped in some varieties like Hetami, Hillali *etc*. during the year. Early fruit maturity *i.e. doka* stage was recorded in cv. Nagal and harvested in last week of June month. Maximum fruit yield per plant was recorded in cultivar Hayani (82 kg) followed by Zahidi, while minimum was recorded in Nagal Hillali (10 kg). Five farmers from Rajasthan have submitted application to PPV&FRA for testing of date palm varieties.

2. DUS Centre on ber

Funding agency: PPV& FRA, New Delhi

Twenty five reference and 85 example varieties of ber were maintained in field gene bank. During the year 2020, eight claimed varieties (Fig. 94 & 95) from Jai Durga Krishak Club, VPO-Lakhuri, Janjgeer-Champa, Raipur were evaluated on site and validated the collected data as per descriptor (all 36 parameters). DUS activity monitoring team and variety validation committee meeting held at ICAR-Central Institute for Arid Horticulture, Bikaner on 3-4 March, 2020 under chairmanship of Prof. (Dr.) P.L. Saroj (Director, ICAR-CIAH, Bikaner), Dr. O.P. Awasthi as expert (Professor, Department of FH&T, IARI, New Delhi) and Dr. Ravi Prakash (Registrar, PPV&FRA, New Delhi). Report has been submitted to PPV&FR authority (Fig. 96).

3. DUS Centre on bael

Funding agency: PPV& FRA, New Delhi

Reference varieties, *viz.,* Goma Yashi, Thar Divya, Thar Neelkanth, Thar Srishti, NB-5, NB-7, NB-9, NB-16, NB-17, Pant Aparna, Pant Sujata, Pant Shivani, Pant Urvashi, CISH-B-1 and CISH-B-2 are being maintained at the station to characterize the farmer's varieties.

Lakhuri ber-15/ REG/2015/2420

Quality attributes:
Fruit weight:9.88 g
Stone weight:0.63 g
TSS: 19.8 ^{o}Brix
Acidity:0.30 %
Ascorbic acid:60.56 mg/100 g

Lakhuri ber 32/ REG/2015/2437

Quality attributes :
Fruit weight:14.17 g
Stone weight:2.3 g
TSS: 18.5 ^{o}Brix
Acidity:0.78 %
Ascorbic acid:37.00 mg/100 g

Lakhuri ber 53/ REG/2015/2458

Quality attributes:
Fruit weight:9.17g
Stone weight:0.72 g
TSS: 15.6 ^{o}Brix
Acidity:0.52 %
Ascorbic acid:47.32 mg/100 g

Lakhuri ber 80/ REG/2015/2331

Quality attributes:
Fruit weight:20.28 g
Stone weight:2.64 g
TSS: 21.1 ^{o}Brix
Acidity:0.81%
Ascorbic acid:63.8 mg/100 g

Fig. 94. DUS descriptors of claimed varieties of ber

Lakhuri ber 88/ REG/2015/2340	Lakhuri ber 89/ REG/2015/2339	Lakhuri ber 125/ REG/2015/2376	Lakhuri ber 144/ REG/2015/2395
			
Quality attributes: Fruit weight:8.56 g Stone weight:0.98 g TSS: 24.2 ^{o}Brix Acidity:0.40 % Ascorbic acid:27.12 mg/100 g	Quality attributes: Fruit weight:14.59 g Stone weight:2.88 g TSS: 18.88 ^{o}Brix Acidity:0.51 % Ascorbic acid:96.68 mg/100 g	Quality attributes: Fruit weight;9.08g Stone weight:1.23g TSS: 22.3 ^{o}Brix Acidity:0.44 % Ascorbic acid:94.64 mg/100g	Quality attributes: Fruit weight:6.85 g Stone weight:1.0 g TSS: 13.9 ^{o}Brix Acidity:0.82 % Ascorbic acid:43.8 mg/100 g

Fig. 95. Quality attributes of claimed varieties under DUS

Fig. 96. DUS activity monitoring team field visit and interaction

Farmer's varieties of Chhatishgarh, West Bengal and Bihar are being studied for DUS characters.

4. DUS Centre on aonla

Funding agency: PPV& FRA, New Delhi

Reference varieties, *viz*., NA-7, NA-6, Banarasi, Chakaiya, Francis, Anand-1, Anand-2, NA-4, Goma Aishwarya, NA-10 and NA-5 are being maintained at the station to characterize the farmer's varieties.

5. DUS Centre on jamun

Funding agency: PPV& FRA, New Delhi

Morphological descriptors and DUS test guide lines for jamun have been developed and submitted to the Authority. Varieties are being maintained at the station.

6. DUS Centre on chironji and tamarind

Funding agency: PPV& FRA, New Delhi

Morphological descriptors and DUS test guide lines for tamarind and chironji have been developed and submitted to the Authority. Varieties are being maintained at the station.

7. DUS Centre on watermelon and muskmelon

Funding agency: PPV& FRA, New Delhi

Conducted DUS testing of four hybrids of watermelon and two varieties of muskmelon. Maintained the seed of reference varieties of watermelon and muskmelon for further use in DUS testing.

8. Enhancing food and water security in arid region through improved understanding of quantity, quality and management of blue, green and grey water

Funding agency: Department of Science and Technology, New Delhi

Conjunctive use of surface and ground water resources in arid horticultural crops

As per the activity assigned, an experiment on" conjunctive use of surface (canal) and

ground water (tubewell) in pomegranate (*Punica granatum* L.) fruit crop in sandy soils of western Rajasthan" was executed. In the experiment, the disease free tissue cultured plants of Bhagwa cultivar were planted in August 2019. The treatments were deployed in the month of April 2020 with following details:

- Cultivar: Bhagwa
- Treatments
- T_1: 100% Canal water (EC- 0.75 dSm^{-1})
- T_2: 75% Canal water + 25% tube well water (EC- 1.75 dSm^{-1})
- T_3: 50% Canal water + 50% tube well water (EC- 2.25 dSm^{-1})
- T_4: 25% Canal water + 75% tube well water (EC- 3.50 dSm^{-1})
- T_5: 100% tube well water (EC- 4.85 dSm^{-1})
- Replications: 5
- Number of plants per Treatment: 3
- Design: Randomized Block Design

The amount of water per plant given following the empirical formula as given here:
Amount of water for irrigation= A*B*C*D*E* F (Litres per day)

A: Evaporation from open pan (mm/day)
B: Crop factor (0.50)
C: Area (m^2) - Plant to plant and row to row
D: Wetted area (15%)
E: Treatment
F: Pan factor (0.70)

During the period under report observations were recorded on survival, plant height, spread and number of stems. The plant survival was ranged from 85 to 95% in different treatment and maximum survival was recorded in T_1, T_2 and T_3 and minimum survival was recorded in T4 and T_5 treatments (Table 132).

Data on plant height, plant spread and number of plants recorded in the month of November 2020 in different treatments. Initial data revealed that maximum plant height (1.54 m) was recorded in T_1 treatment and minimum plant height (1.30 m) in T_5 treatment. Plant spread recorded in East to West direction and North to South direction and only differences was recorded in E-W direction while in N-S direction spread was statistically at par. Looking to the standard management practice three stem per plant have been kept for further observation. Although some plants irrespective of treatments flowered also but looking to plant age, they were plucked. The soil samples were collected before the deployment of treatments for different physico-chemical properties of the experimental site (Fig. 97).

Table 132. Effect of conjunctive use of water on growth attributes of pomegranate

Treatments	Plant height (m)	Plant spread (m)		Number of stems /plant stem
		E-W	N-S	
T1	1.54	0.72	0.58	3
T2	1.48	0.68	0.54	3
T3	1.42	0.60	0.54	3
T4	1.30	0.50	0.48	3
T5	1.30	0.45	0.42	3
SEm±	0.11	0.10	0.12	-
CD (5%)	0.23	0.21	NS	-

Fig. 97. Effect of conjunctive use of water on growth attributes of pomegranate

5. TRANSFER OF TECHNOLOGY

MEGA EVENTS ORGANIZED

Kisan Sammelan

Institute has organized Kisan Sammelan programme on the occasion of "PM Kisan Samman Nidhi Scheme" on 25 December, 2020 in which more than 300 farmers, civil society officials, scientists and students were participated. During the occasion, participants were sensitized about PM Kisan Samman Nidhi Scheme through live telecast of the Hon'ble Prime Minister address. Prof (Dr.) P. L. Saroj, Director, ICAR-Central Institute for Arid Horticulture, Bikaner was presided over the function along with Chief Guest Sh. Modaram Meghwal, Special Guest Sh. Vijya Acharya (Member IMC, CIAH, Bikaner), Dr. Uday Bhan Singh, Joint Director Agriculture, Bikaner (Govt. of Rajasthan), Dr. P. S. Shekhawat, Director of Research, SKRAU, Bikaner.

Kisan Sammelan programme organized at ICAR-CIAH, Bikaner

Kisan Divas

Institute has celebrated Kisan Divas on 23 December, 2020 at Meghasar village of Bikaner district in the memory of India's fifth Hon'ble Prime Minister Chaudhary Charan Singh to symbolize his birth anniversary. Prof. (Dr.) P. L. Saroj, Director, ICAR-CIAH, Bikaner was chaired the function and shared experience on Swachhata initiative by Farmers and Civil Society Official. In this occasion, village Sarpanch Sh. Askaran Upadhay, Jeela Pramukh Modaram Meghwal, Special Guest Sh. A. H. Gori, Add. Collector, Bikaner and more than 150 farmers were participated.

ICAR-CIAH, Bikaner celebrated Kisan Divas at Meghasar village of Bikaner

National Webinar on Date Palm

A national webinar on date palm was organized virtually on 21-22 July, 2020 at ICAR-CIAH, Bikaner. The webinar was inaugurated by the Honb'le State Minister for Agriculture and farmers welfare and Dr. A. K. Singh, Deputy Director General (Horticulture) was the Guest of Honour. In the conference, 85 scientist/research workers and progressive from different states were participated and presented the research work. In the webinar, an interaction session with farmers was also organized.

National Webinar on Date Palm organized at ICAR-CIAH, Bikaner

Brainstorming Meeting

The institute has organized one day brainstorming meeting on "Improvement of Arid Zone Fruits" at Jobner in collaboration with SKNAU, Jobner on 18 January, 2020. In the brainstorming meeting Hon'ble Vice Chancellor Prof. J. S. Sandhu was graced the occasion and addressed the participants. In this meeting different AICRP centres working on improvement aspects of arid zone fruits were participated and presented their breeding programmes.

AICRP-AZF Workshop

The institute has organized 24th Annual Research Workers Group Meeting of ICAR-All India Coordinated Research Project on Arid Zone Fruits from 25 February to 01 March, 2020 at Tamil Nadu Agricultural University, Coimbatore (TN). In this workshop, seventy five scientists from 18 different centres of SAUs and ICAR institutes were participated and presented their annual progress report.

Inauguration of Library-cum-Video Conference Building

The Hon'ble Secretary DARE and DG, ICAR, New Delhi Dr. Trilochan Mohapatra has inaugurated the newly constructed library-cum-video conference building of the institute on 12

Brainstorming session organized at SKNAU, Jobner

AICRP-AZF Research Workers Annual Group Meeting organized at TNAU, Coimbatore

October, 2020 through virtual mode and addressed the scientists and dignitaries. The occasion was graced with virtual presence of Dr. A. K. Singh, DDG (Horticulture) and Prof. (Dr.) P. L. Saroj, Director, ICAR-CIAH, Bikaner. All staffs of the institute have participated in the occasion.

Inauguration of Farmers' Hostel

The Hon'ble Union Agriculture and Farmers' Welfare Minister, Sh. Parshottam Rupala has virtually inaugurated the Farmers' Hostel constructed at KVK Panchmahal, Gujarat on 15 January, 2021. The occasion was graced with virtual presence of Dr. Trilochana Mohapatra, Secretary DARE & DG, ICAR,

Virtual inauguration of newly constructed library-cum-video conference building

Virtual inauguration of newly constructed Farmers' Hostel building at KVK Panchmahal

New Delhi, Dr. A. K. Singh, DDG (Agril. Extn.) and Prof. (Dr.) P. L. Saroj, Director, ICAR - CIAH, Bikaner. All staff of the institute have participated in the occasion.

DEMONSTRATIONS CONDUCTED

Front Line Demonstration

Different front line demonstrations (FLDs) were conducted at farmers field on improved varieties of arid fruit and vegetable crops developed by the institute (Table 133). Also conducted FLD on protected cultivation of arid vegetables like snapmelon (AHS-82), longmelon (Thar Sheetal) and *palak* (Thar Hariparana) in Meghsar village of Bikaner district at field of Sh. Askaran Upadhya on 17 December, 2020. In addition to FLDs, 82 method demonstrations on the production technologies of arid horticultural crops were also performed for visiting farmers at the institute.

Exhibitions

- Participated and displayed technological exhibition of the institute in "Farmers' Fair" organized at ICAR-NRCSS, Ajmer during 15-16 February, 2020.

Table 133. Front Line Demonstration organized at farmers' field

S. No.	Crop and variety	Farmers name and address	Date
1	*Kachri* (AHK-119), snapmelon (AHS-82), ridgegourd (Thar Karni) and clusterbean (Thar Bhadvi)	Sh. Lal Chand Meghwal S/o Sh. Ral Lal Meghwal, Village - Naiyo Ki Basti, Tehsil - Kolayat, Bikaner	27 February, 2020
2	*Kachri* (AHK-119), snapmelon (AHS-82), ridge gourd (Thar Karni) and clusterbean (Thar Bhadvi)	Sh. Mange Lal Meghwal S/o Sh. Kheta Ram Meghwal, Village - Salasar, Tehsil - Kolayat, Bikaner	28 February, 2020
3	*Kachri* (AHK-119) and ridge gourd (Thar Karni)	Sh. Shiv Kumar Sarswat S/o Sh. Tara Chand Sarswat, Village - Kanasar, Bikaner	7 March, 2020
4	*Kachri* (AHK-119), Snapmelon (AHS-82), and cluster bean (Thar Bhadvi)	Sh. Jetha Ram Meghwal, Village - Ambasar, Bikaner	23 July, 2020
5	*Kachri* (AHK-119), ridge gourd (Thar Karni) and long melon (Thar Sheetal)	Sh. Megh Singh Rajprohit S/o Sh. Hanuman Singh Rajprohit, Kisanasr, Tehsil - Nokha, Bikaner	24 July, 2020
6	Ber (Gola, Kathali and Thai apple), *Khejri* (Thar Shobha) and Lasoda (budded Thar Bold)	Sh. Megh Chand Rajprohit S/o Sh. Hnuman Singh Rajpurohit, Village - Kishnasar, Tehsil - Nokha, Bikaner	29 September, , 2020
7	*Lasora* (Thar Bold) and *Khejri* (Thar Shobha)	Sh. Megh Chand Rajpurohit S/O Sh. Hnuman Singh Rajpurohit, Village - Kishnasar, Tehsil - Nokha, Bikaner	29 September, 2020
8	*Khejri* (Thar Shobha)	Sh. Mukesh Kumar Pareek S/o Sh. Satya Narayan Pareek, Village - Dholera (4 KHM), Bikaner	21 October, 2020
9	*Khejri* (Thar Shobha)	Sh. Lal Ji Yadav S/o Sh. Ram Swaroop Yadav, Village - Sarah Rupayat (8 JMD), Bikaner	21 October, 2020

- Displayed an exhibition of the institute in "Kisan Mela" organized by KVK Gudamalani, Barmer-II on 24 February, 2020.

Capacity Building Programmes

Agriculture Skill Council of India Sponsored Training Programmes

- Organized a 21 days training program on 'Quality Seed Grower' from 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.
- Organized a 21 days training on 'Organic Grower' from 16 January to 05 February, 2020 at ICAR-CIAH, Bikaner.

National Training Programmes

- Three days farmers' training on 'Plant propagation, orchard development and management techniques for ber and *khejri*' was organized from 4 to 6 February, 2020. The training was sponsored by BIAF Development Research Foundation, Barmer (Rajasthan).
- Three days farmers' training was organized on 'Improved production technologies of arid horticultural crops' from 11 to 13

Skill development training programmes organized by ICAR-CIAH, Bikaner

February, 2020. The training programme was sponsored by ATMA, Hanumangarh (Rajasthan).

- Organized three days farmers' training program on 'Improved production technologies of arid fruits and vegetables' from 4 to 6 March, 2020. The training programme was sponsored by ATMA, Gurugram (Haryana)

Training programme organized at CHES, Vejalpur

- Four days training programme was conducted on "Nursery techniques and management" for skill supporting staff at ICAR-CIAH regional centre, CHES, Vejalpur (Gujarat) during 10-13 February, 2020.

Other Training Programmes

- One day farmers' training was organized at Ambasar village of Bikaner district on 23 July, 2020.
- One day farmers' training programme was organized at Sujasar village of Bikaner district on 23 July, 2020.
- One day training programme was organized at Kishnasar village, Tehsil-Nokha, Distt. Bikaner on 29 September, 2020.
- One day farmers' training on 'Production of leafy vegetables during winter season and protected cultivation of arid vegetables with

Farmers' training programme organized at ICAR-CIAH, Bikaner

low cost' was organized at Khara village of Bikaner district on 5 December, 2020.

Besides, several training programmes for farmers and students were conducted at ICAR-CIAH Regional Station, Vejalpur during 2020 on various aspects of semi-arid fruits and vegetables. The details of programmes are given below (Table 134).

Extension Activities

- Fifteen on/off campus Research-Extension-Farmers-Interface-Meetings were held with visiting farmers/stakeholders at the institute.
- Eleven diagnostic visits (advisory visits) were made to the farmer's fields to provide technical suggestion for better production of arid fruit and vegetable crops.
- The activities like visit, meetings/group

Table 134. Farmers and students visit at ICAR-CIAH Regional Station, Vejalpur during 2020

S. No.	Date	Sponsors	Total no. of participants
1.	08.01.2020	ATMA Project, Distt. -Betul, Madhya Pradesh	50
2.	24.01.2020	ATMA Project, Distt. -Khandva, Madhya Pradesh	39
3.	05.02.2020	ATMA Project, Distt. -Shajapur, Madhya Pradesh	51
4.	10.02.2020	RAWE Students, ACHF, NAU, Navsari, Gujarat	58
5.	12.02.2020	College of Horticulture, Junagarh Agril. University, Junagarh, Gujarat	49
6.	14.02.2020	Shri N.M. Sadguru Foundation, Chosala, Dahod	45
7.	15.02.2020	ATMA Project, Distt. -Zabhua, Madhya Pradesh	26
8.	20.02.2020	ATMA Project, Distt. -Khargon, Madhya Pradesh	32
9.	25.02.2020	Shri N.M. Sadguru Foundation, Chosala, Dahod	10
10.	02.03.2020	Shri N.M. Sadguru Foundation, Chosala, Dahod	56
11.	02.03.2020	ATMA Project, Distt. -Dhar, Madhya Pradesh	45
12.	03.03.2020	ATMA Project, Distt. Dhar, Madhya Pradesh	51
13.	05.03.2020	ATMA Project, Distt. -Dhar, Madhya Pradesh	46
14.	09.12.2020	ATMA Project, Distt. -Dahod, Gujarat	15
15.	10.12.2020	ATMA Project, Distt. -Dahod, Gujarat	15
16.	11.12.2020	ATMA Project, Distt. -Dahod, Gujarat	30
17.	11.12.2020	ATMA Project, Distt. -Badvani, Madhya Pradesh	35
18.	15.12.2020	ATMA Project, Distt. -Dahod, Gujarat	30
19.	16.12.2020	ATMA Project, Distt. -Dahod, Gujarat	30
20.	21.12.2020	ATMA Project, Distt. -Kheda, Gujarat	46
21.	22.12.2020	ATMA Project, Distt. -Kheda, Gujarat	45
22.	23.12.2020	ATMA Project, Distt. -Kheda, Gujarat	40
23.	24.12.2020	ATMA Project, Distt. -Khargon, Madhya Pradesh	11
24.	24.12.2020	ATMA Project, Distt.-Kheda, Gujarat	40
25.	28.12.2020	ATMA Project, Distt. -Kheda, Gujarat	42
26.	28.12.2020	ATMA Project, Distt. -Indore, Madhya Pradesh	15
27.	28.12.2020	ATMA Project, Distt. -Khargon, Madhya Pradesh	11
28.	29.12.2020	ATMA Project, Distt. -Kheda, Gujarat	40
29.	29.12.2020	ATMA Project, Distt. -Dhar,Madhya Pradesh	39
30.	30.12.2020	ATMA Project, Distt. -Kheda, Gujarat	40
31.	31.12.2020	ATMA Project, Distt. -Kheda, Gujarat	40

Interaction meeting organized with trainee farmers of Hanumangarh, Rajasthan

discussion training, interaction, etc. were also organized for empowerment of farm women, particularly in the field of arid horticulture.

- Several farmers' programmes and activities were conducted in adopted villages under MGMG Scheme of the institute.
- More than 200 farmers, students, field workers, supervisors, SMS, dignitaries/ NGO, etc. were visited to institute during 2020.
- More than 500 technical folders/literature were distributed among the farmers/ clients during different extension programmes and activities within/outside of the institute.

Scheduled Caste Sub Plan Programme (SCSP)

The institute has organized more than 20 training programmes for empowerment of scheduled caste farmers on "Improved arid horticultural crop production and value addition technologies". More than 600 farmers were benefitted through the training programmes. The inputs like fertilizers, seeds of improved varieties of vegetable, spices, vegetable seed packet for kitchen garden, milk collection canes, sprayers, technical folders, *etc*. were distributed to farmers.

Activities organized under SCSP

- Farmers' training and input distribution programme was organized on 25 January, 2020 at the Institute and inputs/items like milk cane, vegetable seeds as ridge gourd, bottle gourd, clusterbean, kitchen garden vegetable seed packets, technical folders, etc. were distributed among 53 SC farmers of Gigasar village.
- Farmers' training and input distribution programme was organized on 13 March, 2020 at 465 RD, Block- Chhatargarh of Bikaner district. During this programme, the inputs/items (improved seeds of ridge gourd, bottle gourd and technical folders) were distributed among the 28 SC farmers.
- Organized seven days training program on 'Value addition of arid fruits and vegetables' from 24 February to 01 March, 2020 for economic empowerment of rural women (SC) through development of value addition-based horticulture enterprises.
- Organized three days on campus training on "Nursery and orchard management for livelihood security in semi-arid region" under Schedule Caste-Sub Plan (SCSP) for 15 farmers from 11-13 March, 2020 at CHES, Vejalpur, Godhra.
- Farmers' training programme was organized and inputs like Urea, DAP, clusterbean seed, kitchen garden vegetable seed kit, technical

folder were distributed among the SC farmers (25 Farmers) of Takhatpura village, Tehsil-Chhatargarh of Bikaner on 24 June, 2020.

- Farmers' training programme was organized and inputs like sprayer, clusterbean, bottle gourd, kitchen garden vegetable seed kit, technical folders were distributed among the 40 SC farmers of 2D Badi, 4C Badi, Odaki village of Sri Ganganagar on 06 July, 2020.
- Farmers' training programme was organized and inputs like clusterbean, ridgegourd, kitchen garden vegetable seed kit, technical folder were distributed among the 40 SC farmers of 1 DBN village of Sri Ganganagar on 07 July, 2020.
- Farmers' training programme was organized and inputs like shade net, clusterbean, ridgegourd, kitchen garden vegetable seed kit, technical folders were distributed among the 50 SC farmers of Kaliyan village of Sri Ganganagar on 07 July, 2020.
- Farmers' training programme was organized and inputs like DAP, clusterbean, ridge gourd, bottle gourd sponge gourd, kitchen garden vegetable seed kit, technical folders were distributed among the 13 SC farmers of Pemasar village, of Bikaner on 18 July, 2020.
- Farmers' training programme was organized and inputs like vermicompost, bottle gourd, ridge gourd, kitchen garden vegetable seed kit, technical folders were distributed among the 27 SC farmers of Bharupawa village of Badrasar Block of Bikaner on 31 July, 2020.
- Farmers' training programme was organized and inputs like plants/ saplings (625 plants of lime, moringa, karonda), kitchen garden vegetable seed kit and technical folders were distributed among the 35 SC farmers of Khood village of Danta-Ramgarh Block of Sikar on 19 August, 2020.
- Farmers' training programme was organized and inputs like plants (625 plants of lime, moringa, karonda), kitchen garden vegetable seed kit and technical folders were distributed among the 42 SC farmers of Chainpura village of Piprali Block of Sikar on 20 August, 2020.
- Farmers' training programme was organized and inputs like plants (475 plants of lime, moringa, karonda, phalsa), kitchen garden vegetable seed kit and technical folders were distributed among the 35 SC farmers of Chak Hirasinghwala of Sangaria Block of Hanumangarh on 25 August, 2020.
- Farmers' training programme was organized and inputs like plants (475 plants of lime, moringa, karonda, phalsa), kitchen garden vegetable seed kit, technical folder were distributed among the 35 SC farmers of Chak Jandwala of Sangaria Block of Hanumangarh on 25 August, 2020.
- Organized two days training programme on "Arid Horticulture" at Barmer under Schedule Cast Sub Plan (SCSP) at Budiwara and Dhandal was villages of Barmer on 4-5 September, 2020. Farm inputs like quality planting material (1825 plants of lime, pomegranate, moringa, karonda, phalsa), kitchen garden vegetable seed kit and technical folder were distributed among the 45 SC farmers of Budiwara village of Balotra, Barmer on 04 September, 2020
- Farmers' training programme was organized and inputs like plants (1825 plants of lime, pomegranate, moringa, karonda, phalsa), kitchen garden vegetable seed kit and technical folders were distributed among the 47 SC farmers of Dhandhawas village of Gudamalani Block of Barmer on 05 September, 2020.
- Farmers' training programme was organized and inputs like kitchen utensils, kitchen garden vegetable seed kit and technical folders were distributed among the 24 SC women farmers of Beechwal and Udasar villages of Bikaner on 10 October, 2020.
- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and technical folders were distributed among the 40 SC Farmers of Kalimali village of Phalodi, Jodhpur on 19 October, 2020.
- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and technical folders were distributed among the 40 SC farmers of Dudhiya (Gogliyon Ki Dhani) of Pokaran Block of Jaisalmer on 19 October, 2020.
- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and

technical folders were distributed among the 51 SC farmers of Basanpeer (Daksin) village of Jaisalmer on 21 October, 2020.

- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and technical folders were distributed among the 35 SC farmers of Dingali village of Rajgarh Tehsil of Churu on 02 November, 2020.
- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and technical folders were distributed among the 50 SC farmers of Bangothari village of Pilani Block of Jhunjhunu on 03 November, 2020.
- Farmers' training programme was organized and inputs like vermicompost, kitchen garden vegetable seed kit and technical folders were distributed among the 55 SC farmers of Khara Chak 4JMD village of Bikaner on 05 December, 2020.
- Farmers' training programme was organized and inputs like seeds of cumin, coriander, methi, kitchen garden vegetable seed kit and technical folders were distributed among the 40 SC farmers of Kanwalisar village of Nagaur on 07 December, 2020.
- Farmers' training programme was organized and inputs like seeds of coriander, methi, kitchen garden vegetable seed kit, technical folders were distributed among the 41 SC farmers of Bisalpur village of Sumerpur Block of Pali on 08 December, 2020.

Training programme organized under SCSP at Barmer, Rajasthan

Farmers' training programme organized and input distributed under SCSP at ICARCIAH, Bikaner

Scientists-Farmers Interaction Programmes

- **Vegetable Seed Sale Day:** The institute has organized vegetable seed sale day on 6 February, 2020 in which more than 1000 farmers from different parts of Rajasthan, Punjab, Haryana, Madhya Pradesh, Gujarat, *etc* were participated. The farmers have purchased the seeds of improved varieties of

Vegetable Seed Sale Day celebrated at ICAR-CIAH, Bikaner

arid vegetables like *kachri* (AHK-119), snapmelon (AHS-82), longmelon (Thar Sheetal), ridge gourd (Thar Karni), sponge gourd (Thar Tapish), brinjal (Thar Rachit), *palak* (Thar Hariparna), *etc*. The scientists of the institute also provided the technical know-how of improved production technologies to the farmers.

- ***Khejri* Sapling Sale Day:** Organized *khejri* sapling sale day on 21 September, 2020 and sold quality planting material of Thar Shobha among the farmers. More than 400 farmers purchased the saplings and also learned about production technology of *khejri* through interaction with scientists.
- **Institute Foundation Day**: The foundation day of the institute was celebrated on 28 September, 2020 through online mode. The occasion was graced with the virtual presence of Dr. O.P. Pareek, Former Director of the institute as Chief Guest and addressed the employees.

Institute Foundation Day celebrated virtually at ICAR-CIAH, Bikaner

- **World Soil Health Day:** The World Soil Health Day was celebrated at Khara (2 and 4 JMD) of Bikaner district on 5 December, 2020. On this occasion, awareness cum training programme was organized and distributed vermicompost, vegetable seed packets and technical folders among 50 SC farmers under the SCSP scheme.
- **Communal Harmony Campaign Week:** The communal harmony campaign week was observed from 19 to 25 November, 2020. During the week, the collection of money was made voluntarily from the employees of the institute to raise the fund of National Foundation for Communal Harmony, New Delhi.

World Soil Health Day organized at Khara village of Bikaner district.

- **Accreditation of Institute Nursery:** During the year, a nursery accreditation team visited the institute and appreciated the performance of nursery unit. The team extended the existing accreditation of nursery with NHB for next two years.
- **Institute Technology Management Committee Meeting:** The Institute Technology Management Committee Meeting was held on 20 February, 2020 under the Chairmanship of Prof. (Dr.) P. L. Saroj, Director of the institute.

Institute Technology Management Committee Meeting

- **DUS Monitoring Meeting:** The meeting of DUS activity Monitoring Team was held on 3 to 4 March, 2020 under the Chairmanship of Prof. (Dr.) P. L. Saroj, Director, ICAR-CIAH, Bikaner. During the monitoring, Dr. Ravi Prakash, Registrar, PPV&FRA, New Delhi reviewed the progress of DUS testing of ber.

DUS activity monitoring meeting at ICAR-CIAH, Bikaner

- **Shooting of Documentary Film**: The shooting of video film (documentary film) of the institute was carried out on 27 January, 2020 with the help of Sh. Sunil Batra and Team of DD-Kisan Channel.
- **Celebrated International Yoga Day:** All employees of the institute participated and celebrated the online International Yoga Day on 21 June, 2020.

- **Celebrated *Rashtriya Poshan Abhiyaan*-2020:** As per directions of the Government of India and ICAR, New Delhi celebrated the Rashtriya Poshan Abhiyan-2020. The month of September, 2020 was observed as Poshan Maah with the concept of Poshan Vatika and Poshan Thaali to eliminate malnutrition of rural families. During the month, several technical demonstrations, exhibitions on the Poshan Vatika and training programmes on kitchen gardening and value addition were organized. Distributed seed packets of vegetable crops for kitchen garden and organized capacity development training programmes for SC farmers and farm women.
- **Constitution Day Celebrated:** The institute celebrated the Constitution Day on 26 November, 2020 and oath of the Preamble of the Constitution of India was taken by all employees.
- **Swachchhta Abhiyan organized:** The institute celebrated the Swachchhta Abhiyan from 16-31 December, 2020 and Swachchhta Abhiyan oath was taken by all employees.


Swachchhta Abhiyan and tree plantation programme organized at ICAR-CIAH, Bikaner

Activities during COVID-19 Pandemic

The institute has organized the several activities during the lockdown period for farmers, labourers and staff to break the chain of COVID-19.

- **Precautionary measures taken against spread of COVID-19:** The institute has followed all precautionary measures like regular sanitization of office, hygienic conditions, use of mask, thermal scanning, use of sanitizer and maintained social distance against spread of COVID-19 pandemic. Pamphlets were pasted in office premises to create awareness among the employees and visitors. Also distributed the mask and sanitizer among all the staff members, SRFs, YPs and labourers. Moreover, 'ArogyaSetu App' was also downloaded and used by all staff and family members.
- **Created awareness about COVID-19:** Several efforts were made to create awareness among the farmers, rural people and visitors against spread of COVID-19 through electronic and print media.
- **Support/help of labourers:** During the lockdown period, the institute distributed arid fruits and vegetables among the several needy labourers for their life support. The fruits of pomegranate were also distributed among the staff of police station, Beechwal, Bikaner.
- **Sold fresh vegetables and fruits at low cost:** The institute sold the fresh fruits and vegetables to the people at lower cost to boost their immunity.
- **Distributed seed/planting material/input to farmers:** The seeds of improved varieties of arid vegetables, quality planting material of arid fruits, seed spices, fertilizers, technical folders, mask, etc. were distributed among the SC farmers under SCSP scheme following COVID-19 guidelines.

Distribution of satirizers, fresh vegetable activities during COVID-19 pandemic

- **Farmers' advisories released:** During the lock down period, the institute released seasonal advisories on arid horticultural crops in Hindi and English. The wide publicity of the released advisories was made through institute website, WhatsApp group of arid horticultural farmers (Arid Hort Farmers@CIAH), ICAR website, daily newspapers, etc. to benefit large number of farmers. The following seasonal advisories (Table 135) were released during the lockdown period:

Table 135. Farmers' advisories released by ICAR-CIAH, Bikaner during the lockdown period

S. No.	Farmers' advisory	Date of release
1	Arid horticultural crops	30.03.2020
2	Arid horticultural crops	18.04.2020
3	Arid horticultural crops	18.04.2020
4	Protection and proper care of arid horticultural crops	23.05.2020
5	Arid vegetable production during *Kharif* season	08.06.2020
6	*Kharif* arid vegetables	06.07.2020

Locust swarming and its management

During May and June months, 2020, the deadly locust swarms (2-4 km long) attacked the experimental blocks/farm and campus premises of the institute. The swirling swarms attacked four times during day hours and partially damaged all the experimental crops. All staff members of the institute along with labourers started to make metallic sound and succeeded to save the crops.


A view of locust attack at ICAR-CIAH, Bikaner

Lead/Oral Presentations in Seminar/Symposium/Conferences

Dr. P. L. Saroj

- Presented Lead Paper on "Horticulture therapy for boosting immunity during and post COVID era" during National Webcon organized by Chandra Shekhar Azad University of Agriculture and Technology, Kanpur on 6 May, 2020.
- Presented Key Note address on "Scenario on Arid Horticulture" during National Webinar on Quality Production of Pomegranate in Arid Region organized by SK Rajasthan Agriculture University, Bikaner on 3 July, 2020.
- Presented Lead Paper on "History of date palm in India" during National Webinar on Date palm organized by ICAR-Central Institute for Arid Horticulture, Bikaner (Rajasthan) on 22 July, 2020.
- Presented Lead Paper on "Arid Horticulture for economic and nutritional security" during National Webinar on Boosting immunity through Horticulture organized by Society for Horticultural Research and Development, Ghaziabad (UP) on 8 September, 2020.
- Presented a lead paper on 'Horticulture based integrated farming system in Arid Region" during National Webinar on Climate smart integrated farming system organized by ICAR-National Institute of Abiotic Stress Management, Baramati (Maharashtra) on 18 September, 2020.
- Presented lead paper on "Arid Horticulture" during National Webinar on Avenues in Horticulture in post COVID scenario organized by College of Horticulture and Forestry, Agriculture University, Jhalawar (Rajasthan) on 8 June, 2020.
- Presented lead paper on "Arid vegetables" during National Webinar on Changing scenario in vegetable production and marketing in pandemic period organized by College of Horticulture, SVPUAT, Meerut (UP) on 28 July, 2020.
- Presented Key Note Address on "Opportunities and Challenges in arid Horticulture" during National E-conference organized by Suresh Gyan Vihar University, Jaipur (Rajasthan) on 21 October, 2020.

Dr. Sanjay Singh

- Lead speaker to present a paper on "Underutilized fruits for improving the farmers income under semi-arid conditions" in one day National webinar on Recent advances in underutilized fruits organized by college of Horticulture, SDAU, Jagudan, Mehsana on 05 September, 2020.
- Lead speaker to present a paper on "Underutilized fruits" in one day National webinar on Underutilized fruits converting waste land in to gold mine organized by college of agriculture, Navsari Agriculture University, Campus Bharuch on 30 September, 2020.
- Lead speaker to present a paper on "Dry land fruit culture in western India" in National webinar on Prospective, priorities and preparedness of sustainable agriculture development in India on 28 December, 2020 organized by Dr. Ram Avatar Shiksha Samiti, Lucknow during 28 to 29 December, 2020.

Dr. A. K. Singh

- Delivered expert lecture on "Strategies to make wasteland productive through underutilized Fruits" during Webinar on Underutilized Fruits Converting wasteland into Goldmine held at College of Agriculture, NAU Campus Bharuch on 30 September, 2020.
- Presented lead paper on "Underutilized fruit crops for nutritional security" during Indian Horticulture Summit, 2020, Mitigating Climatic Changes and Doubling Farmers Income through Diversification held from 14 to 16 February, 2020 at MGCGV, Chitrakoot, MP.
- Oral presentation on "Kinetics of productivity and economics of Goma Yashi bael under high density" in the Session Improving productivity and quality through Production Technology during Indian Horticulture Summit, 2020, Mitigating Climatic Changes and Doubling Farmers Income through Diversification held from 14 to 16 February 2020 at MGCGV, Chitrakoot, MP.
- Delivered expert lecture on "Strategies to make wasteland productive through underutilized

fruits" during Webinar on Underutilized Fruits converting wasteland in to goldmine on 30 September, 2020 conducted by College of Agriculture, Bharuch, NAU, Navsari, Gujarat.

Dr. D. S. Mishra

- Oral presentation on "Evaluation of acid lime germplasm for growth, fruit yield and quality" in Progressive International Web Conference on Global Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2020) organized during 28-30 December, 2020 organized by ASTHA Foundation, Meerut.

Dr. Ramesh Kumar

- Delivered lead lecture on "Pomegranate flower regulation and fruit setting" in the webinar on Pomegranate cultivation: Problems and solutions organized by the Krishi Vigyan Kendra, Gudamalani (AU, Jodhpur) on 19 October, 2020.

Dr. Anita Meena

- Oral presentation on "Judicious management of saline water with amendments for higher productivity of Kachari (*Cucumus callous*) under hot arid agro ecosystem" during E- International conference on Effect of COVID 19, Pandemic on Agriculture and allied science from 23 to 24 August, 2020 CPAAS,2020 at Lucknow.
- Oral presentation on "Effect of saline water irrigation with amendments on *kachri* crop performance under arid region" in International Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2019) during 20-22 October 2019 at ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana (India).
- Oral presentation on "*Kachri* (*Cucumus callous*) (AHK-119): Novel and potential source of antioxidant in arid region" in National Seminar on Agriculture Resource Management for Atmnirbhar Bharat at Central Agriculture University, during 17-18 July, 2020 at Imphal, Manipur.

Dr. A. K. Verma

- Presented an oral presentation on "Performance studies on tomato, brinjal and chilli germplasm for improvement under hot arid agro-ecosystem" in International e-Conference on Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity organized by UHS, Bagalkot during 24-27 November, 2020.

Dr. Ramya Shree Devi S

- Oral presentation on "To identify suitable low cost substrates which enhance sporulation capacity of *Bacillus licheniformis*" in e-Conference on Effect of COVID Pandemic on Agriculture and Allied Sciences (ECPAAS-2020) during 23-24 August, 2020.

Lectures Delivered

Dr. Sanjay Singh

- Delivered a lecture on "Cultivation of mango and jamun to the farmers of District Jhabua, MP under ATMA at CHES, Vejalpur on 15 February, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of District Ratlam, MP under ATMA at CHES, Vejalpur on 18 February, 2020.
- Delivered a lecture on "Dry land horticulture" to RAWE students of B.Sc. Ag.VIII semester (58 students) of NAU, Navsari on 02 October, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Limkheda Taluka, Dahod district under ATMA at CHES, Vejalpur on 10 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Dahod Taluka, District Dahod under ATMA at CHES, Vejalpur on 10 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Fatepura Taluka, District Dahod under ATMA at CHES, Vejalpur on 11 December 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Sanjeli Taluka, District Dahod under ATMA at CHES, Vejalpur on 11 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Singwad Taluka, District Dahod under ATMA at CHES,

Vejalpur on 15 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Zalod Taluka, District Dahod under ATMA at CHES, Vejalpur on 15 December, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of District Ratlam under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Dhanpur Taluka, District Dahod under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation of mango and sweet orange" to the farmers of Deogadhbaria, Taluka, District Dahod under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of Matar Taluka, District Kheda under ATMA at CHES, Vejalpur on 21 December, 2020.
- Delivered a lecture on "Dry land horticulture" to RAWE students of B.Sc. Ag. VIII semester (45 students) of college of Horticulture, SDAU, Jagudan, Mehsana on 22 December, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of Galteswar Taluka, District a Kheda under ATMA at CHES, Vejalpur on 23 December, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of Mahuda Taluka, District Kheda under ATMA at CHES, Vejalpur on 28 December, 2020.
- Delivered a lecture on "Cultivation of mango and jamun" to the farmers of District Indore, MP under ATMA at CHES, Vejalpur on 28 December, 2020.

Dr. A. K. Singh

- Delivered virtual lectures on "Genetic diversity and varietal wealth of underutilized fruits" on 17 November, 2020 and Advances in production technology of aonla and bael on 18 November, 2020 during two days training programme on 17-18 November, 2020 on the Hi-tech Intervention for Underutilized Fruits held at SAMETI, Jammu.
- Delivered virtual lectures to B. A. College of Agriculture, AAU, Anand under Student Ready Programme on 06 October, 2020.
- Delivered a lecture on "Production technology of bael" to 30 farmers under ATMA, Limkheda taluka, district Dahod, Gujarat under ATMA on 10 December, 2020.
- Delivered a lecture on "Production technology of aonla" to 30 farmers of Fatepura and Sanjeli, Dahod on 11 December, 2020.
- Lecture given on "Medicinal and nutritional value of semi-arid fruits production technology of aonla" to farmers (ATMA), Zalod, Dahod on 15 December, 2020.
- Delivered a lecture on "Agro-techniques of bael and aonla" to 25 farmers (ATMA), Ratlam, (MP) on 15 December, 2020.
- Delivered a lecture on "Pruning techniques in bael" to 25 farmers (ATMA), Garbada, Dahod on 16 December, 2020.
- Delivered a lecture on medicinal and nutritional value of semi-arid fruits to 45 farmers (ATMA), Dhanpura, Dahod on16 December, 2020.
- Delivered a lecture on "Sustainable production of bael and aonla" to 46 farmers (ATMA), Matar, Kheda on 21 December, 2020.
- Delivered a lecture on "Nursery management of fruit crops" to 41 farmers (ATMA), Khera, Kheda on 24 December, 2020.
- Lecture given on "Propagation techniques of bael and aonla" to 39 farmers (ATMA), Dhar, (MP) on 29 December, 2020.
- Delivered a lecture on "Cultivation practices of rainfed semi-arid fruits" to 40 farmers (ATMA), Dhar, M. P. on 30 December, 2020.

Dr. D. S. Mishra

- Delivered a lecture on "Work on semi-arid fruit crops" on 15 June, 2020 in one month Orientation Training Programme of ARS Scientists Probationers of ICAR-CIAH, Bikaner during 21 May to 19 June, 2020.
- Delivered a lecture on "Potential of citrus and guava fruits" in Virtual mode during Research Station Phase under student READY programme organized by BA College of Agriculture, AAU, Anand on 07 October, 2020.
- Delivered a lecture on "Cultivation of guava"

to 30 farmers of Limkheda, District Dahod, Gujarat under ATMA at CHES, Vejalpur on 09 December, 2020.

- Delivered a lecture on "Cultivation of acid lime" to 30 farmers of Fetepura, District Dahod, Gujarat under ATMA at CHES, Vejalpur on 11 December, 2020.
- Delivered a lecture on "Cultivation of guava" to 30 farmers of Singwad, District Dahod, Gujarat under ATMA at CHES, Vejalpur on 15 December, 2020.
- Delivered a lecture on "Cultivation of acid lime and guava" to 30 farmers of Ratlam (MP) under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation of pomegranate" to 30 farmers of Matar, District Kheda, Gujarat under ATMA at CHES, Vejalpur on 21 December, 2020.
- Delivered a lecture on "Cultivation of guava" to 30 farmers of Mahudha, District Kheda, Gujarat under ATMA at CHES, Vejalpur on 28 December, 2020.
- Delivered a lecture on "Cultivation of acid lime" to 30 farmers of Mahemdawad, District Kheda, Gujarat under ATMA at CHES, Vejalpur on 29 December, 2020.

Dr. V. V. Appa Rao

- Delivered lectures on "Soil Testing and Fertilizer recommendation" to farmers of Dahod district, Gujarat under ATMA at CHES, Vejalpur on 10, 11, 15 and 16 December, 2020.
- Delivered lectures on "Soil Testing and Fertilizer recommendation" to farmers of Kheda district, Gujarat under ATMA at CHES, Vejalpur on 16, 23 and 28 December, 2020.

Dr. S. K. Maheshwari

- Delivered a lecture on 'Integrated disease management in vegetables" on 23 January, 2020 during 21 days skill development training on Organic growers from 16 January to 05 February, 2020.
- Delivered two lectures on 'Integrated disease management in arid vegetable crops' and 'Integrated disease management in arid fruit crops' on 13 February, 2020 during training on Improved production technologies of arid horticultural crops from 11 to 13 February, 2020.
- Delivered a lecture on 'Mushroom Utpaadan ek Atirikt Udyam' on **26** February **2020** in 07 days women training on "Economic Empowerment of Rural Women through Value Added Horticultural Enterprises" from 24th February to 01 March, 2020.
- Delivered a lecture on 'Disease symptoms of cucurbits and their management" on 05 March, 2020 during 21 days skill development training on "Quality Seed Growers" from 20 February to 11 March, 2020.
- Delivered lectures on "IRC meeting, its proceedings, RPPs, PIMS and plant pathology experiments on 22 May, 2020 to orient 04 newly joined scientists during their 01 month institutional orientation programme from 21 May to 19 June 2020.
- Delivered a lecture on "Disease management research in arid fruits and vegetables" on 03 July, 2020 to Shri M. S. Bhinda, Scientist (Genetics & Plant Breeding) of ICAR-VPKAS, Almora (Utrakhand) during his attachment training from 15 June to 14 September, 2020 and also oriented about IRC system and project documentations.
- Delivered a lecture on "Integrated disease management of arid fruit and vegetable crops" on 21 September, 2020 to Dr. Shantanu Rakshit, Scientist (Ag. Extension) of ICAR-NRC on Camel, Bikaner during his attachment training from 19 August to 18 November, 2020 and also oriented about IRC system and project documentations.

Dr. B. R. Choudhary

- Delivered a lecture on "Quality seed production of vegetables" on 18 January, 2020 in a skill development training programme on Organic grower organized at ICAR-CIAH, Bikaner from 16 January to 05 February, 2020.
- Delivered a lecture on "Cultivation of muskmelon, watermelon and *mateera*" on 25 January, 2020 in a skill development training programme on Organic Grower organized at ICAR-CIAH, Bikaner from 16 January to 05 February, 2020.
- Delivered a lecture on "Low tunnel cultivation of cucurbits for early production" on 29 January, 2020 in a skill development training

programme on Organic Grower organized at ICAR-CIAH, Bikaner from 16 January to 05 February, 2020.

- Delivered a lecture on "Improved agro-techniques of growing watermelon, ridge gourd, round melon, long melon, *etc*." in a training programme on Improved production technologies of arid horticultural crops organized at ICAR-CIAH, Bikaner from 11-13 February, 2020.
- Delivered a lecture on "Protected cultivation of vegetables in arid region" in a training programme on Economic empowerment of rural women through value added horticulture enterprise organized at ICAR-CIAH, Bikaner from 24 February to 1 March, 2020.
- Delivered a lecture on "Improved agro-techniques of growing watermelon, ridge gourd, round melon, long melon, *etc*." in a training programme on Improved production technologies of arid horticultural crops organized at ICAR-CIAH, Bikaner from 04-07 March, 2020.
- Delivered 19 lectures in a skill development training programme on Quality seed grower organized at ICAR-CIAH, Bikaner from 20 February to 11 March, 2020.

Dr. D. K. Sarolia

- Delivered a lecture on "Ber production and orchard establishment technology" in training programme on Plant propagation, orchard development and management techniques of ber and *khejri* at ICAR-CIAH, Bikaner from 04 February, 2020.
- Delivered a lecture on "Ketchup preparation" on 26 February, 2020 in training on Economic empowerment of rural women through value added horticulture enterprises from 24 February to 01 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Ber pickle and preservation" on 01 March, 2020 in training on Economic empowerment of rural women through value added horticulture enterprises from 24 February to 01 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Improved production technologies of arid fruit crops" on 04 March, 2020.
- Delivered a lecture on "Improved propagation techniques of arid fruit crops" on 06 March, 2020.
- Delivered lectures on "Nursery management organically" on 22 January, 2020 and Acquaintance with nursery unit CIAH on 01 February, 2020 in the training programme on Organic growers during 16 January to 05 February, 2020 at ICAR-CIAH, Bikaner.
- Delivered lectures on "Nursery preparation for vegetables" on 26 February, 2020 and Acquaintance with nursery unit CIAH on 04 March, 2020 in the training programme on Organic growers during 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered online lecture on "Improved production technologies of guava" in Scientist-farmers interaction organized by KVK, Sawaimadhopur on 24 June, 2020.

Dr. R. K. Meena

- Delivered a lecture on "Preparation of marmalades" in a training programme on Post-harvest management and value addition in fruits held on 15 January, 2020 at SKRAU, Bikaner.
- Delivered a lecture and conducted a practical "Scientific cultivation of bael crop" on 19 January, 2020 in training programme on Organic grower from 16 January to 05 February, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture and conducted a practical "Scientific cultivation of date palm" on 21 January, 2020 in training programme on Organic grower from 16 January to 05 February, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Improved production technologies of bael and date palm" on 13 February, 2020 in training programme on Improved technology of arid horticultural crops held at ICAR-CIAH, Bikaner
- Delivered lecture on "Improved production technologies of bael and date palm" on 06 March, 2020 in training programme on Improved technology of arid horticultural crops held at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Seed production of pea

and guar crops" in training programme on Quality seed producer during 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.

Dr. Mukesh Berwal

- Delivered a lecture on "Role of information technology in organic farming" in farmers training on Organic Growers at ICAR-CIAH, Bikaner during 16 January to 05 February, 2020.
- Delivered a lecture on "Use of information technology in agriculture" in farmers training on Quality Seed Growers at ICAR-CIAH, Bikaner during 20 February to 11 March, 2020.
- Delivered a lecture on "Nutritional values of arid horticultural produces" during training for woman farmers under SCSP Scheme on March, 2020.
- Delivered a Seminar on "The new insights of abiotic stresses in agriculture/ horticulture" at ICAR-CIAH, Bikaner on virtual mode on 19 December, 2020.

Dr. Ramesh Kumar

- Delivered a lecture on "Problem and prospects of pomegranate cultivation in Rajasthan" in the National webinar on Scenario of pomegranate cultivation in India organized by the ICAR-NRC on Pomegranate, Solapur in collaboration with Kisan Samvad, Pune from 24 to 26 September, 2020.
- Delivered a lecture on "Constraints and opportunities for pomegranate cultivation in Rajasthan" in the National webinar organized by Pomegranate Grower Association of India and Kisan Samvad, Pune during 13 to 16 October, 2020.
- Delivered a lecture on "Indian Seed Act 1966 and its provisions" in the training programme on Organic Grower organized by the ICAR-CIAH, Bikaner from 20 February to 11 March, 2020.
- Delivered a lecture on "Nursery bed and pot mixture preparation" in the training programme on Empowerment of rural women through nursery management organized by the ICAR-CIAH, Bikaner from 13 to 19 March, 2020.
- Delivered lecture on "Research work on pomegranate" on 30 May, 2020 and "Research work on citrus and potential of floriculture in arid region" on 16 June, 2020 in the orientation training programme of 4 newly joined ARS Probationers at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Pomegranate and citrus research in arid region, training-pruning, plant architecture, crop regulation and orchard management innovations" in the three months professional attachment training programme of a ARS Probationer during 15 June to 14 September, 2020 at ICAR-CIAH, Bikaner.
- Delivered lectures on "Pomegranate and citrus research in arid region" and "Crop regulation in pomegranate" in the three months professional attachment training programme of an ARS Probationer during 19 August to 18 November at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Pomegranate cultivation and its flower regulation" in the two days training programme on Arid Horticulture at Barmer under SCSP on 04 September, 2020 at Budiwara and 5 September, 2020 at Dhandalwas, Gudamalani organized by ICAR-CIAH, Bikaner in collaboration with KVK, Gudamalani.
- Delivered a lecture on "Good management practices for orchards of arid zone fruit crop plants" in the training programme on Plant propagation, orchard development and management techniques of ber and *khejri* organized by ICAR-CIAH, Bikaner from 04 to 06 February, 2020.

Dr. Chet Ram

- Delivered a lecture on "Tissue culture: A technique of plant production" on 18 January, 2020 to the participants of 21 days training on Organic Growers at ICAR-CIAH, Bikaner from 16 January to 05 February, 2020.
- Delivered a lecture on "Importance of molecular markers and abiotic stress tolerant genes to characterize the germplasm of arid fruits and vegetable crops" during 3 months Professional Attachment Training programme of Dr. Shantanu Rakshit, Scientist, ICAR-NRC on Camel, Bikaner from 19 August to 18 November, 2020.
- Delivered lectures on "Molecular diversity

and DNA fingerprinting of arid horticultural germplasm and varieties, and identification and characterization of drought tolerant genes from watermelon" during 3 months Professional Attachment Training programme of Sh. Mahendar Singh Bhinda, Scientist of ICAR-VPKAS, Almora (Utrakhand) from 15 June to 14 September 2020.

- Delivered lectures on "Development and application of molecular markers in arid horticultural crops, DNA fingerprinting of released cultivars of arid horticultural crops and identification and characterization of abiotic stress tolerant genes from arid horticultural crops" on 17 June, 2020 during one month institute's orientation training programme from 21 May to 19 June 2020 of 4 newly joined scientists, ARS probationers at ICAR-CIAH, Bikaner.

Dr. Anita Meena

- Delivered a lecture on "Kitchen garden and its role in nutritional security" in 7 days training programme on Economic empowerment of rural women through value added horticultural enterprises from 24 February to 1 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Utilization of horticultural waste" in 7 days training programme Economic empowerment of rural women through value added horticultural enterprises from 24 February to 1 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a practical lecture on "Value added products from anola (candy/mouth freshener)" in 7 days training programme on Economic empowerment of rural women through value added horticultural enterprises during 24 February to 1 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Women empowerment through horticulture" in 7 days training programme on Women empowerment through nursery management during 13 to 19 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Soil testing for nursery management" in 7 days training programme on Women empowerment through nursery management during 13 to 19 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Drip irrigation system for nursery" in 7 days training programme on Women empowerment through nursery management during 13 to 19 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Integrated management techniques of saline alkaline soil and crop for quality seed production" in 21 days training programme on Organic seed grower during 13 to 19 March, 2020, under Skill development programme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Soil sampling and testing for analysing soil health and fertility standard" in 4 days training programme on Improved production technologies for arid horticulture crops during 4 to 7 March, 2020 under collaborative farmers training programme with Agriculture and framers' Welfare Department, Haryana at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Management of saline and alkaline soil for quality seed production" in 21 days training programme on Organic seed grower during 11 February to 3 March, 2020 under Skill Development programme at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Importance of soil sampling, testing and fertilizer recommendation" during International Soil Health Day celebration on 5 December, 2020 at Kanasar village of Bikaner district.

Dr. A. K. Verma

- Delivered lectures on "Need of organic farming, seed treatment and its importance and organic cultivation and seed production of leafy vegetables and field practical on organic vegetable cultivation" to the participants of 21 days training on Organic Growers at ICAR-CIAH, Bikaner from 16 January to 05 February, 2020.
- Delivered lectures on "Seed production technology of tomato, brinjal, chilli, sponge gourd, onion, palak, fenugreek, cowpea, Indian bean, leafy vegetables, importance of bee and insect pollination in seed production

and quality seed production under protected conditions" to the participants of 21 days training on Quality Seed Growers at ICAR-CIAH, Bikaner from 20 February to 11 March, 2020.

Dr. Vikas Yadav

- Delivered a lecture on "Cultivation practices of custard apple" to 30 farmers of Zalod, District Dahod, Gujarat under ATMA at CHES, Vejalpur on 15 December, 2020.
- Delivered lectures on "Cultivation practices of wood apple" to 30 farmers each of Garbala and Devgarh, District Dahod, Gujarat under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Scientific cultivation practices of custard apple" to 30 farmers of District Kheda, Gujarat under ATMA at CHES, Vejalpur on 22 December, 2020.
- Delivered a lecture on "Scientific cultivation practices of custard and wood apple" to 30 farmers of District Kheda, Gujarat under ATMA at CHES, Vejalpur on 24 December, 2020.
- Delivered a lecture on "Management practices of custard apple for better yield production" to 30 farmers of District Kheda, Gujarat under ATMA at CHES, Vejalpur on 29 December, 2020.
- Delivered a lecture on "Scientific propagation technique of wood apple" to 30 farmers of District Kheda, Gujarat under ATMA at CHES, Vejalpur on 31 December, 2020.

Dr. Kamlesh Kumar

- Delivered lectures on "Underutilized fruits, new orchard establishment and management, landscape management" in 3 months Professional Attachment Training programme of Dr. Shantanu Rakshit, Scientist, ICAR-NRC on Camel, Bikaner during 19 August to 18 November, 2020.
- Delivered a lecture on "Underutilized fruits and their importance in horticultural development in hot arid and semi-arid regions" on 04 March, 2020 in 4 days collaborative training programme on Improved production technologies of arid horticultural crops organized with Agriculture and Farmer's Welfare Department, Haryana at ICAR-CIAH, Bikaner during 04-07 March, 2020.
- Delivered a lecture on "Underutilized fruit crops and their uses" in a training programme on Economic empowerment of rural women through value added horticulture enterprises during 24 February to 01 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Underutilized fruits and their importance in horticultural development in hot arid and semi-arid regions" on 12 February, 2020 in 3 days collaborative farmer's training programme with ATMA of Hanumangarh district of Rajasthan on Improved production technologies of arid horticultural crops during 11-13 February, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture and conducted practical on "Pit digging, preparation of media and mixes and filling of polybags for planting" on 14 March, 2020 in training programme on Economic empowerment of rural women through nursery management during 13-19 March, 2020 to at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Landscaping and kitchen gardening" on 16 March, 2020 in a training programme on Economic empowerment of rural women through nursery management during 13-19 March, 2020 to at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Knowledge on biotechnology laboratory facilities and its importance in agriculture" on 06 March, 2020 in a training programme on Quality seed grower during 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered lectures on "Tissue culture and mass-multiplication of plant research, date palm, underutilized fruits propagation, orchard establishment and landscaping" in 3 months Professional Attachment Training programme of Sh. Mahendar Singh Bhinda, Scientist of ICAR-VPKAS, Almora (Utrakhand) from 15 June to 14 September 2020.
- Delivered lectures on "Research work on underutilized fruit crops and date palm tissue

culture research" in one month institute's orientation training programme of 4 newly joined scientists, ARS probationers at ICAR-CIAH, Bikaner from 21 May to 19 June 2020.

Dr. L. P. Yadav

- Delivered a lecture on "Cultivation practices of drumstick under dryland condition" to the 15 farmers of dahod district under ATMA at CHES, Vejalpur on 10 December, 2020.
- Delivered a lecture on "Cultivation practices of tomato under dryland condition" to the 35 farmers of dahod district under ATMA at CHES, Vejalpur on 11 December, 2020.
- Delivered a lecture on "Cultivation practices of bottle gourd under dryland condition" to the 30 farmers of dahod district under ATMA at CHES, Vejalpur on 15 December, 2020.
- Delivered a lecture on "Nutritional importance of drumstick" to the 30 farmers of dahod district under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation practices of ivy gourd and spine gourd under dryland condition" to the 35 farmers of Badwani district, MP under ATMA at CHES, Vejalpur on 16 December, 2020.
- Delivered a lecture on "Cultivation practices of cucurbitaceous crops under dryland condition" to the 45 farmers of Kheda district under ATMA at CHES, Vejalpur on 22 December, 2020.
- Delivered a lecture on "Cultivation practices of bottle gourd and ivy gourd under dryland condition" to the 40 farmers of Kheda district under ATMA at CHES, Vejalpur on 24 December, 2020.
- Delivered a lecture on "Horticultural crops under dryland conditions" to the 35 farmers of Dhar district, MP under ATMA at CHES, Vejalpur on 29 December, 2020.
- Delivered a lecture on "Scientific cultivation of vegetable crops under dryland condition" to the 40 farmers of Kheda district under ATMA at CHES, Vejalpur on 30 December, 2020.

Dr. Ramya Shree Devi S.

- Delivered a lecture on "Importance of *Trichoderma* in organic farming" in a training programme on Organic growers at ICAR-CIAH, Bikaner during 16 January to 5 February, 2020.
- Delivered a lecture on "Identification of major insect pest in arid vegetable crops" in 21 days skill development training on Quality seed growers from 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Integrated pest management in arid vegetable crops" in 21 days skill development training on Quality seed growers from 20 February to 11 March, 2020 at ICAR-CIAH, Bikaner.
- Delivered a lecture on "Mushroom cultivation" in 7 days training programme on Economic empowerment of rural women through value added horticultural enterprises during 24 February to 1 March, 2020 under SCSP scheme at ICAR-CIAH, Bikaner.

Activities of KVK, Panchmahal

On Farm Trials (OFTs)

During 2020, eight on farm trials (OFTs) were conducted on farmers' field involving 67 farm families. The major OFTs were conducted on nutrient management in mango cv. Kesar, evaluation of improved variety of okra during summer season, integrated nutrient management in castor, management of pink boll worm in *Bt* cotton, termite management in wheat, use of curd as probiotic supplementation for growing goats and nutrition management of cattle calves with commercial probiotics and traditional curd.

Front Line Demonstrations (FLDs)

During the reporting period, a total of 24 FLDs were laid out in 180 ha area at 559 farmers' field (Table 136). Out of 24 FLDs, twenty one FLDs were completed and rest of the FLDs on castor, pigeon pea and gram crops are in progress.

Table 136. Front line demonstrations conducted by KVK, Panchmahal

Particular of the FLD	Season	Name of crop (variety)	Critical input	Area (ha)	No. of farmers	Yield (q/ ha)		Increase in yield (%)	B:C ratio
						Demo.	Local		
Use of HYV with INM	*Kharif*	Pigeon pea (AGT-2)	Seed	30	75	14.60	10.10	44.55	3.20
Use of HYV with INM	*Kharif*	Castor (GCH-7)	Seed	10	25	26.90	20.70	29.90	3.80
Use of HYV with INM	*Rabi*	Maize (GAM-3)	Seed	10	25	29.70	20.40	45.59	2.40
Use of HYV with INM	*Rabi*	Gram (GG-3)	Seed	10	25	16.70	11.50	45.21	4.03
Use of HYV with INM	*summer*	Groundnut (GJG-32)	Seed	10	20	18.40	16.50	31.35	3.10
Use of HYV with INM	Summer	Green gram (GAM-5)	Seed	20	50	9.60	7.20	35.00	2.30
Use of HYV with INM	Summer	Sesamum (GT-4)	Seed	10	25	5.10	4.20	21.50	2.20
Use of HYV with improved practices	*Kharif*	Chilli (NSC 623B)	Seedling	04	10	174.60	313.80	32.47	3.85
Use of HYV with improved practices	*Kharif*	Brinjal (NSC 627B)	Seedling	04	10	371.40	277.50	33.84	4.22
Use of HYV with improved practices	*Kharif*	Tomato (Arka Rakshak)	Seedling	02	5	478.50	298.20	46.69	4.62
Use of HYV with improved practices	*Rabi*	Fennel (GF-1	Seed	4	10	14.75	10.85	35.94	3.60
Use of HYV with improved practices	*Kharif*	Mango (Kesar and Rajapuri)	Grafted plants	2	10	Planting distance (8 x 6m), Average plant height upto February (1.38m)			
Management of pod borer in pigeon pea	*Kharif*	Pigeon pea	Emamectin benzoate & Pheromone traps	02	10	10.70	8.45	23.63	2.31
Management of fall armyworm in maize crop	*Kharif*	Maize	Neem oil	02	10	33.10	24.70	34.01	2.35
Management of diseases in maize crop (*Maydis*, *turcicum* leaf blight and*Curvularia* leaf spot)	*Rabi*	Maize	*Trichoderma viridae*	02	10	31.50	25.00	26.00	2.56
Management of wilt and root rot in chickpea	*Rabi*	Chickpea	*Trichoderma viridae*	02	10	16.50	13.50	22.22	2.15
Green fodder Production	*Kharif*	Sorghum (CoFS-29)	Seed	08	20	476	311	53.05	3.12
Green fodder production	*Rabi*	Lucerne (Anand-3)	Seed	08	20	630	380	65.79	4.24
Mineral mixture	-	Buffalo (ASMM	Mineral mixture	-	30	7.32	6.09	20.19	3.17
Mineral mixture	-	Cow (ASMM	Mineral mixture	-	30	8.37	6.78	23.45	3.33
Backyard poultry production	-	Poultry (Ankleshwar	Chicks	-	29	Egg production up to 40 wks- 46 No.	Egg production up to 40 wks- 31 No.	48.39	4.13

Training Programmes Organized

During 2020, KVK, Panchmahal organized 45 training programmes on different aspects of agriculture and animal husbandry in which 933 farmers were benefited (Table 137).

Table 137. Training programmes organized by KVK, Panchmahal during 2020

Title of training	Duration (Days)	Venue/place	Beneficiaries (No.)
Weed management in *kharif* crops	01	Ghushar	24
Green manuring	01	RatanpurReliya	20
Integrated nutrient management in pigeonpea and soybean	01	Pandyapura	26
Organic farming in field crops	03	KVK, Panchmahal	20

Title of training	Duration (Days)	Venue/place	Beneficiaries (No.)
Micro nutrient deficiency symptoms and management in crops	01	Naysda	29
Bio-fertilizer application in field crops	01	Sureli	06
Integrated water management	01	Harkundi	20
Integrated crop management	03	KVK, Panchmahal	20
Vermi-compost production technology	01	Kharsaliya	30
Production and use of organic inputs	03	Kharoda	28
Soil health and fertility management	01	KVK, Panchmahal	21
Soil and water sampling and testing	01	Karada	34
Importance and scope of Bael cultivation	01	Wata	16
Propagation techniques in fruit crops	02	KVK, Panchmahal	21
Vegetable nursery management	01	Rayanwadiya	18
Recent trends in cultivation of mango	01	Jarod	16
Scientific cultivation of tomato	01	Richhiya	22
Improved cultivation of cole crops	01	KVK, Panchmahal	18
Cultural practices in orchard	01	Vanseti	19
Importance and scope of protected cultivation	01	KVK, Panchmahal	20
Recent trends in cultivation of fruit and vegetable in rainfed conditions	02	KVK, Panchmahal	18
Off season vegetable cultivation	01	Richhiyawata	17
Cultivation of cucurbits in *mandap*/*pandal* system	01	KVK, Panchmahal	19
Recent trends in cultivation of summer okra	01	KVK, Panchmahal	21
Plant protection measures in chickpea	01	Bediya	24
Management of stored grain pest	01	KVK, Panchmahal	22
Use of neem and other plant products in insect pests management	03	KVK, Panchmahal	20
IPM in cotton	01	Sureli	21
Pest management in pigeonpea	01	Kharsaliya	20
Use of microbial pesticides in insect pests and disease management	03	KVK, Panchmahal	17
Plant protection measures in okra	01	Godhra	19
Pest management in paddy	01	Bhadroli	20
Training on beekeeping	07	Virtual	35
Pest management in wheat crop	01	Nesda	22
IPM in maize	01	Bediya	20
Pest and disease management in chickpea crop	03	KVK, Panchmahal	18
Nutrition for growing goats	01	Kharsaliya	31
Broiler production and management	03	KVK, Panchmahal	23
Green fodder production round the year	01	Bhukhi	26
Scientific management of dairy animals	07	KVK, Panchmahal	20
Broiler production and management	05	KVK, Panchmahal	17
Clean and quality milk production	05	KVK, Panchmahal	21

Skill Development Programme

- Twenty days skill development training programme on "Small Poultry Farmers" was organized from 02 to 21 March, 2020 sponsored by Agriculture Skill Council of India, New Delhi.

Workshop cum Training Programme

- ICAR-KVK, Panchmahal organized a workshop cum training programme on "Kitchen Garden" in collaboration to Dipak Foundation, Halol on 25 February, 2020 in which 30 farm women were participated.

RAWE Programme

- ICAR-KVK, Panchmahal organized 17 days RAWE programme for the students of B. Sc. Ag. Students from 14-30 September, 2020 in which 05 students from NAU, Navsari and JAU, Junagarh were participated.

FLD programmes conducted by KVK, Panchmahal

Training programmes conducted by KVK, Panchmahal

Kisan Mela

- ICAR-KVK, Panchmahal organized a Kisan Mela at KVK, Panchmahal on 21-22 January, 2020. Lectures on different aspects of agriculture and animal husbandry were delivered and exhibited the technologies suitable for semi-arid region. Also distributed the literature among the farmers.

Other Extension Activities

- Organized Annual Zonal Workshop of KVKs virtually on 10-12 July, 2020 at KVK, Panchmahal.


Kisan Mela organized at KVK, Panchmahal

- The programme on "Nutrition Month" was celebrated for women on 17 September, 2020 to spread awareness about nutritional needs, deficiencies and malnutrition.
- The KVK, Panchmahal celebrated National Women Farmer's Day (Rashtriya Mahila Kisan Diwas) on 15 October, 2020. On this occasion, several activities were organized mainly to empower women in the field of agriculture.
- ICAR-KVK, Panchmahal organized nutrition and health awareness programme for adolescent girls on 11 November, 2020. The programme was focused on education of the importance on health and to promote locally available food resources and creates awareness on ethnic/traditional foods rich in nutrients.


Celebtared nutrtion month at KVK, Panchmahal


National Women Farmer's Day organized at KVK, Panchmahal

- Celebrated World Soil Day on 05 December, 2020 at KVK, Panchmahal with the theme "Keep soil alive, protect soil biodiversity". Motivated the people to proactively engage in improving soil health and to fight soil biodiversity loss.
- Organized live telecast of "PM Kisan Samman Nidhi Scheme" on 9 August, 2020 and 25 December, 2020 for farmers to create awareness about PM Kisan Samman Nidhi Scheme.

Nutrition and health awareness programme organized

Live telecast of 'PM Kisan Samman Nidhi Scheme'

Exhibitions Organized

Date	Venue	No. of participants	Organizing agency
21 January, 2020	KVK, Panchmahal	1500	KVK, Panchmahal, FTC and ATMA, Panchmahal
22 January, 2020	KVK, Panchmahal	1350	KVK, Panchmahal, FTC and ATMA, Panchmahal
17 September, 2020	KVK, Panchmahal	156	KVK, Panchmahal
15 October, 2020	KVK, Panchmahal	130	KVK, Panchmahal

Exhibitions organized at different occassions

Field days, Awareness and Extension programmes

Title	Date	Place	Beneficiaries
Field day on " Nano fertilizer technology" collaboration with IFFCO'	24 February, 2020	Palla	25
World Yoga day	21 June, 2020	KVK, Panchmahal	17

Title	Date	Place	Beneficiaries
Hindi Divas	14 September, 2020	KVK, Panchmahal	21
Animal health awareness camp	19 November, 2020	Bediya	49
Swachchta Abhiyan	16 to 31 December, 2020	KVK, Vejalpur, Kalantra Nesda and Kharsaliya	246
Animal health awareness camp	17 December, 2020	Kalantra	43
Field day on "Backyard poultry production"	21 December, 2020	Kharsaliya	37
Kisan Divas	23 December, 2020	KVK, Panchmahal	54
Advisory services	Advisory services were given on problems pertaining to agriculture and animal husbandry.		1288
Telephone helpline	Helpline were dealt related to agriculture and allied sectors.		1347
Diagnostic visit	Diagnostic visits were carried out at farmers' field to solve the problem related to agriculture and animal husbandry.		74
Method demonstration	Method demonstrations were carried out at farmers' field/ KVK		31

Radio Talks/DD Kisan (Hello Kisan) Programme

- Dr. Kanak Lata delivered a radio talk on "Precaution and agricultural work to be done during corona period (Covid-19)" on 7 April, 2020.
- Dr. Kanak Lata delivered a radio talk on "Utility of kitchen garden during COVID-19 period" on 12 May, 2020.
- Dr. B. S. Khadda delivered a radio talk on "Care and management of dairy animal during summer season" on 03 February, 2020.
- Dr. B. S. Khadda delivered a radio talk on "Important advisory for livestock owners during lockdown of COVID-19" on 17 April, 2020.
- Dr. Raj Kumar delivered a radio talk on "Lay out and establishment of orchard under rainfed conditions" on 22 May, 2020.
- Dr. Shakti Khajuria delivered a radio talk on "Government schemes for women development" on 22 May, 2020.
- Dr. Kanak Lata delivered a TV talk on "Precaution and agricultural work to be done during corona period (COVID-19)" at DD Kisan, New Delhi on 13 January, 2020.
- Dr. Kanak Lata delivered a TV talk on "Krishi Ki Aadhar Mahila Kisan" at DD Kisan, New Delhi on 28 February, 2020.
- Dr. Kanak Lata delivered a TV talk on "Akshay Urja" at DD Kisan, New Delhi on 08 July, 2020.
- Dr. Kanak Lata delivered a TV talk on "Poshak Vatika" at DD Kisan, New Delhi on 30 November, 2020.

Awards

- Dr. B.S. Khadda received "Best KVK Scientist Award" from Society of Krishi Vigyan during National Conference held virtually on Advances in Sustainable Agriculture on 26-28 September, 2020.
- Dr. Raj Kumar received "Best KVK Scientist Award" and "Best Paper Presentation Award" from Society of Krishi Vigyan during National Conference held virtually on Advances in Sustainable Agriculture on 26-28 September, 2020.

Seminar/symposium/conference attended

- Dr. Kanak Lata, Head attended National workshop of KVK at New Delhi held on 28-

20 February, 2020.

- Dr. Kanak Lata, Head attended National webinar conducted by Prasansa Foundation on 14 June, 2020
- Dr. B.S. Khadda attended National webinar conducted by Prasansa Foundation on 14 June, 2020.
- Dr. B.S. Khadda attended International web-conference on resource management and biodiversity conservation to achieve sustainable development goals on 11-12 September, 2020.
- Dr. B.S. Khadda attended National webinar on "Prospects and challenges in poultry sector: Small scale farming to large commercial enterprises" conducted by College of Veterinary Science & Animal Husbandry, Rewa (MP) on 28 July, 2020.
- Dr. B.S. Khadda and Dr. Raj Kumar attended National conference on "Advances in sustainable agriculture" organized virtually by Society of Krishi Vigyan on 26-28 September, 2020.

Training programmes attended

- Dr. Kanak Lata, Head attended 3 days training programme on "Participatory programme planning, monitoring and evaluation" at AAU, Anand, Gujarat during 7-9 October, 2020.
- Dr. B.S. Khadda and Dr. Shakti Khajuria attended 5 days training programme on "Entrepreneurship development in pest management for youth" at College of Agriculture, Iroisemba (CAU, Imphal) during 29 June to 03 July, 2020.
- Dr. B.S. Khadda attended 5 days training programme on "Smart dairy farming boosting productivity through innovations" at NAU, Navsari, Gujarat during 18-22 August, 2020.
- Dr. B.S. Khadda and Dr. Shakti Khajuria attended 10 days training programme on "Research methodology for social sciences" at AAU, Anand, Gujarat during 01-11 September, 2020.
- Dr. B.S. Khadda and Dr. Shakti Khajuria attended 3 days training programme on "Participatory programme planning, monitoring and evaluation" at AAU, Anand, Gujarat during 7-9 October, 2020.
- Dr. B.S. Khadda attended 6 days training programme on "Poultry entrepreneur training" at Karnataka Veterinary, Animal and Fisheries Science University, Bidar during 12-17 October, 2020.
- Dr. Raj Kumar attended 5 days training programme on "Role of technology in community level disaster mitigation" at Centre for Disaster Management, Mussoorie during 23-27 November, 2020.
- Dr. Shakti Khajuria attended 3 days training programme on "Climate smart agriculture and efficient water management" organized by Govt. of India (Ministry of Agriculture) at AAU, Anand, Gujarat during 12-14 October, 2020.

6. TRAINING AND CAPACITY BUILDING

Training and Capacity Building of ICAR-CIAH employees

The following staff member of the institute underwent in different training programmes

Scientists			
Name	**Topic**	**Organization**	**Duration**
Dr. Dhurendra Singh	Intellectual property rights in agricultural research and education (online)	ICAR- New Delhi	12-28 September, 2020
Dr. A. K. Singh	Online training workshop for vigilance officers of ICAR Institutes	ICAR-NAARM, Hyderabad	5-7 August, 2020
Dr. D.K. Sarolia	Advance agro -meteorological techniques for climate smart agriculture (online)	CAAST-CSAWM, MPKV, Rahuri	30 April to 4 May, 2020
Dr. M.K. Berwal	Effective health management for enhancing work efficiency of ICAR employee	ICAR-IIHR, Bengaluru	22 October, 2020
Dr. Anita Meena	Integrated nutrient management and nutrient budgeting through advanced models to improved crop productivity	ICAR–Indian Institute of Soil & Water Conservation, Nilgiris (TN)	3-7 February, 2020
Dr. Kamlesh Kumar	Conventional approaches for genetic improvement of perennial horticultural crops	ICAR–IARI, New Delhi	17 January to 6 February, 2020
Dr. A. K. Verma & Dr. Hanuman Ram	Seed production in vegetable crops	National Seed Research and Training Centre, Varanasi	10-11 December, 2019
Dr. A. K. Verma	Climate resilient technologies for rainfed agriculture	VNMKV, Parbhani	11-15 June, 2020
Dr. Kishan Lal Kumawat	Climate change challe nges and responses (online)	Lal Bahadur Sastri National Academy of administration, Maissoorie (UK)	14-18 December, 2020
Dr. Rekha Rani	Impact assessment and future trading: A case study of coriander	ICAR-NRC S eed Spices, Ajmer	22 June to 21 September, 2020.
	Market research & value chain management of agricultural commodities	ICAR-NAARM, Hyderabad	17-21 December, 2020
	Agricultural policy research	ICAR-NAIP, New Delhi	3-9 December, 2020
	Business plan development and accelerating FPOs/FPCs	ICAR-NARM Hyderabad	14-19 December, 2020
Mr. Rajeshwar Sanodia	Training on identification and classification of water and nitrogen stress in maize crop	ICAR-CIAE, Bhopal	22 June to September, 2020
	Role of technology in the community level disaster integration (online)	LBSNAA, Maissoorie (UK)	23-29 November, 2020
Mr. Mahendra Kumar Choudhary	Inheritance of branching and bearing habit in guar	ICAR-CAZRI, Jodhpur	22 June to 22 September, 2020
Technical staff			
Dr. Raj Kumar	Role of technology in the com munity level disaster integration (online)	LBSNAA, Maissoorie (UK)	23 to 29 November, 2020
Dr. B.S. Khadda	Entrepreneurship development in pest management for youth	Central A gricultural University, Imphal	29 June to 03 July 2020
	Smart dairy farming bo osting productivity through innovations (online)	NAU, Navsari	18-22 August, 2020
	Participatory programme planning, monitoring and evaluation	AAU, Anand	7-9 October, 2020
	Poultry entrepreneur training	Karnataka Veterinary, Animal and fisheries Science University, Bidar	12-17 October, 2020
Dr. Shakti Khajuria	Entrepreneurship development in pest management for youth	Central Agricultural University, Imphal	29 June to 03 July 2020
	Research methodology for social sciences (online)	AAU, Anand	01-11 Sep tember, 2020
	Participatory programme planning, monitoring and evaluation	AAU, Anand	7-9 October, 2020

Name	Topic	Organization	Duration
	Poultry entrepreneur training	Karnataka Veterinary, Animal and fisheries Science University, Bidar	12-17 October, 2020
Dr. Shakti Khajuria	Entrepreneurship development in pest management for youth	Central Agricultural University, Imphal	29 June to 03 July 2020
	Research methodology for social sciences (online)	AAU, Anand	01-11 Sep tember, 2020
	Participatory programme planning, monitoring and evaluation	AAU, Anand	7-9 October, 2020
	Climate smart agriculture and efficient water management	AAU, Anand	12-14 October, 2020
Mr. D.C. Joshi	Role of technology in the community level disaster integration	LBSNAA, Maissoorie (UK)	23-29 November, 2020
Administrative staff			
Mr. S.N. Patel	Capacity building programme for CJSC member	ICAR-NAARM, Hyderabad	27-31 January, 2020
Smt. N.G. Solanki	Establishment matters for UDC & LDC	ICAR-CIFE, Mumbai	03-09 January, 2020
SSS Staff			
Mr. V. G. Patel	Nursery techniques and management	ICAR-CIAH, Bikaner	10-13 February, 2020
Mr. D.S. Rawat	Nursery techniques and management	ICAR-CIAH, Bikaner	10-13 February, 2020
Mr. Z.A. Chauhan	Nursery techniques and management	ICAR-CIAH, Bikaner	10-13 February, 2020
Mr. C.D. Rathva	Nursery techniques and management	ICAR-CIAH, Bikaner	10-13 February, 2020

Seminar/Symposium/Conferences Attended by ICAR-CIAH Employees

Prof. (Dr.) P. L. Saroj

- Presented online paper entitled “Horticulture therapy for boosting immunity during and post COVID era” in National Webcon organized by CSAU, Kanpur on 6 May, 2020.
- Participated in the National Webinar on “Quality production of pomegranate in arid region” during COVID-19 at SKRAU, Bikaner and presented a paper on “Scenario of Arid Horticulture” on 3 July, 2020.
- Organized and participated in National Webinar on Date palm through virtual platform during 21-22 July, 2020 at CIAH, Bikaner.
- Participated in the National Webinar on "Boosting immunity through horticulture" through virtual mode organized by Society for Horticultural Research and Development, Ghazibad (U.P.) on 8 September, 2020.
- Participated and presented a talk on "Horticulture based integrated farming system in arid region" in National Webinar on Climate Smart Integrated Farming System by ICAR-National Institute of Abiotic Stress Management Malegaon, Baramati, Maharashtra on 18 September, 2020.
- Participated as Chief Guest in the National Webinar on "Scenario of pomegranate cultivation in India" on the occasion of sixteenth Foundation Day of ICAR-NRC-Pomegranate, Solapur in virtual mode on 25 September, 2020.
- Participated in special lectures session on Gandhian Philosophy organized by IASRI, New Delhi through virtual mode on 25 September, 2020.
- Participated and delivered key note lecture in National e-conference on "Opportunities and challenges in arid horticulture" organized by Suresh Gyan Vihar University, Jaipur in virtual mode on 21 October, 2020.
- Acted as panelist of Theme II: Pollinizers in Horticulture of Brainstorming Session on “Honey Bees, Other pollinators, Pollinizers in Horticulture” organized by Indian Academy of Horticultural Sciences on 22 December, 2020.

Dr. Sanjay Singh

- Participated and exhibited the different exhibits of the station in Kisan Mela, exhibition and farmer workshop organized by ATMA Panchmahals at KVK Panchmahals during 21-22 January, 2020.
- Participated and exhibited different

exhibits of the station in Global Potato Conclave 2020 at Mahatma Ashram, Gandhinagar, Gujarat organized by ICAR-CPRI, Shimla during 28-31 January, 2020.

- Participated in National Webinar on Date palm organized by ICAR-CIAH, Bikaner during 21-22 July, 2020.
- Participated National Webinar on recent advances in underutilized fruits organized by college of Horticulture, SDAU, Jagudan, Mehsana on 5 September, 2020.
- Participated in National Webinar on "Underutilized fruits converting waste land in to gold mine" organized by College of Agriculture, Navsari Agriculture University, Campus Bharuch on 30 September, 2020.
- Participated in National Webinar on "Prospective, priorities and preparedness of sustainable agriculture development" in India during 28-29 December, 2020 organized by Dr. Ram Avatar Shiksha Samiti.
- Participated in one day online seminar on "Under utilized horticultural crops" organized by college of horticulture, AAU, Anand on 5 January, 2021.

Dr. S. K. Maheshwari

- Attended National Webinar on Date palm" held at ICAR-CIAH, Bikaner during 21-22 July, 2020.

Dr. A. K. Singh

- Participated in Indian Horticulture Summit-2020 "Mitigating climatic changes and doubling farmer's income through diversification" held from 14-16 February, 2020 at MGCGV, Chitrakoot, Madhya Pradesh.
- Participated in Brain Storming Session on "Crop improvement on arid zone fruits" held at SKNAU, Jobner, Rajasthan on 18 January, 2020.
- Participated in National Webinar on "Boosting immunity through horticulture" from 1-9 September, 2020 organized by SHRD, Ghaziabad, Uttar Pradesh.

Dr. D.K. Sarolia

- Participated in International Webinar on "DUS testing data management/ automation/ image analysis" on 6-7 October, 2020.

Dr. D.S. Mishra

- Attended progressive International Web Conference on "Global initiatives for sustainable agriculture and allied sciences (GRISAAS-2020)" organized by ASTHA Foundation, Meerut during 28-30 December, 2020.

Dr. B.R. Choudhary

- Attended Indian Horticulture Summit-2020 on "Mitigating climate changes and doubling farmer's income through diversification" held at MGCGV, Chitrakoot (MP) from 14-16 February, 2020.
- Attended National Webinar on "Intellectual property right in agriculture sector" organized by SKRAU, Bikaner (Rajasthan) on 17 July, 2020.
- Attended National Webinar on "Boosting immunity through horticulture" organized by Society for Horticultural Research and Development, Ghaziabad (UP) from 1-9 September, 2020.
- Attended International Webinar on "DUS testing data management/ automation/ image analysis" organized by PPV&FRA, New Delhi from 6-7 October, 2020.

Dr. R.C. Balai

- Attended National Web Conference on "Utilization of organic waste for soil health management and energy production under changing climate scenario" held at SKNAU Jobner on 6 October, 2020.

Dr. R. K. Meena

- Participated in National Webinar on "Pollen conservation and utilization in effective pollination in date palm" held at ICAR-CIAH, Bikaner during 21-22 July, 2020.
- Attended International Webinar on "DUS testing data management/ automation/image analysis" organized by PPV&FRA, New Delhi during 6-7 October, 2020.

Dr. Ramesh Kumar

- Attended National Webinar on Date palm organized by ICAR-Central Institute for Arid Horticulture, Bikaner on 21-22 July, 2020.
- Participated in National Webinar on

"Scenario of pomegranate cultivation in India" organized by the ICAR-NRC on Pomegranate, Solapur in collaboration with Kisan Samvad, Pune during 24-26 September, 2020.

- Participated in National Webinar on pomegranate organized by Pomegranate Grower Association of India and Kisan Samvad, Pune during 13-16 October, 2020.
- Participated in Webinar on "Pomegranate cultivation: Problems and solutions" organized by the Krishi Vigyan Kendra, Gudamalani (AU, Jodhpur) on 19 October, 2020.

Dr. Anita Meena

- Attended International e-Conference on "Effect of COVID 19 pandemic on agriculture and allied science" held at CPAAS, Lucknow during 23-24 August, 2020.
- Attended E-National Seminar on "*Agriculture Resource management for Atmnirbhar Bharat"* at Central Agriculture University, held at Imphal, Manipur during 17-18 July, 2020.

Dr. A. K. Verma

- Participated in National Webinar on "Approaches towards development of rural and agriculture sector in the present scenario" organized by JNKVV, Jabalpur from 8-9 May, 2020.
- Participated in National Webinar on "Strategies and policy interventions for agricultural development in north-east India during COVID-19 era" organized by CAU, Imphal and AIASA, New Delhi from 13-14 June, 2020.
- Participated in ten days Online National Workshop on "Underutilized plant species: Future smart crops for food, nutritional security and income generation" organized by SKUAST-Kashmir during 20-29 August, 2020.
- Participated in International Web Conference on "Biodiversity in vegetable crops for healthier life and livelihood" organized by BAU, Sabour, Bhagalpur during 27-28 August, 2020.
- Participated in International Webinar on "Harnessing the potential of tropical tuber crops under changing climate (HPTTC 2020)" organized by ICAR-CTCRI, Kerala on 27 October, 2020.
- Participated in International e-Conference on "Advances and future outlook in biotechnology and crop improvement for sustainable productivity" organized by UHS, Bagalkot, Karnataka during 24-27 November, 2020.

Dr. Vikas Yadav

- Attended International e-Conference on "Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture" held at UHS, Bagalkot, Bengaluru during 6-9 October, 2020.

Dr. Gangadhara K.

- Participated in International Webinar series on "Moringa- A super food boon to mankind" organized by Department of Vegetables in association with ED II Periyakulam Horti Business Incubation Forum from 5-7 October, 2020.
- Participated in International E-conference on "Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture" organized by College of Horticulture, Bengaluru (UHS, Bagalkot) during 6-9 October, 2020.

Meeting Attended

Prof. (Dr.) P. L. Saroj

- Participated institute Research Advisory Committee Meeting organized at ICAR-CIAH, Bikaner on 3-4 January 2020 under chairmanship of Dr. T.A. More.
- Acted as Technical Committee Member to assess the suitability of the land to be acquired at Bikaner for establishing the RRS of ICAR-DGR, Junagarh on 1 February, 2020.
- Participated in a meeting of Board of Studies of the Faculty of Institute of Agri. Business Management, SKRAU, Bikaner on 3 February, 2020.
- Participated in Webex Meeting to discuss points of ICAR bye-laws with Additional Secretary (DARE) and Secretary, ICAR, New Delhi on 26 June, 2020.
- Organized and chaired Institute Research

Committee meeting during13-14 July, 2020.

- Attended online inauguration of Academic and Administrative Building of RLBCAU, Jhansi through virtual mode on 29 August, 2020.
- Attended meeting on "One District One Commodity" chaired by Secretary DARE and Director General, ICAR, New Delhi through virtual mode on 9 September, 2020.
- Chaired and participated in Institute Variety Identification Committee Meeting held on 23 September, 2020.
- Chaired and participated Institute Joint Staff Council Meeting of ICAR-CIAH, Bikaner on 23 September, 2020.
- Attended review meeting of Horticulture Science Division chaired by Minister of State, Govt. of India and DDG (HS), New Delhi on 22-23 September, 2020.
- Participated on 38 Annual Group Meeting of AICRP (VC) in virtual mode on 25 September, 2020.
- Attended the Vaibhav Summit Inauguration Function by Hon'ble Prime Minister, Govt. of India, New Delhi on 03 October, 2020.
- Attended and chaired virtual workshop of AICRP-AZF (Review meeting) on 19 December, 2020 at ICAR-CIAH, Bikaner.
- Participated as Visitor's Nominee in Selection Committee Meeting at BHU, Varanasi in virtual mode on 10-13 October, 2020.
- Participated as Chief Guest in the pomegranate meeting at Barmer organized by Pomegranate Association, Rajasthan on 13 October, 2020.
- Participated in 75th Anniversary of the Food and Agriculture Organization (FAO) virtual mode on 16 October, 2020.
- Participated in meeting of EFC/SFC of Horticultural Science Division in virtual mode on 22-23 October, 2020.
- Attended as Jury Committee Member of Padma Bhusan Dr. R.S. Paroda Best Scientists Award by SKNAU, Jobner in virtual mode to decide modalities of award on 2 November, 2020.
- Attended ICAR-Regional Committee-IV meeting in virtual mode on 2 November, 2020.
- Participated in Annual General Body Meeting of IAHS New Delhi on 5 November, 2020.
- Attended Director Conference in virtual mode on 5 December, 2020.
- Acted as Subject Expert Member of selection committee for appointment of contractual assistant professor for College of Horticulture, Khuntpani (Chaibasa) under Birsa Agricultural University, Ranchi on 9 December, 2020.
- Attended EFC/SFC Meeting of Horticultural Science Division on 15 December, 2020.

Dr. D. K. Sarolia

- Attended ZREAC meeting Rabi 19-20 held at the Agricultural Research Station, SKRAU, Bikaner on 7-8 September, 2020.

Dr. A. K. Mishra

- Participated in online pre-review group meeting of AICRP on Arid Zone Fruits on 19 December, 2020.

Dr. B. R. Choudhary

- Attended Scientific Advisory Committee (SAC) meeting of KVK, Lunkaransar held on 8 January, 2020.

Dr. Ramesh Kumar

- Attended Annual Group Meeting of ICAR-All India Coordinated Research Project on Arid Zone Fruits held from 28 February to 1 March, 2020 at TNAU, Coimbatore.
- Participated in Review Meeting of ICAR-All India Coordinated Research Project on Arid Zone Fruits on 19 December, 2020 held at ICAR-CIAH, Bikaner.

Dr. Kamlesh Kumar

- Attended virtual review meeting of ICAR-AICRP on AZF on 19 December, 2020 at ICAR-CIAH, Bikaner.

7. EMPOWERMENT OF WOMEN AND PERSON WITH DISABILITIES (DIVYANGIAN)

TRAINING PROGRAMMES ON WOMEN EMPOWERMENT

Different trainings programmes for women empowerment were organized on various aspects of arid horticulture like value addition, nursery management and kitchen gardening under different occasion like SC-SP programmes and institutional trainings. A total of 330 farm women were benefitted through the different training programmes/modules. The inputs like seeds of improved varieties of vegetable, spices, kitchen gardening packets, milk collection canes, pots, *etc.*, were distributed to trainee farm women. The visit of experimental blocks, technological museum and nursery complex of the institute was also conducted to create awareness and impart knowledge on modern production, propagation and post harvest management technologies of arid horticultural crops.

SPECIFIC TRAINING MODULES FORMULATED AND CONDUCTED FOR WOMEN

- Organized seven days training programme on "Economic empowerment of rural women through value added horticultural enterprises" from 24 February to 1 March, 2020 under SC-SP scheme at ICAR-Central Institute for Arid Horticulture (ICAR-CIAH), Bikaner.
- Organized seven days training programme on "Women empowerment through nursery management" during 13 to 19 March, 2020 under SC-SP scheme at ICAR-CIAH, Bikaner.
- One day on campus training and input distribution programmes was organized on 15 May, 2020 for empowerment of farm women through value addition under SC-SP scheme. The items like Bhagona, spoon,

Training organized for women empowerment and input distributed under SC-SP scheme

Training programme organized on "Women empowerment through nursery management"


Training programme organized on "Women empowerment through value addition"

utensil stands, *etc*. were also distributed among the trainee women under SC-SP scheme at ICAR-CIAH, Bikaner.

- Organized one day training program on "Women empowerment for self reliance" on 15 July, 2020 and distributed inputs under SC-SP scheme at ICAR-CIAH, Bikaner.

ACCESSIBILITY TO THE PERSON WITH DISABILITIES (DIVYANGIAN)

The Institute has constructed ramp and washrooms in all office buildings/library building/ guest house for person with disabilities (divyangian). The scientists also interacted with them and conducted their visit to museum, experimental fields, *etc*.

8. AWARDS AND RECOGNITION

Institute Awards

- ICAR-CIAH, Bikaner, received Ganesh Shankar Vidyarthi Hindi Patrika Puraskar for 'Maru Bagwani' 2018-19 Hindi patrika from ICAR, New Delhi. The award was given by Hon'ble Agriculture & Farmer's Welfare Minister, Govt. of India through virtual mode during ICAR Foundation Day celebration on 16 July, 2020.
- The Institute participated and displayed technological exhibition stall during the Farmers' Fair organized at NRCSS, Tabijee Ajmer from 15.02.2020 to 16.02.2020. The Institutes' exhibition was honoured with "Best Technological Exhibition Award" during this Mela.
- The Institute participated and displayed another technological exhibition stall during the Kisan *Mela* organized by KVK Gudamalani, Barmer-II under Agricultural University, Jodhpur on 24.02.2020 and received "Best Technological Exhibition Award". Hon'ble Union Agriculture and Farmers' Welfare Minister, Sh. Kailash Chaudhary Ji was the Chief Guest of this Kisan Mela. He visited the technological exhibition stall of Institute and he highly appreciated the arid horticultural technologies developed by the Institute.

ICAR-CIAH, Bikaner received Best Technological Exhibition Award at NRCSS, Ajmer and KVK, Gudamalani

- ICAR-CIAH, regional station CHES, Vejalpur received "First Best Exhibition Award" during "Krishi Mela, Exhibition and Farmer workshop" organized by ATMA, Panchmahals, Gujarat during 21-22 January, 2020 for displaying of station exhibition. In the krishi mela various institute technologies/varieties of fruits and vegetable crops were displayed through posters, banners, folders and live samples.

ICAR-CIAH regional station CHES, Vejalpur received first best exhibition award in krishi mela

Individual Awards

Prof. (Dr.) P. L. Saroj

- Awarded with "Life Time Achievement Award" during Indian Horticultural Summit-2020 on 14 February, 2020 for contribution in the field of arid horticulture.
- Received "Dr. Girdhari Lal Chadda Medal in Fruits" by IAHS on 6 November, 2020 by Dr. K. L. Chadha, president IAHS, New Delhi in presence of Secretary DARE and DG, ICAR, New Delhi.

Dr. A. K. Singh

- Received "Distinguished Horticultural Scientist Award-2019" by Society for Horticultural Research and Development during Indian Horticulture Summit, 2020 held from 14-16 February, 2020 at MGCGV, Chitrakoot, Madhya Pradesh.
- Received "Research Excellence Award (Horticultural Science) -2020" by Global Research Foundation, New Delhi on the occasion of Teachers Day, 5 September, 2020.
- Received "*Best Oral Presentation" award for paper* entitled "Kinetics of productivity and economics of Goma Yashi bael under high density" during Indian Horticulture Summit, 2020 held from 14-16 February, 2020 at MGCGV, Chitrakoot, Madhya Pradesh.

Dr. Anita Meena

- Received "Research Excellence Award" from Institute of scholar, Bangalore (ISO 9001:2015) certified Institute by International Accurate Certification, Accredited by UASL during , 2020.
- Received the "Third Best Oral Presentation" award in National conference "Agriculture resource management for Atmnirbhar Bharat" organized by Central Agriculture University, Imphal, Manipur during 17-18 July, 2020.

Miscellaneous Award

- Dr. S.K. Maheshwari received first prize in "Hindi Bhasha Gyan Pratiyogita" during Hindi Pakhwada held from 14-30 September 2020 at ICAR-CIAH, Bikaner.
- Dr. D.K. Sarolia awarded first prize in "Vad Vivad Pratiyogita" organized during Hindi Pakhwada held from 14-30 September 2020 at ICAR-CIAH, Bikaner.
- Dr. Anita Meena awarded third prize in "Vad Vivad Pratiyogita" organized during Hindi Pakhwada, celebrated from 14-30 September, 2020 at ICAR-CIAH, Bikaner.
- Dr. Kamlesh Kumar received first Prize in "Hindi Shabd Lekhan Pratiyogita" organized during Hindi Pakhwada celebrated from 14-30 September, 2020 at ICAR-CIAH, Bikaner.
- Dr. A.K. Verma received second prize in "Vad Vivad Pratiyogita" organized during Hindi Pakhwada held from 14-30 September 2020 at ICAR-CIAH, Bikaner.
- Dr. A.K. Verma received second prize in "Hindi Shabd Lekhan Pratiyogita" organized during Hindi Pakhwada held from 14-30 September 2020 at ICAR-CIAH, Bikaner.

Recognitions

Prof. (Dr.) P. L. Saroj

- Acted as Subject Expert Member of selection committee for appointment of Assistant Professor for College of Horticulture, Khuntpani (Chaibasa) under Birsa Agricultural University, Ranchi on 9 December, 2020.
- Acted as Panelist of Theme II: Pollinizers in Horticulture of Brainstorming Session on Honey Bees, Other pollinators, Pollinizers in Horticulture organised by Indian Academy of Horticultural Sciences on December 22, 2020.
- Acted as Guest of Honour during Farmer's Fair organized by Sri Karan Narendra Agriculture University at SKNAU, Jobner on 24 February, 2021.
- Acted as Referee for viva-voce exam conducted on 7 September, 2020 of the student Sh. Palepad Kailas Baliram (Reg No. 016/58)-Horticulture (Fruit Science), MPKV, Rahuri.

Dr. Sanjay Singh

- Acted as Expert on 11 March, 2020 and evaluated Ph. D. thesis of Sri Rakesh Kumar Jat on "Influence of different

organic sources of nutrients on growth yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa" SDAU, Jagudan, Mehsana.

- Acted as Expert on 5 June, 2020 and evaluated M.Sc. Ag. (Fruit Science) thesis of Sri Nandish H.S. entitled "Effect of microbial consortia on growth and development of jamun (*Syzygium cuminii* L.) cv. Goma Priyanka", college of horticulture and forestry, Jhalawar (A.U., Kota).
- Evaluated Ph.D. thesis (Horticulture) and acted as expert on 22 December, 2020 to conduct viva voce exam (virtual mode) of Mr. Abhinav Kumar entitled "Effect of plant growth regulators and micronutrients on Gladiolus (*Gladiolus grandiflorus* L.) cv. Novalux" ANDUAT, Ayodhya.
- Acted as expert on 30 December, 2020 and evaluated M.Sc. Ag. (Horticulture) thesis of Patel Khushbuben Ashokbhai entitled "Evaluation of rejuvenation of Mango (*Mangifera indica* L.) cultivars for growth, yield and quality under south Gujarat region", NAU, Navsari.
- Acted as Chief Guest in seminar on "Underutilized horticultural crops" organized by college of horticulture, AAU, Anand.

Dr. S. K. Maheshwari

- Nominated as election officer for election of Members of IJSC (2020) at ICAR-CIAH, Bikaner, its Regional Station (CHES), Godhra and KVK-Panchmahal in the month of December, 2020.

Dr. A. K. Singh

- Evaluated the Ph.D. thesis (Horticulture) of Kachchadia Palak Arvindbhai entitled "Effect of foliar spray of silicon and boron on fruiting nutritional status of leaves and fruit quality of rejuvenated mango (*Mangifera indica* L.) cv. Sonpari" Agriculture University, Navsari, Gujarat.
- Evaluated the M.Sc. thesis of Mukesh Chand Bhateshwar entitled "Effect of thickness of mulch on growth and development of khirni (*Monilkara hexandra* Roxb) cv. Thar Rituraj" Agricultural University, Kota, Rajasthan.
- Evaluated the P.G. thesis of Patel Tanviben Ashokbhai entitled "Influence of pre-harvest treatment on yield and biochemical behavior of mango cv. Amrapali", ASPEE College of Horticulture and Forestry, NAU, Navsari, Gujarat.
- Acted as Rapporteur during session-Social Science and Horticulture Business, Indian Horticulture Summit-2020, 14-16 February, 2020, held at Chitrakoot, Madhya Pradesh.
- Acted as a Convener in one month training course on "Production technology and post harvest management in semi-arid horticultural crops" for MSW students from 6 February to 25 March, 2020 at CHES, Godhra.
- Acted as Convener for three days on campus training on "Nursery and orchard management for livelihood security in semi-arid region" under Schedule Caste-Sub Plan from 11-13 March, 2020 at CHES, Godhra.

Dr. B. R. Choudhary

- Admitted as Fellow of the Society for Horticultural Research and Development, Ghaziabad during Indian Horticulture Summit-2020 on Mitigating climate changes and doubling farmer's income through diversification held at MGCGV, Chitrakoot (MP) from 14-16 February, 2020.

Dr. D. K. Sarolia

- Nominated as member of NHB nursery accreditation and the rating team for accreditation of M/s Digvijay Nursery, Pugal, Bikaner on 4 December 2020.
- Acted as member for select Young Professional-II at SKRAU, Bikaner on 27 October 2020.

Dr. D. S. Mishra

- Acted as Editor (National) of the *HortFlora Research Spectrum* (Biosciences & Agriculture Advancement Society), Meerut.
- Acted as Editor (PHT) for ISAH Indian Journal of Arid Horticulture (Indian Society for Arid Horticulture), Bikaner.
- Worked as Co-convener in a three days on-campus training programme under SC-SP project held at CHES, Godhra during 11-13 March, 2020 on "Nursery and orchard management for livelihood security in semi-

arid region".

Dr. R. K. Meena

- Acted as Rapporteur in AICRP on Arid Zone Fruits review meeting at ICAR-Central Institute for Arid Horticulture held on 19 December 2020.

Dr. M. K. Berwal

- Acted as Co-organizing secretary in national webinar on Date palm organized in virtual mode at ICAR-CIAH, Bikaner during 21-22 July, 2020.

Dr. Ramesh Kumar

- Acted as Rapporteur in the session "Plant Propagation, Planting System, Canopy Management and PHT" of the Annual Meeting Report-2020 of ICAR-AICRP on Arid Zone Fruits, held at TNAU, Coimbatore, Tamil Nadu during 28 February to 1 March, 2020.
- Acted as Rapporteur in the Review Meeting of ICAR-AICRP on Arid Zone Fruits, held at ICAR-CIAH, Bikaner on 19 December, 2020.
- Acted as Associate Editor of Indian Journal of Arid Horticulture published by Indian Society for Arid Horticulture, Bikaner.
- Acted as Academic Editor for International Journal of Agriculture Sciences published by Bioinfo Publication, Pune, Maharashtra.

Dr. Chet Ram

- Acted as Member of Editorial Board of Journal of Plant Sciences, Science Publishing Group, New York, NY 10020 USA in 2020.

Dr. L. P. Yadav

- Acted as Member of Editorial Board of International Journal of Environment, Agriculture and Biotechnology (IJEAB) in 2020.

Dr. Gangadhara K.

- Worked as Co-convener in three days on campus training on "Nursery and orchard management for livelihood security in semi-arid region" organized under Schedule Caste-Sub Plan from 11-13 March, 2020 at CHES, Vejalpur.
- Acted as a Co-convener in one month training course on "Production technology and post harvest management in semi arid horticultural crops" for MSW students, from 6 February to 3 March, 2020 at CHES, Vejalpur.

Dr. Kamlesh Kumar

- Acted as Member of Flying Squad Team in JET examination organized by Kota Agricultural University at Bikaner centre on 29 September 2020.
- Acted as Rapporteur for Review Meeting of ICAR-All India Coordinate Research Project on Arid Zone Fruits organized on 19 December, 2020 at ICAR-CIAH, Bikaner.

9. Publications

Research Papers

- Berwal, M.K., Chugh, L.K., Goyal, Preeti and Kumar, R. 2020. Exploiting Genetic Diversity for Identification of Protein Dense Seed Parent in Pearl Millet. *Indian Journal of Plant Genetic Resources.* 33(1): 85–89. (http://krishi.icar.gov.in/jspui/handle/123456789/44926).
- Kumar, K., Singh, D. and Saroj, P.L. 2020. Callus induction, somatic embryogenesis, in vitro plantlet development and ex vitro transplantation of two date palm (*Phoenix dactylifera* L.) cultivars. *International Journal of Chemical Studies,* 8(1): 758-763. (http://krishi.icar.gov.in/jspui/handle/123456789/44912).
- Kumar, K., Srivastav, M., Singh, S.K. and Singh, A. 2020. SSR marker based differentiation of zygotic and nucellar seedlings in mango (*Mangifera indica*). The *Indian Journal of Agricultural Sciences*, 90 (11): 2101–7. (http://krishi.icar.gov.in/jspui/handle/123456789/44911)
- Kumar, R., Saroj, P.L., Sharma, B.D. and Yadav, P.K. 2020. Studies on flowering induction, sex ratio and fruit set improvement in pomegranate. *Indian Journal of Horticulture*, 77(4): 610-618. (http://krishi.icar.gov.in/jspui/handle/123456789/44919)
- Kumar, R., Saroj, P.L., Sharma, B.D., Yadav, P.K. and Sarolia, D.K. 2019. Yield and economics of pomegranate as influenced by flower regulation under hot arid climate. *Indian Journal of Arid Horticulture*, 1(2):24-30. (http://krishi.icar.gov.in/jspui/handle/123456789/44917)
- Maheshwari, S.K., Choudhary, B.R., Saroj, P.L. and Sharma, B.D. 2020. Field efficacy of botanicals and inorganic salts against mosaic disease on ridge gourd in western Rajasthan. *International Journal of Current Microbiology & Applied Sciences*, 9(7): 1300-1304. (http://krishi.icar.gov.in/jspui/handle/123456789/44885)
- Meena, C.L., Meena, R.K., Sarolia, D.K., Dashora L.K., and Meena V.S. 2020. Effect of integrated nutrient management on the quality of Ganesh pomegranate, *Indian Journal of Horticulture*, (2):1384-388
- Pareek, P.K., Yadav P.K., Kumar, S., Sarolia, D.K. and Sharma, B.D. 2020. Integrated nutrient management in Khadrawy date palm under hot arid region. *Indian Journal of Horticulture*, *77(3): 450-455. (*http://krishi.icar.gov.in/jspui/handle/123456789/44923)
- Ram, Chet, Muthuganeshan Annamalai, Murali Krishna Koramutla, Rekha Kansal, Ajay Arora, Pradeep K. Jain and Ramcharan Bhattacharya 2020. Characterization of STP4 promoter in Indian mustard Brassica juncea for use as an aphid responsive promoter. *Biotechnology Letters*, 42: 2013–2033.
- Sarolia D.K., Meena R.K. and Singh U.V. 2019. Multiplication of mulberry varieties through semi hardwood cuttings in arid region. *Indian Journal of Arid Horticulture*,1*(2): 96-98. (*http://krishi.icar.gov.in/jspui/handle/123456789/44928)
- Sarolia, D. K., Kumar, K. and Meena, R.K. 2019. Standardization of seed and seedling standards of phalsa (*Grewia subinaequalis* L.). *Indian Journal of Arid Horticulture*, 1*(2):67-71.* (http://krishi.icar.gov.in/jspui/handle/123456789/44921)
- Singh, A.K., Singh, Sanjay and Saroj, P.L. 2019. Leaf morphology, floral biology pollination behavior of elite bael accessions under semi-arid conditions. *Indian Journal of Arid Horticulture, 1(2):16-23.* (http://krishi.icar.gov.in/jspui/handle/123456789/44931*).*
- Singh, R.S., Meena, R.K., Kumar, K. and Singh, D. 2019. Variability in date palm fruits (*Phoenix dactylifera* L.) collected from Kachchh region of Gujarat. *Indian Journal of Arid Horticulture*, 1(2): 84-86.
- Singh, Sanjay, Singh, A.K., Mishra, D. S. and Appa Rao, V.V. 2019. Genetic diversity in jamun under semi arid ecosystem of western India. *Indian Journal of Arid*

Horticulture, 1(2):34-38.
- Verma, A.K., Mehta, A.K., Singh, R.P., Singh, P.P. and Sharma, D. 2020. Studies on hybrid vigour for yield and contributing traitsin cowpea (*Vigna unguiculata* L. Walp). *Research Journal of Biotechnology*, 15(10): 72-79.

Scientific Reviews

- Saroj, P.L. and Choudhary, B.R. 2020. Improvement in cucurbits for drought and heat tolerance-a review. *Current Horticulture*, 8(2):3-13. (http://krishi.icar.gov.in/jspui/handle/123456789/45105)
- Saroj, P.L., Ram, Chet and Kumar, K. 2020. Arid horticultural crops: Status and opportunities under changing climatic conditions. *Indian Journal of Plant Genetic Resources*, 33(1):17-31.
- Selvakumar, R., Praveen K.S., Manjunathagowda, D.C and Gangadhara, K. 2020. Genome editing for improvement of vegetable crops. *Food and Scientific Reports,* 1(10):26-30.
- Singh, A.K., Singh Sanjay, Saroj, P.L., Mishra, D.S., Vikas Yadav and Kumar, Raj. 2020. Underutilized fruit crops of hot semi-arid region: Issues and challenges- a review. *Current Horticulture,* 8(1):12-23. (http://krishi.icar.gov.in/jspui/handle/123456789/44929)
- Yadav, P., Pandiaraj, T., Kumar V., Yadav, V. and Singh P. 2020. Concept, present status, prospective and myth and reality of organic farming with special reference to Indian context. *International Journal of Current Microbiology and Applied Sciences*, 9(8): 3742-3748.
- Yadav, P., Pandiaraj, T., Yadav, V., Yadav V., Yadav, A. and Singh, V. 2020. Traditional values of medicinal plants, herbs and their curable benefits. *Journal of Pharmacognosy and Phytochemistry*, 9(1): 2104-2106.

Popular Articles

- Choudhary, B.R., Berwal, M.K. and Saroj, P.L. 2019. YF 5-2-7: A carotenoid rich genotype of watermelon. *ICAR News* (Oct.-Dec., 2019), 25(4):8. (http://krishi.icar.gov.in/jspui/handle/123456789/45106)
- Meena, A., Singh, N., Kumar, J., Kumar, K., Meena, M. and Meena, N. 2020. Contribution of information technology in increasing agriculture income. *Krishi Sewa, pp. 883.*
- Meena, A., Singh, N., Kumar, J., Kumar, K., Meena, M. and Meena, N. 2020. Use of plasticulture in agriculture. *Krishi Sewa*, pp. 773.
- Samadia, D.K. and Verma, A.K. 2020. Ivy gourd – Thar Sundari for cultivation in dry-land climate. *Indian Horticulture*, 65(4): 35-37. (http://krishi.icar.gov.in/jspui/handle/123456789/44880)
- Singh, N., Kumari, A., Singh, S.P. and Meena, A. 2020. Nutri-cereal pearl millet. Importance and challenges ahead, *Rastriya Krishi*, (15)2:67-69.
- Singh, A.K., Singh Sanjay, Saroj, P.L., Mishra, D.S. and Yadav, V. 2020. Ardhshusk kshetron me bael ki bagwani. *Phal Phool*, 41 (4):37-43. (http://krishi.icar.gov.in/jspui/handle/123456789/44934)
- Singh, A.K., Singh, Sanajy, and Saroj, P.L. 2020. Bael ki unnat prajati Goma Yashi. *Phal Phool*, 41 (6):49-50. (http://krishi.icar.gov.in/jspui/handle/123456789/44933)
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TV and Radio Talks

- Dr. A.K. Singh gave Telephonic recording on the topic "Corona kal me aonla ki kheti aur ayurvedic mahatva" was broadcasting by AIR, Godhra Gujarat on 1 August, 2020.
- Dr. D.S. Mishra delivered a radio talk on "Management of acid lime orchards" at All India Radio Godhra broadcasted on 16 July, 2020.
- Dr. D.S. Mishra delivered a TV talk on "Cultivation of guava and acid lime" at DD Kisan broadcasted on 9 December, 2020.
- Dr. L.P. Yadav recorded Radio talk at All India Radio, Godhra on "Cultivation and management practices of vegetable crops during July-August" in Hindi for 'Kishanvani' programme broadcasted on 28 July, 2020.
- Dr. L.P. Yadav recorded TV talk "Bael cultivation" broadcasted on News 18 Rajasthan entitled on 14 October, 2020.
- Dr. L.P. Yadav recorded TV talk entitled "Bottle gourd production technology" broadcasted on News 18 Rajasthan on 26 August, 2020.
- Dr. L.P. Yadav recorded TV talk entitled "How to get more income from tomato cultivation" broadcasted on News 18 Rajasthan on 8 October, 2020.
- Dr. L.P. Yadav recorded TV talk entitled "Improved production technology of moringa" broadcasted on News 18 Rajasthan on 22 September, 2020.
- Dr. L.P. Yadav recorded TV talk entitled "Improved production technology for higher yield of Sahjan" broadcasted on News 18 Rajasthan on 23 September, 2020.
- Dr. L.P. Yadav recorded TV talk entitled "Nursery management in vegeble crops" broadcasted on News 18 Rajasthan on 27 August, 2020.
- Dr. Ramesh Kumar delivered a TV talk on "Pomegranate and citrus cultivation in hot arid region" at DD Kisan, New Delhi telecasted on 5 November, 2020.
- Dr. Sanjay Singh delivered radio talk at Godhra Radio Station on the topic Post harvest technology of mango and precautions for COVID 19 broadcasted on 8 May, 2020.
- Dr. Sanjay Singh delivered TV talk on DD Kisan New Delhi on guava, mango and jamun broadcasted on 20 July, 2020.
- Dr. Vikas Yadav delivered a radio talk on "Corona kaal me sitaphal ki kheti" broadcasted on 20 July, 2020.

10. RESEARCH PROJECTS

Code	Title of the projects	Name of PI & Co-PI
A. Institute Projects		
I. New Research Project Proposal		
1)	Water budgeting in fruit crops of arid region.	Dr. M. K. Jatav
2)	Impact assessment ofadoption of pomegranate and date palm in hot arid and semi-arid regions of Rajasthan.	Dr. S. R. Meena Shri R. C. Balai Dr. Rekha Rani
3)	Development of ber cultivation with natural resource management (NRM) practices in arid region.	Shri R. C. Balai Dr. S. R. Meena
4)	Use of saline water for native crop -plant production under hot arid climate.	Shri R. C. Balai Dr. Anita Meena Shri R. Sanodiya
5)	Major diseases and their control measures in important arid fruit crops (pomegranate and date palm).	Dr. S. K. Maheshwari Ms. Ramyashree Devi Dr. Ramkesh Meena Dr. Ramesh Kumar
II. On-going Research Projects		
CIAH: 1	**Introduction, collection, characterization, conservation and evaluation of germplasm of arid and semi-arid fruit and vegetable crops:**	
(a)	Ber (*Ziziphus* spp.)	Dr. D. K. Sarolia Dr. Kamlesh Kumar Sh. M. K. Choudhary
(b)	Pomegranate (*Punica granatum* L.)	Sh. Ramesh Kumar Dr. D. S. Mishra Dr. Ramkesh Meena Dr. Chet Ram
c)	Date palm (*Phoenix dactylifera* L.)	Dr. R. S. Singh Dr. B. D. Sharma Dr. Ramkesh Meena
(d)	Aonla (*Emblica officinalis* Gaertn)	Dr. A. K. Singh Dr. D. S. Mishra Dr. Mukesh K. Berwal
(e)	Bael (*Aegle marmelos* Correa.)	Dr. A. K. Singh Dr. Ramkesh Meena Sh. Roop Chand Balai Dr. Vikas Yadav
(f)	Wood apple (*Feronia limonia*) and custard apple (*Annona squomosa)*	Dr. Vikas Yadav Dr. A. K. Singh
(g)	Jamun and Manila tamarind.	Dr. Sanjay Singh Dr. A. K. Singh Dr. V. V. Appa Rao Dr. D. S. Mishra

(i)	Guava and acid lime.	Dr. D. S. Mishra Dr. Vikas Yadav
(j)	Underexploited fruit crops (Lasoda, ker, karonda and phalsa).	Dr. Kamlesh Kumar Dr. Chet Ram Dr. D. K. Samadia
(k)	Maintenance and use of arid vegetable genetic resources for crop improvement.	Dr. D. K. Samadia Dr. Ajay Kr. Verma Smt. Monika Puniya
(l)	Cucurbitaceous crops: M uskmelon, watermelon, sponge gourd and longmelon.	Dr. B. R. Choudhary Dr. S. K. Maheshwari
(m)	Introduction, collection, characterization, conservation and evaluation of vegetable crops (dolichos bean, cluster bean and cowpea) under rainfed semi-arid conditions of western India	Dr. Gangadhara, K. Dr. V. V. Appa Rao Dr. L. P. Yadav Ms. Ramyashree Devi
(n)	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 Dr. Gangadhara, K.
CIAH: 2	**Improvement of arid and semi arid fruit and vegetable crops including biotechnological interventions:**	
(d)	**Biochemical and biotechnological interventions:**	
(iii)	Biochemical mechanism of abiotic stress tolerance in arid horticultural crops.	Dr. Mukesh K. Berwal Dr. Chet Ram
iv)	Development, exploitation and validation of genomic resources for enhanced utilization of arid horticultural crops.	Dr. Chet Ram Dr. M. K. Berwal Dr. Ajay K. Verma Dr. Kamlesh Kumar Dr. Ramesh Kumar
CIAH: 3	**Standardization of arid and semi-arid fruits and vegetables production technology:**	
(c)	Intensification of research on tissue cultured date palm in hot arid region.	Dr. B. D. Sharma Dr. R. S. Singh Dr. Ramkesh Meena
(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.	Dr. Ramesh Kumar Dr. B. D. Sharma Sh. Roop Chand Balai
(f)	Studies on flowering regulation, cracking management and root stock adaptability in pomegranate under hot arid environment of Rajasthan.	Dr. Ramesh Kumar Dr. M. K. Jatav Dr. Ramkesh Meena Ms. Ramyashree Devi
(i)	Nutrient management in chironji, custard apple, jamun and tamarind.	Dr. V. V. Appa Rao Dr. Sanjay Singh Dr. A. K. Singh
(j)	Production system management in *ber* under hot arid ecosystem.	Prof. (Dr.) P. L. Saroj Dr. D. K. Sarolia Dr. B. D. Sharma

(k)	Standardization of production technology of jamun and custard apple under semi-arid conditions of western India.	Dr. Sanjay Singh Dr. D. S. Mishra Dr. V. V. Appa Rao
(l)	Response of date palm cultivar to pollen sources, pollen quality, quantity and suitability under hot arid ecosystem.	Dr. Ramkesh Meena Dr. Chet Ram
(m)	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. Anita Meena Sh. R. C. Balai
(n)	Protected cultivation of vegetables under hot arid conditions.	Dr. Ajay Kr. Verma Dr. Dhurendra Singh Dr. D. K. Samadia Dr. B. R. Choudhary
(o)	Management practices for saline soil and water for crop production in arid region.	Dr. Anita Meena Sh. Roop Chand Balai
(p)	Tuber crops in the arid region (Potato).	Dr. M. K. Jatav Ms. Ramyashree Devi Shri R. C. Balai
(q)	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 K. Berwal
(s)	Development of functional foods and nutraceutical value added products from arid horticultural crops.	Dr. Vijay R. Reddy Dr. Mukesh K. Berwal Dr. Ramesh Kumar
CIAH: 4	**Plant health management studies in arid and semi-arid fruit and vegetable crops:**	
(c)	Development of a bio -fertilizer cum bio -pesticide formulations of native *Rhizobium* sp. for vegetable cultivation.	Ms. Ramyashree Devi Dr. Anita Meena
	III. Concluded Projects	
CIAH: 2 (b)	Breeding for abiotic stress tolerance in solanaceous crops.	Dr. Ajay Kr. Verma
CIAH:2 (d-i)	Standardization and commercialization of micro -propagation techniques of horticultural crops under arid agro eco-system: Date palm	Dr. Dhurendra Singh Dr. Kamlesh Kumar Dr. Chet Ram
CIAH: 3 (a)	Evaluation of fruit based diversified cropping models for arid region.	Dr. M. K. Jatav Dr. Ajay Kr. Verma Dr. Anita Meena Shri R. C. Balai
CIAH: 3 (h)	Intensification of production technology in guava, jamun and mulberry under hot arid conditions.	Dr. D. K. Sarolia Dr. Dhurendra Singh Dr. Vijay R. Reddy Dr. Anita Meena
CIAH: 3 (q)	Technological interventions for arid horticulture development and its impact assessment.	Dr. S. R. Meena Dr. R. S. Singh Dr. D. K. Samadia Dr. D. K. Sarolia Shri R. C. Balai

CIAH: 4 (b)	Management of different diseases of arid hort icultural crops through botanicals and inorganic salts under hot arid conditions of Rajasthan.	Dr. S.K. Maheshwari Dr. B. R. Choudhary Dr. M. K. Berwal
B. Externally funded projects/Collaborative projects		
1.	DUS centre (watermelon and muskmelon).	Dr. B. R. Choudhary
2.	DUS centre for *ber* (*Ziziphus* sp.).	Dr. D. K. Sarolia
3.	DUS centre for date palm horticultural crop.	Dr. R. S. Singh Dr. Ramkesh Meena
4.	DUS nodal centre for bael.	Dr. A. K. Singh Dr. Sanjay Singh
5.	DUS co-nodal centre for aonla.	Dr. A. K. Singh
6.	DUS co-nodal centre for jamun.	Dr. Sanjay Singh
7.	DUS nodal centre for chironji and tamarind.	Dr. Sanjay Singh Dr. A.K. Singh
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 Dr. Kamlesh Kumar
9.	Enhancing food and water security in arid region through improved understanding of quantity, quality and management of blue, green and grey water.	Dr. B. D. Sharma Dr. Ramesh Kumar
10.	Road map for branding rose products.	Prof. (Dr.) P. L. Saroj Dr. Vijay R. Reddy
11.	Performance and evaluation of onion varieties under hot arid conditions.	Dr. A. K. Verma

11. RAC, IMC AND IRC

RESEARCH ADVISORY COMMITTEE

In pursuance of Rule 71(A) of the Rules and Bye-laws of the ICAR Society, the Director General, ICAR, New Delhi has constituted the following Research Advisory Committee to review the progress of the ongoing research programme and suggest the future modalities of the future programme. The RAC meeting was held on 3-4 January, 2020 under the chairmanship of Dr. T. A. More at ICAR-CIAH, Bikaner.

Chairma

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

Asstt. Director General (Hort.-I)

ICAR, KAB-II
New Delhi

Member Secretary

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

Institute Research Committee

During the reported period, the meeting was held at ICAR-CIAH, Bikaner on 13-14 July, 2020 to discuss the progress of the ongoing research programmes and to finalize the new proposals. Dr. B. K. Pandey, ADG (Hort.) was the chief guest and meeting was chaired by Director of the Institute. The progress of ongoing research projects were presented in details by the scientist and discussion were also held on new project proposal.

Chairman

Prof. (Dr.) P. L. Saroj
Director
ICAR-CIAH, Bikaner

Members

All Scientists of the Institute

Member Secretary

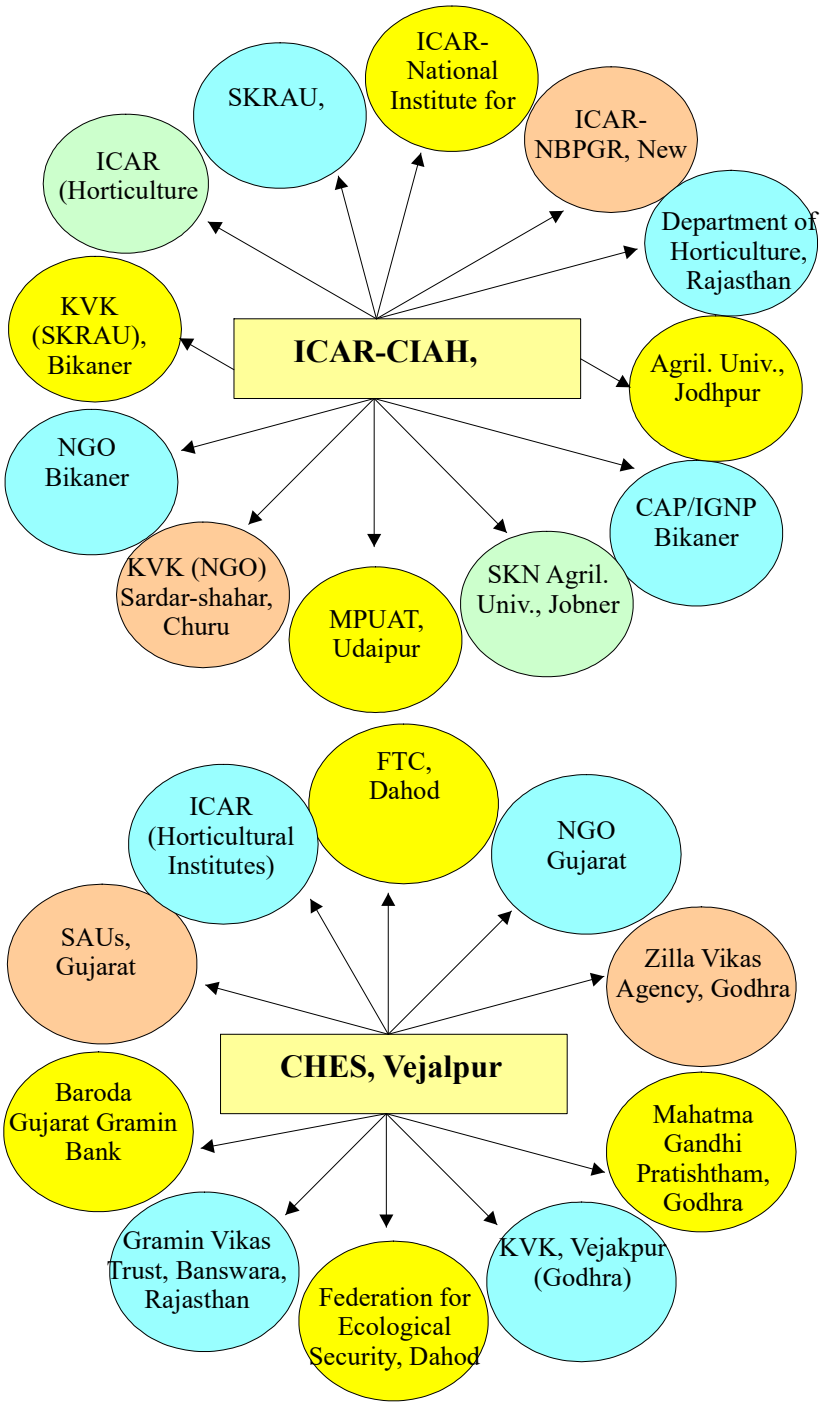
Dr. S. K. Maheshwari
Principal Scientist (Plant Pathology)

RAC meeting held during 3-4 January, 2020

IRC meeting held virtually during 13-14 July, 2020

12. LINKAGES AND COLLABORATIONS

The Institute has made linkages with the other ICAR Institutes, SAUs and other developmental agencies to exchange the research information, inter-institutional projects and exchange of seed and planting materials and guiding and teaching of the PG students. The Institute has made MoUs with S. K. RAU, Bikaner and Agriculture University, Jodhpur. The Institute also initiated collaborative projects with other ICAR Institutes i.e. ICARCPRI, Shimla, ICAR-DOGR, Pune and ICAR-CAZRI, Jodhpur.



13. RAJBHASHA

राजभाषा कार्यन्वयन समिति की बैठक एवं त्रैमासिक हिन्दी कार्यशाला

राजभाषा कार्यन्वयन समिति की तिमाही बैठकों का आयोजन कोविड–19 महामारी के लोकडाऊन एवं अन्य बंधनों के कारण समय पर एवं तिमाही आधार पर नहीं हुआ। यद्धपि संस्थान ने वर्ष 2020 के दौरान चार बैठक आयोजन की प्रतिबद्धता को पुरा किया है। इस क्रम में प्रथम एवं द्वितीय बैठक एक साथ 15 जुलाई को ऑनलाईन माध्यम से आयोजित की गयी, जिनमें जनवरी–मार्च 2020 और अप्रैल–जून 2020 के बिंदुओं पर चर्चा की गयी। जुलाई–सितम्बर की बैठक का आयोजन भी ऑनलाईन माध्यम से दिनांक 24 जुलाई, 2020 को किया गया था। अक्टूबर–दिसम्बर, 2020 तिमाही की बैठक का आयोजन 8 दिसम्बर, 2020 को किया गया था। इन सभी बैठकों में संस्थान की राजभाषा गतिविधियों की समीक्षा की गयी एवं हिन्दी की प्रगति को संस्थान के दैनिक कार्यों में सुनिश्चित किया गया। इन बैठकों का कार्यवत्त तैयार कर उसी अनुसार कार्रवाई की गयी।

संस्थान में कार्यरत अधिकारियों/कर्मचारियों को हिन्दी में कार्य करने की प्रेरणा के लिए दिनांक 19 सितम्बर, 2020 को हिंदी कार्यशाला का आयोजन किया गया था।

संराकास की ऑनलाईन बैठक की झलक

हिंदी सप्ताह का आयोजन

भाकृअनुप.–केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर में हिंदी सप्ताह के दौरान दिनांक 14 सितम्बर 2020 को हिंदी दिवस का आयोजन किया गया। इसमें हिंदी सप्ताह के उद्घाटन के साथ सप्ताहभर चलने वाले कार्यक्रमों की रूपरेखा को भी प्रस्तुत किया गया।

इस अवसर पर मुख्य अतिथि जयनारायण व्यास विश्वविद्यालय, जोधपुर की पूर्व विभागाध्यक्ष प्रो. कैलाश कौशल थी। श्रीमती कौशल ने ऑनलाईन माध्यम से बोलते हुए ने हिंदी की उत्पति से लेकर उसके वर्तमान प्रसार का विहंगम् दृश्य प्रस्तुत किया। उन्होंने कहा कि आधुनिक हिंदी के जनक और प्रेरणास्त्रोत भारतेन्दु हरिशचंद्र थे। भाषा के साथ संस्कृति के जुड़ाव को बताते हुए उन्होंने कहा कि भाषा है तो संस्कृति है और संस्कृति है तो देश का अस्तित्व है। भारत में 50 प्रतिशत के लगभग जनसंख्या हिंदी बोलती है। यह वर्तमान में विश्व में सर्वाधिक बोले जाने वाली भाषा है। महात्मा गांधी ने देश आजाद होने के बाद अंग्रेजी में बोलना छोड़ दिया था। हिंदी भाषा के प्रचार प्रसार के लिए केवल सरकार के प्रयासों के उपर निर्भर नहीं रहना चाहिए।

संस्थान के निदेशक प्रो (डॉ.) पी.एल. सरोज ने इस अवसर पर अपने अध्यक्षीय उद्बोधन में संस्थान में हिंदी की प्रगामि प्रगति पर बोलते हुए कहा कि संस्थान ने पिछले कुछ वर्षों में हिंदी के कार्यालयीन कार्य में उल्लेरखनीय प्रगति की है। उन्होंने संस्थान की राजभाषा पत्रिका को इस वर्ष भाकृअनुप, नई दिल्ली द्वारा प्रथम स्थान का पुरस्कार दिए जाने की चर्चा करते हुए कहा कि इस बार की तरह दो वर्ष पूर्व हमें हिंदी कार्य के लिए भाकृअनुप का ही प्रतिष्ठित पुरस्कार भी प्राप्त हुआ था। संस्थान के कार्मिकों से उन्होंने इस प्रगति को निरंतर बढ़ाते रहने की अपील की।

इस अवसर पर केन्द्रीय कृषि एवं किसान कल्याण मंत्री श्री नरेन्द्र सिंह तोमर एवं राज्यमंत्री श्री कैलाश चौधरी के संदेशों का वाचन किया गया। भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली के महानिदेशक डॉ. त्रिलोचन महापात्र का संदेश भी इस अवसर पर प्रसारित किया गया। इसी के साथ हिंदी सप्ताह का प्रारंभ हुआ जिसमें सप्ताहभर संस्थान में हिंदी भाषा को बढ़ावा देने के लिए विभिन्नि प्रतियोगिताएं आयोजित की गयी।

एक सप्ताह तक चले इस आयोजन में विभिन्न प्रतियोगिताएं रखी गयी थी, जिनमें संस्थांन के वैज्ञानिकों के सहित सभी कार्मिकों ने भाग लिया। इस अवसर पर मुख्य अतिथि के रूप में ऑनलाईन बोलते हुए भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के कृषि ज्ञान प्रबंधन निदेशालय के हिंदी संपादकीय एकक के प्रभारी श्री अशोक सिंह ने हिंदी भाषा के महत्व को समझाते हुए ''हिंदी में लोकप्रिय कृषि लेखन'' विषय पर अपना संबोधन दिया। उन्होंने कहा कि लेख लिखने से पूर्व उसके विषय पर मनन करना चाहिए। विषय स्पष्ट् और रोचक हो। लेख में शोध से प्राप्त नव तकनीकियों की जानकारी सरल और सुपाठ्य भाषा में होनी चाहिए। आलेख के वाक्य छोटे–छोटे हों तथा उनके शब्दों में विविधता होनी चाहिए। शब्दों् के बार–बार प्रयोग से बचना चाहिए। लेख में ताजा जानकारी दी जाए और आंकड़े नए होने चाहिए। श्री सिहं ने कहा कि किसानों को आम प्रचलन की भाषा में ही साहित्य दिया जाना चाहिए।

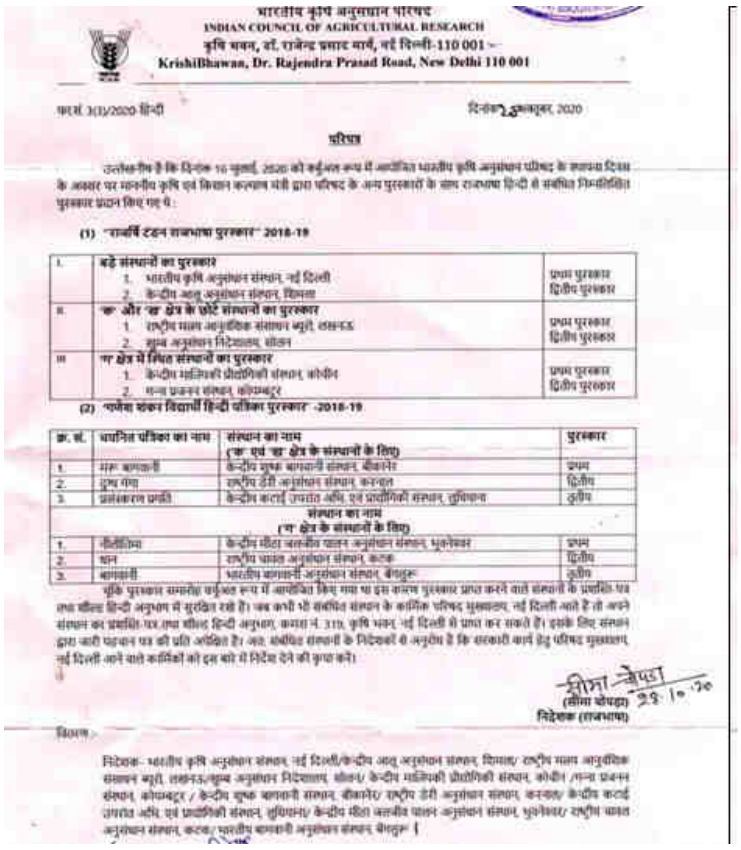
संस्थान के निदेशक प्रो (डॉ.) पी. एल. सरोज ने इस अवसर पर अपने अध्यक्षीय उद्बोधन में कहा कि भाषा संस्कृति की संवाहक होती है। भाषा से किसी देश की संस्कृति की झलक प्राप्त होती है। अतः भाषा का स्थान बहुत ही महत्व का होता है। प्रत्येक देश को अपनी राजभाषा अथवा राष्ट्र भाषा पर गर्व होना चाहिए। उन्होंने हिंदी में कार्य को बढ़ावा देने की अपील करते हुए सभी कार्मिकों से आग्रह किया कि हिंदी में कार्य करना हमारा संवैधानिक दायित्व है। हिंदी में कार्य करने से मन की झिझक दूर होगी। संस्थान द्वारा प्रतिवर्ष प्रकाशित की जाने वाली राजभाषा पत्रिका में अधिक से अधिक लेख देने का आग्रह भी निदेशक महोदय ने किया।

संस्थान द्वारा प्रकाशित हिंदी के प्रकाशन

भाकृअनुप–केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर ने इस वर्ष के दौरान वार्षिक प्रतिवेदन तथा द्विभाषी छःमाही समाचार पत्र प्रकाशित किए।

वर्ष के दौरान प्राप्त पुरस्कार/सम्मान का संक्षिप्त परिचय

संस्थान की राजभाषा पत्रिका ''मरु बागवाणी'' को दिनांक 16 जुलाई 2020 को वर्ष 2018–19 का गणेश शंकर विद्यार्थी हिंदी पत्रिका पुरस्कार प्रदान किया। भारतीय कृषि अनुसंधान परिषद के स्थापना दिवस के अवसर पर आयोजित समारोह में माननीय कृषि एवं किसान कल्याण मंत्री, भारत सरकार, नई दिल्ली के द्वारा ऑनलाईन माध्यम से यह पुरस्कार दिया गया।



भारतीय कृषि अनुसंधान परिषद
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कृषि भवन, डॉ. राजेन्द्र प्रसाद मार्ग, नई दिल्ली-110 001
KrishiBhawan, Dr. Rajendra Prasad Road, New Delhi 110 001

फा.सं. 3(1)/2020-हिंदी दिनांक 23 अक्टूबर, 2020

परिपत्र

उल्लेखनीय है कि दिनांक 16 जुलाई, 2020 को कार्यालय रूप में आयोजित भारतीय कृषि अनुसंधान परिषद के स्थापना दिवस के अवसर पर माननीय कृषि एवं किसान कल्याण मंत्री द्वारा परिषद के अन्य पुरस्कारों के साथ राजभाषा हिन्दी से संबंधित निम्नलिखित पुरस्कार प्रदान किए गए थे :

(1) "राजर्षि टंडन राजभाषा पुरस्कार" 2018-19

i.	बड़े संस्थानों का पुरस्कार 1. भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली 2. केन्द्रीय आलू अनुसंधान संस्थान, शिमला	प्रथम पुरस्कार द्वितीय पुरस्कार
ii.	'क' और 'ख' क्षेत्र के छोटे संस्थानों का पुरस्कार 1. राष्ट्रीय समन्वित कीटप्रबंधन केन्द्र, नई दिल्ली 2. मुख्य अनुसंधान निदेशालय, सोलन	प्रथम पुरस्कार द्वितीय पुरस्कार
iii.	'ग' क्षेत्र में स्थित संस्थानों का पुरस्कार 1. केन्द्रीय मशीनरी प्रौद्योगिकी संस्थान, कोयंबटूर 2. गन्ना प्रजनन संस्थान, कोयम्बटूर	प्रथम पुरस्कार द्वितीय पुरस्कार

(2) "गणेश शंकर विद्यार्थी हिन्दी पत्रिका पुरस्कार -2018-19

क्र. सं.	प्रेषित पत्रिका का नाम	संस्थान का नाम ('क' एवं 'ख' क्षेत्र के संस्थानों के लिए)	पुरस्कार
1.	मरू बागवानी	केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर	प्रथम
2.	कृषि गंगा	राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल	द्वितीय
3.	प्रसंस्करण प्रहरी	केन्द्रीय कटाई उपरांत अभि एवं प्रौद्योगिकी संस्थान, लुधियाना	तृतीय
		संस्थान का नाम ('ग' क्षेत्र के संस्थानों के लिए)	
1.	नीलांबिका	केन्द्रीय मीठा जलीय चारा अनुसंधान संस्थान, भुवनेश्वर	प्रथम
2.	धान	राष्ट्रीय चावल अनुसंधान संस्थान, कटक	द्वितीय
3.	बागवानी	भारतीय बागवानी अनुसंधान संस्थान, बेंगलुरू	तृतीय

यदि पुरस्कार समारोह कार्यालय रूप में आयोजित किए गया था इस वर्ष पुरस्कार प्राप्त करने वाले संस्थानों के प्रकाशित पत्र तथा वार्षिक हिन्दी अनुभाग में सुरक्षित रखे हैं। जब कभी भी संबंधित संस्थान के कार्मिक परिषद मुख्यालय, नई दिल्ली आते हैं तो अपने संस्थान का प्रकाशित पत्र तथा वार्षिक हिन्दी अनुभाग, कमरा नं. 319, कृषि भवन, नई दिल्ली से प्राप्त कर सकते हैं। इसके लिए संस्थान द्वारा जारी पहचान पत्र की प्रति अपेक्षित है। अतः संबंधित संस्थानों के निदेशकों से अनुरोध है कि सरकारी कार्य हेतु परिषद मुख्यालय, नई दिल्ली आने वाले कार्मिकों को इस बारे में निर्देश देने की कृपा करें।

सीमा चोपड़ा 23.10.20
(सीमा चोपड़ा)
निदेशक (राजभाषा)

सेवा में,
निदेशक, भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली/केन्द्रीय आलू अनुसंधान संस्थान, शिमला/ राष्ट्रीय समन्वित कीटप्रबंधन केन्द्र, नई दिल्ली/मुख्य अनुसंधान निदेशालय, सोलन/ केन्द्रीय मशीनरी प्रौद्योगिकी संस्थान, कोयंबटूर /गन्ना प्रजनन संस्थान, कोयम्बटूर / केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर/ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल/ केन्द्रीय कटाई उपरांत अभि. एवं प्रौद्योगिकी संस्थान, लुधियाना/ केन्द्रीय मीठा जलीय चारा अनुसंधान संस्थान, भुवनेश्वर/ राष्ट्रीय चावल अनुसंधान संस्थान, कटक/ भारतीय बागवानी अनुसंधान संस्थान, बेंगलुरू।

हिंदी सप्ताह एवं हिन्दी कार्यशाला का आयोजन

हिंदी पखवाड़ा के दौरान आयोजित प्रतियोगिताएं एवं उनमें पुरस्कृत प्रतिभागी

हिंदी वाद–विवाद प्रतियोगिता

	वैज्ञानिक समूह
प्रथम	डॉ. दीपक कुमार सरोलिया
द्वितीय	डॉ. अजय कुमार वर्मा एवं डॉ. हनुमान राम (संयुक्त रूप से)
तृतीय	डॉ. मुकेश कुमार बेरवाल और डॉ. अनीता मीणा (संयुक्त रूप से)

हिंदी शब्द लेखन प्रतियोगिता

वैज्ञानिक समूह		तकनीकी समूह	प्रशासनिक समूह	एसएसएस एवं वाईपी समूह
प्रथम	डॉ. कमलेश कुमार एवं डॉ. सुशील कुमार महेश्वरी	श्री भोजराज खत्री	श्री स्वरूप चंद राठौड़	श्री लोकेश कुमार
द्वितीय	डॉ. अजय कुमार वर्मा	श्री पृथ्वीराज सिंह	श्री कुलदीप पान्डे	श्री पवन कुमार पारीक
तृतीय	डॉ. पवन कुमार गुर्जर	श्री छुट्टन लाल मीणा	श्रीमती पूजा जोशी	श्री मुकेश कुमार नागर

हिंदी टिप्पण लेखन प्रतियोगिता (प्रशासनिक वर्ग के लिए)

प्रथम	श्रीमती पूजा जोशी
द्वितीय	श्री राजेश दैया
तृतीय	श्री राकेश कुमार स्वामी

क्षेत्रीय केन्द्र, वेजलपुर में राजभाषा कार्यान्वयन हेतु आयोजित गतिविधियां

राजभाषा कार्यन्वयन समिति

राजभाषा कार्यन्वयन समिति की तिमाही बैठकों का आयोजन क्रमशः दिनांक 27.06.2020, 15.09.2020, 17.12.2020 को आयोजित 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 गये।

हिन्दी कार्यशाला

केन्द्र में कार्यरत अधिकारियों को हिन्दी में कार्य करने की प्रेरणा के लिए राजभाषा विभाग के निर्देशानुसार दिनांक 15.09.2020 को "संर्पकभाषा के रुप में हिंदी की भूमिका" कार्यक्रम की शुरूआत में श्री मकवाणा ने बताया सदभावना, प्रेंरणा, पोत्साहन तीन सूत्र पर राजभाषा

चलती है। देश की एकता और अखंडता में राजभाषा हिन्दी का योगदान प्रमुख रहा है। देश की एकता के लिए अंतर की एकता परमावश्यक है और वह राजनीति से नही, भारत की रत्नगर्भा भाषाओं के उपयोग द्वारा स्थापित हो सकती है।

कार्यशाला दौरान प्रश्नोंतरी का भी आयोजन किया गया था जिसमें निम्नलिखित प्रश्नों की चर्चा की गई:–

(1) देश की राष्ट्रभाषा से संबंधित सूचना व अभिलेख कहां से प्राप्त हो सकते है।
उतरः देश की राष्ट्रभाषा से संबंधित सूचना व अभिलेख मानव संसाधन विकास मंत्रालय संस्कृति मंत्रालय से प्राप्त हो सकते है।
(2) भाषाओं के बारे में अनुदान दिलवाने का मामला किस मंत्रालय से संबंधित है।
उतरः भाषाओं के बारे में अनुदान दिलवाने का मामला मानव संसाधन विकास मंत्रालय के भाषा विभाग से संबंधित है।
(3) हिन्दी भाषा और साहित्य के प्रचार–प्रसार के संबंध में किए जा रहे कार्यो की जानकारी कहाँ से प्राप्त की जा सकती है।
उतरः हिन्दी भाषा और साहित्य के प्रचार–प्रसार के संबंध में किए जा रहे कार्यो की जानकारी मानव संसाधन विकास मंत्रालय के अंतर्गत केन्द्रीय हिन्दी निदेशालय से प्राप्त की जा सकती है।

प्रधान महोदय ने संतोष व्यक्त करते हुए बताया कि आज की कार्यशाला में हिन्दी के विकास एवं प्रचार हेतु किये गये प्रयास को देखकर मुझे बहुत हर्ष होता है, तथा ऐसे प्रयास जारी रहने चाहिये।

हिन्दी सप्ताह का आयोजन

केन्द्रीय बागवानी परीक्षण केन्द्र, वेजलपुर (गोधरा) में दिनांक 14.09.20 से 19.09.20 तक हिन्दी सप्ताह मनाने का आयोजन किया गया था। हिन्दी सप्ताह दौरान यह निर्णय लिया गया की सभी कर्मचारी एवं अधिकरियों अपना अधिकांश कार्य हिंदी में ही करने का प्रयास करे।

हिन्दी दिवस

प्रत्येक वर्ष की तरह 14 सितम्बर 2020 को हिंदी दिवस मनाया गया। इस अवसर पर डा. ए. के. सिंह, प्रधान वैज्ञानिक ने कहा कि हिंदी में कार्य करना हमारा संविधानिक दायित्व है।

किसान प्रशिक्षण

केन्द्र द्वारा समय–समय पर आयोजित किए जाने वाले किसान प्रशिक्षणों में केवल हिन्दी भाषा का ही प्रयोग किया जाता है। इस वर्ष आत्मा के सहयोग से आणंद, खेडा, महीसागर, पंचमहल, दाहोद जिलों के महिला और पुरूष किसानों को 'ग्रामिण विकास के लिए अर्ध–शुष्क बागवानी' विषय पर प्रशिक्षण दिया गया था।

14. DISTINGUISHED VISITORS

Name	Designation	Date of visit
Sh. Josh Mohan	Inspector General of Police, Bikaner Range	01/01/2020
Dr. T.A. More	Former Vice-Chancellor, MPKV, Rahuri (Maharastra) & Chairman, RAC	03/01/2020
Dr. Ashwani Kumar	Ex-Director, ICAR-IIWR, Bhubaneswar	03/01/2020
Dr. W.S. Dhillon	ADG, Horticultural Science, ICAR, New Delhi	03/01/2020
Sh. D. D. Singh	Commandant of RAC (IPS), Bikaner	05/02/2020
Sh. P. Mohan Sharma	Superintendent of Police, Bikaner	11/05/2020
Dr. Ravi Prakash	Registrar, PPV & FRA, New Delhi	03/03/2020
Dr. O. P. Awasthi	Member DUS monitoring team, Principal Scientist (Fruit Science), IARI, Pusa, New Delhi	03/03/2020
Dr. H. P. Vyas	Ex Director, DRDO	26/6/2020
Sh. Harish Chaudhary	Hon'ble Minister of Revenue, Govt. of Rajasthan	22/10/2020
Sh. Modaram Meghwal	Jila Pramookh, Bikaner	25/12/2020

DUS Activity Monitoring Team visited ICAR-CIAH, Bikaner

Dr. H. P. Vyas, Ex Director, DRDO visited ICAR-CIAH, Bikaner

Sh. Harish Chaudhary, Hon'ble Minister of Revenue, Govt. of Rajasthan visited ICAR-CIAH, Bikaner

Sh. Modaram Meghwal, Jila Pramookh, Bikaner visited ICAR-CIAH, Bikaner

15. PERSONNEL

Staff Position as on 31.12.2020

ICAR-CIAH, Bikaner (including regional station, CHES, Vejalpur)

S. No.	Category	Sanctioned Posts	Posts filled	Posts vacant
1.	RMP (Director)	01	01	Nil
2.	Scientists	44	28	16
3.	Technical	42	34	08
4.	Administrative	23	15	08
5.	SSS	19	19	Nil
	Total	129	97	32

Krishi Vigyan Kendra

S. No.	Category	Sanctioned Posts	Posts filled	Posts vacant
1.	Programme Coordinator	01	01	00
2.	Administrative	02	02	00
3.	Technical	11	10	01
4.	Supporting	02	01	01
	Total	**16**	**14**	**02**

CIAH, Bikaner Headquarter

S. No.	Name	Designation/Discipline
	I. Research Management Position	
1.	Prof. (Dr.) P.L. Saroj	Director
	II. Scientific	
1.	Dr. Dhurendra Singh	Head, Division of Crop Improvement
2.	Dr. B.D. Sharma	Head, Division of Crop Production
3.	Dr. R.S. Singh	Principal Scientist (Horticulture)-Retired
4.	Dr. D.K. Samadia	Principal Scientist (Horticulture)
5.	Dr. S.K. Maheshwari	Principal Scientist (Plant Pathology)
6.	Dr. S.R. Meena	Principal Scientist (Agril. Extension)
7.	Dr. M.K. Jatav	Principal Scientist (Soil Science)
8.	Dr. Deepak Kumar Sarolia	Principal Scientist (Horticulture-Fruit Science)
9.	Dr. B.R. Choudhary	Senior Scientist (Vegetable Science)
10.	Dr. Ramkesh Meena	Senior Scientist (Horticulture- Fruit Science)
11.	Sh. Roop Chand Balai	Scientist (Soil Science)
12.	Dr. Mukesh Kumar Berwal	Senior Scientist (Agril. Biochemistry)
13.	Dr. S.M. Haldhar	Senior Scientist (Agril. Entomology)- On Lien
14.	Dr. Ramesh Kumar	Scientist (Horticulture- Floriculture)
15.	Dr. Chet Ram	Scientist (Agril. Biotechnology)
16.	Dr. Anita Meena	Scientist (Soil Science)
17.	Sh. Jagan Singh Gora	Scientist (Fruit Science)- On Study Leave
18.	Dr. Vijay Rakesh Reddy	Scientist (Fruit Science)-Transferred
19.	Dr. Kamlesh Kumar	Scientist (Fruit Science)
20.	Dr. Ajay Kumar Verma	Scientist (Vegetable Science)
21.	Ms. Ramyashree Devi G.S.	Scientist (Plant Pathology)
22.	Dr. K. L. Kumawat	Scientist (Fruit science)
23.	Sh. Lal Chand	Scientist (Fruit science)- On Study Leave
24.	Dr. Pawan Singh Gurjar	Scientist (Fruit science)

25.	Dr. Hanuman Ram	Scientist (Vegetable Science)
26.	Dr. Pawan Kumar Poonia	Scientist (Plant Breeding)
27.	Dr. Rekha Rani	Scientist (Agril. Economics)
28.	Sh. Rajeshwar Sanodiya	Scientist (Farm Machinery & Power)
29.	Sh. M. K. Choudhary	Scientist (Plant Breeding)
30.	Ms. Moonika Punia	Scientist (Plant Breeding) -Transferred
III. Administrative		
1.	Shri Ramesh	Administrative Officer
2.	Shri Kuldeep Pandey	Assistant Administrative Officer
IV. Technical		
1.	Dr. U. V. Singh	Asstt. Chief Technical Officer (Field)-Transferred
2.	Shri P.P. Pareek	Asstt. Chief Technical Officer (O.L.)
3.	Shri A.V. Dhobi	Sr. Technical Officer (Overseer)
4.	Shri Sanjay Patil	Sr. Technical Officer (Artist & Photography)
5.	Shri C. L. Meena	Sr. Technical Officer (Field)
6.	Shri M. K. Jain	Technical Officer (Computer)-Retired
7.	Shri B. R. Khatri	Technical Officer (Computer)
8.	Shri P.R. Singh	Technical Officer (Field)

B. Regional Station, CHES, Vejalpur

S. No.	Name	Designation/Discipline
I. Scientific		
1.	Dr. Sanjay Singh	Head
2.	Dr. A.K. Singh	Principal Scientist
3.	Dr. V.V. Appa Rao	Principal Scientist
4.	Dr. Daya Shankar Mishra	Senior Scientist
5.	Dr. Vikas Yadav	Scientist
6.	Dr. Lalu Prasad Yadav	Scientist
7.	Dr. Gangadhara, K.	Scientist
II. Administrative		
1.	Dr. Daya Shankar Mishra	I/c Asstt. Administrative Officer
2.	Sh. Nihal Singh	I/c Asstt. Finance and Account Officer
III. Technical		
1.	Sh. Nihal Singh	Chief Technical Officer (Field)
2.	Sh. G.U. Trivedi	Astt. Chief Technical Officer (Library)
3.	Sh. M.N. Makwana	Astt. Chief Technical Officer (O. L.)
4.	Sh. G.R. Baira	Sr. Technical Officer (Field)
5.	Sh. B.R. Baria	Sr. Tech. Assistant (Lab.)
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. D.C. Joshi	Technical Officer (Field)
10	Sh. K.V. Parmar	Technical Officer (Lab.)
11.	Sh. C.S. Chamar	Technical Officer (Field)
12.	Sh. B.M. Patelia	Technical Officer (Field)
13.	Sh. D.P. Patel	Technical Officer (Field)
14.	Sh. A.J. Solanki	Technical Officer (Field)

ICAR-CIAH KVK, Vejalpur (Panchmahal)

S. No.	Name	Designation/Discipline
	I. Sr. Sci. & Head	
1	Dr. (Mrs) Kanak Lata	Sr. Sci. & Head
	II. Technical	
1	Sh. J.K. Jadav	Astt. Chief Tech. Officer (Agril. Extension)
2	Dr. Balbir Singh	Astt. Chief Tech. Officer (Animal Husbandry)
3	Dr. Ajay Kumar Rai	Astt. Chief Tech. Officer (Soil Science)
4	Dr. Raj Kumar	Astt. Chief Tech. Officer (Horticulture)
5	Dr. Shakti Khajuria	Astt. Chief Tech. Officer (Plant Pathology)

New Entrants

1. Dr. Rekha Rani, Scientist Probationers, Agricultural Economics joined on 04.04.2020 (A/N) by e-mail and physically reported on 05.06.2020.
2. Sh. Mahendra Kumar Choudhary, Scientist Probationers, Genetic & Plant Breeding joined on 04.04.2020 (A/N) by e-mail and physically reported on 04.06.2020.
3. Ms. Moonika Punia, Scientist Probationers, Genetic & Plant Breeding joined on 04.04.2020 (A/N) by e-mail and physically reported on 04.06.2020.
4. Sh. Rajeshwar Sanodiya, Scientist Probationers, Farm Machinery & Power joined on 06.04.2020 (A/N) by e-mail.

Promotion

Scientists

S. No.	Name & Designation of the Scientist(s)	Placement/Promotion on the post of Principle Scientist with Pay Band + RGP/Pay Scale	Date of Placement Promotion
1.	Dr. Deepak Kumar Sarolia	Principal Scientist in the pay scale of Rs.37400-67000+RGP of Rs.10000/- (Pre-revised)/Research Level 14	07-10-2018
2.	Dr. Daya Shankar Mishra	Principal Scientist in the pay scale of Rs.37400-67000+RGP of Rs.10000/- (Pre-revised)/Research Level 14	02-03-2019

Technical

Sl. No.	Name and Present Grade/Designation	Promoted to Grade/Scale	Date of merit Promotion	Present Place of Posting
1.	Sh. Himatsigh Bachubhai Patel Technical Assistant (Driver)	Sr. Technical Assistant (T -4) of Cat. II in the pay band and grade pay of Rs. 9300-34800+4200 (pre-revised) Level-VI (Revised)	29.06.2016	KVK-Vejalpur, Panchmahal
2.	Sh. Iqbal Mohammedkhan Abbaskhan Pathan Technical Assistant (Driver)	Sr. Technical Assistant (T -4) of Cat. II in the pay band and grade pay of Rs. 9300-34800+4200 (pre-revised) Level-VI (Revised)	29.06.2016	KVK-Vejalpur, Panchmahal
3.	Sh. Birdi Chand Meena Sr. Technician (Driver)	Technical Assistant (T-3) of Cat. II in the pay band and grade pay of Rs. 5200 -20200 + 2800 (pre - revised)	28.07.2019	ICAR-CIAH, Bikaner

4.	Sh. B.R. Baria Sr. Technical Assistant (Lab.)	Technical Officer (Lab.) (T -5) of Cat. II in the pay band and grade pay of Rs. 9300-34800+ 4600 (pre-revised) Level-VII (Revised)	05.02.2017	CHES, Vejalpur, Godhra
5.	Sh. B.V. Rathwa Sr. Technical Assistant (Lab.)	Technical Officer (Lab.) (T -5) of Cat. II in the pay band and grade pay of Rs. 9300-34800+ 4600 (pre-revised) Level-VII (Revised)	10.11.2019	CHES, Vejlapur, Godhra
6.	Sh. Rakesh Meel Sr. Technical Assistant/ Farm Manager/T-4	Technical Officer (T -5) of Cat. II in the pay band and grade pay of Rs. 9300 -34800+4600 (pre - revised) Level-VII (Revised)	04.04.2017	KVK-Panchmahal, Vejalpur,
7.	Sh. S.J. Baria Technical Assistant (Field)	Sr. Technical Assistant (T -4) of Cat. II in the pay band and grade pay of Rs. 9300-34800+4200 (pre-revised) Level-VI (Revised)	08.08.2017	CHES, Vejlapur, Godhra

Probation Clearance & Confirmation

S.No.	Name of the Scientist	Date of Appointment	Date from which probation cleared	Date of confirmation in the Senior Scientist/ Scientist grade of ARS
1.	Dr. Deepak Kumar Sarolia Senior Scientist (Fruit Science)	07.10.2015	06.10.2017	07.10.2017
2.	Dr. Daya Shanker Mishra Senior Scientist (Fruit Science)	02.03.2016	01.03.2018	02.03.2018
3.	Dr. Vikas Yadav Scientist (Fruit Science)	01.01.2015	31.12.2016	01.01.2017
4.	Dr. Vijay Rakesh Reddy S., Scientist (Fruit Science)	01.07.2015	30.06.2017	01.07.2017
5.	Dr. Kamlesh Kumar Scientist (Fruit Science)	01.01.2016	31.12.2017	01.01.2018
6.	Dr. Lalu Prasad Yadav Scientist (Vegetable Science)	01.01.2015	31.12.2016	01.01.2017
7.	Dr. Gangadhara K. Scientist (Vegetable Science)	01.07.2015	30.06.2017	01.07.2017
8.	Dr. Ajay Kumar Verma Scientist (Vegetable Science)	01.01.2016	31.12.2017	01.01.2018

Joining on Transfer/Promotion

1. Sh. S.C. Rathore, LDC joined duty back on 28.05.2020 at the ICAR-CIAH, Bikaner consequent upon after completion of one year deputation period at ICAR-CSWRI, RS, Bikaner.
2. Dr. Pawan Singh Gurjar, Scientist (Fruit Science) joined on 10.08.2020 on transfer from ICAR-CISH, Lucknow.
3. Dr. Hanuman Ram, Scientist (Vegetable Science) joined on 10.08.2020 on transfer from ICAR-VPKAS, Almora.
4. Dr. Kishan Lal Kumawat, Scientist (Fruit Science) joined on 17.08.2020 on transfer from ICAR-CITH, Srinagar.
5. Sh. Lal Chand, Scientist (Fruit Science) joined on 28.09.2020 on transfer from ICAR-CARI, Jhansi.

Relieving on Promotion/Transfer

1. Dr. S.M. Haldhar, Scientist relieved from the Institute on 13.01.2020 (A.N.) to join at College of Agriculture, CAU, Imphal as Associate Professor.
2. Dr. Vijay Rakesh Reddy S., Scientist (Fruit Science) relieved in the afternoon of 13.08.2020 on transfer to ICAR-IIHR, Bengaluru.
3. Sh. B.R. Baria, Sr. Tech. Assistant (Lab.) relieved in the afternoon of 31.08.2020 on transfer to regional station CHES, Vejalpur, Godhra.
4. Mrs. Monika Punia, Scientist Probationer (Genetics & Plant Breeding) relieved in the afternoon of 29.09.2020 on transfer to ICAR-IIPR, Regional Station, Bikaner.

Superannuation/Retirement

1. Sh. V.G. Patel, Skilled Supporting Staff retired on superannuation from the Council's services in the afternoon of 30.04.2020.
2. Sh. D.B. Yadav, Skilled Supporting Staff retired on superannuation from the Council's services in the afternoon of 30.04.2020.
3. Sh. M.M. Vankar, Skilled Supporting Staff retired on superannuation from the Council's services in the afternoon of 31.05.2020.
4. Sh. H.B. Patel, Sr. Technical Assistant (Driver) retired on superannuation from the Council's services in the afternoon of 30.06.2020
5. Dr. R.S. Singh, Principal Scientist (Horticulture) retired on superannuation from the Council's services in the afternoon of 30.09.2020.
6. Sh. M.K. Jain, Technical Officer (Computer) retired on superannuation from the Council's services in the afternoon of 31.10.2020.
7. Sh. I.A. Pathan, Sr. Technical Assistant (Driver) retired on superannuation from the Council's services in the afternoon of 31.10.2020.
8. Sh. Z.A. Chouhan, SSS retired on superannuation from the Council's services in the afternoon of 31.10.2020.

16. BUDGET

Progressive Exp Upto 31-12-2020		CIAH			CHES			Consolidate		
S.No.	Head	BE	EXP	Bal	BE	EXP	Bal	BE	EXP	Bal
Grants for creation of Capital Asset (CAPITAL)										
1	Works	0	0	0	0	0	0	0	0	0
	A. Land	0	0	0	0	0	0	0	0	0
	B. Building	0	0	0	0	0	0	0	0	0
	i. Office Building	12000000	2500000	9500000	0	0	0	12000000	2500000	9500000
	ii Residential Building	0	0	0	0	0	0	0	0	0
	iii Minor works	0	0	0	0	0	0	0	0	0
2	Euipments	1500000	50028	1449972	500000	0	500000	2000000	50028	1949972
3	Information Technology	100000	0	100000	100000	0	100000	200000	0	200000
4	Library Books and journals	175000	0	175000	25000	0	25000	200000	0	200000
5	Vehicles & Vessels	0	0	0	0	0	0	0	0	0
6	Livestock	0	0	0	0	0	0	0	0	0
7	Furniture & Fixtures	500000	177833	322167	100000	0	100000	600000	177833	422167
8	Others	0	0	0	0	0	0	0	0	0
Total- Capital(Grants for creation of Capital Assets)		**14275000**	**2727861**	**11547139**	**725000**	**0**	**725000**	**15000000**	**2727861**	**12272139**
		0	0	0	0	0	0	0	0	0
Grants for creation of Salaries (Revenue)		0	0	0	0	0	0	0	0	0
1	Establishment Expenses	70547000	0	70547000	0	0	0	70547000	0	70547000
	Salaries		0	0	0	0	0	0	0	0
	i. Establishment Charges	70547000	74423384	-3876384	60000000	23237116	36762884	130547000	97660500	32886500
	ii. Wages	0	5786683	-5786683	25800000	11581737	14218263	25800000	17368420	8431580
	iii. Overtime Allowance	0	0	0	0	0	0	0	0	0
Total- Establishment Expenses(GIA- Salaries)		**70547000**	**80210067**	**-9663067**	**85800000**	**34818853**	**50981147**	**156347000**	**115028920**	**41318080**
		0	0	0	0	0	0	0	0	0
Grant in Aid- General(REVENUE)		0	0	0	0	0	0	0	0	0
1	**Pension & Other Retirement Benefits**	**15000000**	**10617933**	**4382067**	**5000000**	**916860**	**4083140**	**20000000**	**11534793**	**8465207**
2	**Travelling Alowances**									
	A. Domestic TA/ Transfer TA	1500000	213202	1286798	400000	251823	148177	1900000	465025	1434975
	B. Foreign TA	100000	0	100000	0	0	0	100000	0	100000
	Total- Traveling Allowance	**1600000**	**213202**	**1386798**	**400000**	**251823**	**148177**	**2000000**	**465025**	**1534975**
3	**Research & Operational Expenses**	0	0	0	0	0	0	0	0	0
	A. Research Expenses	3500000	2014512	1485488	1000000	193825	806175	4500000	2208337	2291663
	B. Operation Exp.	7500000	5653155	1846845	1500000	413660	1086340	9000000	6066815	2933185
	Total Research & Operational Expenses	**11000000**	**7667667**	**3332333**	**2500000**	**607485**	**1892515**	**13500000**	**8275152**	**5224848**
4	**Administrative Expenses**	0	0	0	0	0	0	0	0	0
	A. Infrastructure	3500000	5023167	-1523167	1500000	453379	1046621	5000000	5476546	-476546
	B. Communication	1000000	390996	609004	500000	148782	351218	1500000	539778	960222
	C. Repairs & Maintenance	0	0	0	0	0	0	0	0	0
	i.Equipments, Vehicles & Others	250000	263181	-13181	150000	110792	39208	400000	373973	26027
	ii. Office Building	1000000	824600	175400	200000	26853	173147	1200000	851453	348547
	iii. Residential Building	300000	0	300000	100000	5000	95000	400000	5000	395000
	iv) Minor Works	0	48800	-48800	0	0	0	0	48800	-48800
	D. other (Excluding TA)	600000	824269	-224269	150000	142858.52	7141.48	750000	967127.52	-217127.52
	Total Administrative Expenses	**6650000**	**7375013**	**-725013**	**2600000**	**887664.52**	**1712335.48**	**9250000**	**8262677.52**	**987322.48**
5	**Miscellaneous Expenses**	0	0	0	0	0	0	0	0	0
	A. HRD	250000	18500	231500	50000	11000	39000	300000	29500	270500
	B. Other Items(Fellowship, Scholarship etc.)	0	0	0	0	0	0	0	0	0
	C. Publicity & Exibitions	800000	0	800000	200000	0	200000	1000000	0	1000000
	D. Guest House -Maintenance	400000	0	400000	100000	8934	91066	500000	8934	491066
	E. Other Miscellaneous	400000	94321	305679	100000	4710	95290	500000	99031	400969
	Total- Miscellaneous Expenses	**1850000**	**112821**	**1737179**	**450000**	**24644**	**425356**	**2300000**	**137465**	**2162535**
Total Grant In Aid - General		**21100000**	**15368703**	**5731297**	**5950000**	**1771616.52**	**4178383.48**	**27050000**	**17140319.52**	**9909680.48**
		0	0	0	0	0	0	0	0	0
Total Revenue(GIA- Salaries + GIA- Gen + GIA- Pension)		**106647000**	**106196703**	**450297**	**96750000**	**37507329.5**	**59242670.48**	**203397000**	**143704032.5**	**59692967.48**
Grand Total (Capital + Revenue)		**120922000**	**108924564**	**11997436**	**97475000**	**37565836.5**	**59909163.48**	**218397000**	**146431893.5**	**71965106.48**
	SCSP									
	Total Grant In Aid - General	**1500000**	216155	1283845	500000	0	500000	2000000	216155	1783845
	Total- Capital(Grants for creation of Capital Assets)	**400000**	0	400000	100000	0	100000	500000	0	500000
		1900000	**216155**	1683845	**600000**	**0**	600000	**2500000**	**216155**	**2283845**

17. SEED AND PLANTING MATERIAL PRODUCTION

Seed Production at ICAR-CIAH, Bikaner

1. Under Seed Project			
S. No.	**Name of Crop**	**Quantity produced (kg)**	**Quantity sold (kg)**
1	*Kachri* (AKH-119)	100.00	97.70
2	Snapmelon (AHS-82)	73.00	25.60
3	Sponge gourd (Thar Tapish)	27.50	7.90
4	Brinjal (Thar Rachit)	3.350	1.80
5	Indian bean (Thar Kartik)	2.90	1.90
6	Cluster bean (Thar Bhadvi)	57.00	56.00
	Total	**263.75**	**191.9**
2. Institute level			
1	Ridge gourd (Thar Karni)	72.00	38.80
2	Long melon (Thar Sheetal)	4.20	2.80
	Total	**76.20**	**41.60**

Planting material production at ICAR-CIAH, Bikaner

I. RFS			
S. No.	**Name of Crop**	**Quantity produced (Nos.)**	**Quantity sold (Nos.)**
1.	Pomegranate	2000	523
2.	Citrus	2800	765
3.	lasoda	500	178
4.	Karonda	2800	531
5.	Phalsa	1800	418
6.	Aonla Grafted	400	59
7.	Aonla seedling	50	22
8.	Bael grafted	50	15
9.	Bael seeding	1900	159
10.	Kinnow	100	87
11.	Mulberry cutting	700	360
12.	Bougainvillea	200	5
13.	Jamun	800	470
14.	Moringa	1000	168
15.	Bud sticks	100	91
16.	Fig	300	196
17.	Guava	350	109
18.	Meetha Neem	50	16
19.	Custard apple	100	2
20.	Date palm	70	4
	Total	**16070**	**4178**
II. Institute Level			
1.	*Khejri* budded	11200	4909
2.	Ber grafted	7500	5903
3.	Citrus sp.	2500	200
	Total	**21270**	**15190**

Planting material Production at ICAR-CIAH, Regional Station CHES, Vejalpur

I. RFS			
S. No.	**Name of crop**	**Number of plants produce**	**Number of plants sale**
1.	Mango plants grafted	10322	7459
2.	Mango seedlings	5560	--
3.	Aonla budded	121	111
4.	Aonla seedlings	1800	--
5.	Pomegranate air layer	405	251
6.	Kagzi lime air layer	3812	2580
7.	Lime seedling	3365	360
8.	Guava budded	368	161
9.	Guava seedling	1189	100
10.	Karonda seedlings	850	843
11.	Rayan budded	155	150
12.	Tamarind budded	352	338
13.	Jamun budded	2421	2345
14.	Jamun seedlings	5060	--
15.	Bael budded	2410	2402
16.	Bael seedlings	2500	--
17.	Custard apple budded	137	56
18.	Custard apple seedlings	1211	722
19.	Chironji budded	14	13
	Total	**42052**	**17891**
II. Institute Level			
1.	Mango plants grafted	6295	6241
2.	Mango seedlings	6000	--
3.	Pomegranate air layer	75	68
4.	Kagzi lime air layer	460	444
5.	Lime seedling	500	90
6.	Guava budded	620	609
7.	Guava seedling	550	321
8.	Rayan budded	265	262
9.	Tamarind budded	90	86
10.	Jamun budded	775	765
11.	Bael budded	190	161
12.	Bael seedlings	3200	05
13.	Custard apple budded	460	242
14.	Custard apple seedlings	500	45
15.	Wood apple budded	05	00
16.	Wood apple seedlings	400	20
17.	Mahua seedling	50	05
18.	Chironji Seedling	350	25
	Total	**20785**	**9389**

18. METEOROLOGICAL DATA

Meteorological Data: ICAR-CIAH, Bikaner

Month	Temperature (°C)		RH (%)		Total rainfall (mm)	Rainy days	Wind speed (kmph)	Evaporation (mm/day)	BSSH
	Max.	Min.	RH1	RH2					
January	20.0	5.1	85.9	49.3	21.8	2.0	3.8	6.5	6.7
February	27.0	8.0	76.6	31.3	0.0	0.0	4.1	9.6	9.4
March	29.6	14.1	73.4	32.3	29.8	4.0	6.1	5.0	7.3
April	37.7	21.0	58.5	26.9	7.0	1.0	6.4	9.1	9.2
May	42.3	25.2	55.3	26.0	29.4	3.0	8.2	11.3	0.3
June	42.5	28.0	57.9	35.6	2	0.0	10.5	11.2	1.2
July	40.6	27.9	71.4	46.9	13.4	2.0	10.1	9.0	8.7
August	37.6	27.0	80.8	55.3	128.9	6.0	8.6	6.4	8.0
September	37.5	24.9	75.4	46.3	15.6	1.0	4.7	9.3	7.6
October	35.3	16.8	55.6	20.1	0.0	0.0	3.4	8.7	9.3
November	28.5	9.4	62.0	35.7	1.2	0	3.1	8.4	8.1
December	24.2	5.5	72.4	36.4	0.0	0.0	3.3	8.2	8.0

Meteorological Data: CHES, Vejalpur

Month	Temperature (°C)			RH (%)	Rainfall (mm)	Rainy days
	Max.	Min.	Mean			
January	28	12	20	50	---	---
February	32	15	23	43	---	---
March	36	19	28	34	---	---
April	40	24	32	35	---	---
May	42	27	35	42	---	---
June	39	28	3	58	213.5	7
July	34	26	30	76	73.5	4
August	33	25	29	79	541.5	17
September	34	25	30	74	137.1	7
October	36	22	29	55	57.5	3
November	33	17	25	52	---	---
December	30	14	22	51	---	---

भाकृअनुप
ICAR

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