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Cover

Front: Aonla cv. NA-7 in bearing
Back: Genetic variability in:
Top - Muskmelon
Middle - Snapmelon
Bottom- Kachri

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Introduction

In the present agricultural scenario, where the agricultural land is shrinking due to increase in urbanization and population pressure, hot arid region provides an ideal nitch to expand agricultural production. This region is spread on nearly 12 percent of the land area in the States of Rajasthan, Gujarat, Haryana, Punjab, Andhra Pradesh, Karnataka and Maharashtra. It has been established that horticultural crops particularly perennial fruit trees, not only provide nutrition and income security to the people but can also ameliorate the harsh environment of the arid region. However, it requires the development of technologies for production of these crops under such harsh conditions. Accordingly, NRCAH was established at Bikaner which later got upgraded to Central Institute for Arid Horticulture in October, 2000.

Mandate

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

Mission/objectives

*To introduce, collect, characterize, conserve and evaluate the biodiversity of horticultural crops under arid environment.

*To utilize the available biodiversity and improve the target fruit crops such as *ber*, pomegranate, *aonla*, date palm and cucurbitaceous, leguminous and solanaceous vegetables to develop high quality and productive types having tolerance to biotic and abiotic stresses.

*To study the factors related to rapid multiplication of propagules in case of established as well as new crops and the problems related to their growth and fruit development.

*To standardize agrotechniques with respect to efficient use of soil, water and nutrients for increased horticultural productivity involving water harvesting and conservation techniques under rainfed conditions, efficient use of the scarce irrigation water and nutrient management.

*To study the ecophysiological parameters of cropping system models for utilization of high temperature and radiation resources.

*To develop postharvest technology package for extended use of the horticultural produce of arid region.

*To develop integrated pest and disease management technologies for horticultural crops under arid environment.

The salient research achievements of the Institute during 2000-2001 were:

1. During the period under report budwood of 15 genotype of ber, 05 genotype of aonla, 05 in grape, 32 genotype of gonda, 03 of phalsa, 01 of pillu were collected. With this, a total of 300 germplasm of ber, 150 of pomegranate, 22 of aonla, 106 of cactus pear, 47 of date palm, 558 of kachari, 193 of mateera, 90 of snapmelon, 132 of chillies, 55 of muskmelon and 60 varieties/strain of different fruit trees (Table 22.) are being maintained and evaluated at the Institute.

2. Studies on floral biology of ber was undertaken and it was recorded that time of anthesis is a varietal character.

3. Attempts have been initiated to identify and select indigenous and exotic underutilized fruits of arid region.

4. In a persuit to incorporate drought hardy characters of mateera in water-melon, F3 progenies of Mateera AHW 19 x Sugarbaby were evaluated and found to be promising with respect to fruit yield, fruit size, flesh content, colour, firmness and TSS.

5. It was observed that treatment of cuttings of *Capparis decidua* with 7000 ppm IBA along with 1000 ppm Thymine gave 50% sprouting in the mouth of September.

6. Studies on photosynthesis in ber reveals that cultivars can be grouped on the basis of net photosynthesis, carboxylation efficiency, mid day depression in photosynthesis and water use efficiency.

7. Screening of parameters for drought in cucurbit reveals that plant height stress index and dry matter stress index can be used for screening of germplasm.

8. Application of organic manure and inorganic fertilizer were compared in pomegranate. It was observed that plant height and WUE were best under vermicompost and inorganic fertilizer. Vermicompost either alone or in combination with inorganic fertilizer improves N. content of plants.

9. In persuit to identify the biological control of major diseases in arid fruits and vegetables different substrates were evaluated for the growth and multiplication of *Trichoderma* sp. It was observed that soil incorporated with *Prosopis* pod powder was better for spomlation of different isolates of *Trichoderma.*

10. The scientists of the centre took active part in Kisan melas and other extension activities and acted as resource persons for various training programmes and as faculty to teach courses in RAU.

Germplasm conservation

Mission A: Introduction, collection, characterization, conservation and evaluation of horticultural bio-diversity.

At CIAH, Bikaner

A 1.1 Collection, conservation and evaluation of *ber* (*Ziziphus mauritiana* Lamk.)

1. **Collection of genotype/strains of *ber*:** The bud wood of 15 genotype of *ber* were collected from already identified spots of the Gujarat and Rajasthan (04 from Sirohi (Raj.), 03 Patan, 03 Mehsana, 02 Anand, 02 Panchmahal and 01 Sabarkanta district of Gujarat.) during the month of August, 2000 under NATP on plant biodiversity programme. The collected bud wood was subjected to *in situ* budding in national repository of ber.

2. **Floral biology of *ber*:** Observations were recorded with respect to number of flowers per cluster and time of anthesis. Further, the number of flowers per cluster varied between 10-16 depending upon the cultivars. The number of flowers were maximum on secondary shoots of Gola, Umran, Mundia and Banarasi Karaka as compared to tertiary and primary shoots. The time of anthesis varies between 7.30 AM to 1.00 PM depending upon the cultivars e.g. the time of anthesis for Gola, Katha and Umran was 12.55 PM whereas it was between 7.00 to 9.00 AM in Banarsi Pewandi, Seb, Mundia Nazuk and Nehrumandal.

3. **Frost resistance in *ber*:** Observation were recorded with regard to frost incidence and it was observed that cultivars Chhuhara, Tikadi, Kathaphal, Kharki No.1, Badami, Manukhi, Glori, Safeda Rohtak, Dharki No.2, Mundia Munehra, Tacbatasa were unaffected from the frost.

4. **Fruit fly resistance in *ber*:** Data with regard to fruit fly tolerance/resistance among the cultivars/genotype is being recorded.

5. Observation with regard to Morphological and Physiological parameters of 300 genotypes of ber is being recorded at regular intervals.

A 1.2 Collection, conservation and evaluation of *Boradi* (*Ziziphus mauritiana* var. *rotundifolia*)

22 genotype of Bordi are being maintained at CIAH and their evaluation on the basis of vegetative characters is in progress.

A 1.3 Collection, conservation and evaluation of aonla (*Emblica officinalis* Gaertn.)

Five genotypes of aonla have been collected from Gujarat i.e. one from Anand and four from Talod (Table 1). At present 22 genotypes of aonla are being maintained in germplasm block.

Observations were recorded with respect to flowering and floral attributes such as flowering period, sex ratio, concentration of flowers, length of branch let (determinate shoots), size of pedicel, smiling bud, petal, androceium, gynaecium etc. of cultivars Chakaiya, Krishna, NA7, NA6 and Kanchan (Table 2). During the year 2000 the first time fruiting in aonla was observed, initial varietal evaluation was done. NA 7 performed better over others

Table 1. Detail of aonla germplasm collected from Gujarat during August, 2000

S.No.	Strain/Genotype No.	Site of bud wood collected
1	NRCAH 1	Anand
2	NRCAH 2	Talod
3	NRCAH 3	Talod
4	NRCAH 4	Talod
5	NRCAH 5	Talod

Table 2. Flowering behaviour of aonla cultivars

S.No.	Cultivar	Flowering period		Concen-tration of flower	Sex ratio		Length of branchlet with full of flower (cm)	Length of branchlets (cm)	Pedicel size (mm)	Bud size (mm) (Smiling)	Petal size (mm)		Size of Gynaecium (mm)	Size of Androcium (mm)
		Initiation	Peak		F	M					M	F		
1	Chakaiya	10th March	18th March	Distal	1	89	3.5-7.2	6.2-12.3	50	90	105	140	215	35
2.	Krishna	13th March	24th March	Distal	1	56	4.4-4.6	7.5-9.0	70	63	76	99	173	70
3.	NA7	12th March	25th March	Distal	1	20	10.3-10.4	13.0-14.0	53	73	92	100	161	72
4.	NA6	10th March	22nd March	Distal	1	58	7.6-8.1	11.8-13.0	65	80	80	100	115	69
5.	Kanchan	14th March	21st March	Distal	1	12	3.2-5.6	7.0-9.1	70	67	92	130	198	76

A 1.4 Introduction, collection, characterization, conservation and evaluation of pomegranate (*Punica granatum* L.) under hot arid environment

i) Germplasm collections

150 genotypes collected since 1995 and were evaluated and maintained. Different morphological, flowering, fruiting and various physico-chemical characteristics of fruits were recorded. Out of 150 genotypes, 55 types were of deciduous and rests 95 were of evergreen in nature. Flowering and fruiting was recorded for *mrig bahar*. Fruit set of various varieties varied from first week of August to end of November, depending upon respective genotype characters. The acidity of the fruits varied from 0.51% in Alah to 4.35% in Bocha lines. Maximum TSS was recorded in Jodhpur collections (22.0° Brix) and minimum was recorded in Agah (14.0° Brix).

ii) Introduction

In addition to early introductions during 1998-99 (11 from Iran, 2 from Argentina), 5 lines in the form of cuttings were introduced from Davis campus California through NBPGR, New Delhi.

iii) Evaluation of selected progenies

Single plant seedling progenies of 52 collections and 9 clonal collections of Jalore seedless types collected from seedling orchards and planted in close spacing are under evaluation.

After establishment of NRCAH (now CIAH) at Bikaner efforts were made to introduce, collect and evaluate pomegranate genetic diversity. As a result of this, during 1997 four clonal collections (AHPG-C1 to C 4) were made directly from Iran. Where as seven clonal types assembled from Iran through NBPGR N. Delhi during 1998. Besides collection of nine promising clones from seedling originated orchards in 1998. All these clones were planted in the field for multiplication and evaluation purpose. Observations (Table 3.) related to growth, flowering and fruit quality is under way.

Table 3. Growth and development in pomegranate clonal collection (2 years old)

Genotype	Plant height (cm)	Branches /plant	Foliage
AHPG-C1	174	4.5	Deciduous
AHPG-C2	138	2.0	-do-
AHPG-C3	155	3.9	-do-
AHPG-C4	140	4.8	-do-
Pust Piyazi	145	4.2	-do-
Zay Evedevan	94	1.5	-do-
Aleka Parend	146	4.8	-do-
Aga Mohamad Ali	84	2.3	-do-
Mahesh Beh Bahan	115	2.0	-do-
Pust Garmet	135	3.5	-do-
Malish Sarin	141	3.8	-do-
AHP/JS/C/98-1	138	4.0	Evergreen
AHP/JS/C/98-2	124	5.0	-do-
AHP/JS/C/98-3	100	6.0	-do-
AHP/JS/C/98-4	105	6.0	-do-
AHP/JS/C/98-5	108	4.0	-do-
AHP/JS/C/98-6	88	3.0	-do-
AHP/JS/C/98-7	125	4.0	-do-
AHP/JS/C/98-8	101	5.0	-do-
AHP/JS/C/98-9	120	5.1	-do-

iv) Effect of Boron and GA_3 for control of fruit cracking in pomegranate

A preliminary trial was conducted in pomegranate variety Jalore Seedless to see the effect of Boron and GA_3 to control cracking of fruits.

Results obtained during 2000-2001 reveals that all the chemical treatments were found effective to control cracking of the fruits. Boron 0.2% was found most effective to check the cracking in the early harvests but in later harvests control of fruit cracking was found less effective, comparatively. This observation gives indication that >1 spray of 0.2% Boron is required to control the cracking.

A.1.5. Introduction and evaluation of different citrus species and root stocks under arid ecosystem.

During 2000-2001 under this sub project Kinnow mandrin was introduced during October to study its performance under arid ecosystem. About 9 months after planting > 90% survival was recorded in the field. At this stage average height of the plant was recorded up to 1.07 m having average girth of 1.8 cm and spread of the plants was 33 x 35 cm across and along the row, respectively. These budded plants of Kinnow mandrin are performing better in the field.

ii) Performance of tissue culture plants

Tissue culture plants of cultivars Khalas, Yakoob, Nubsully, Khuneizi, Dhamas, Khasab and Ford were maintained in field conditions. Survival of plants was cent per cent. Spathe emergence and new sucker formation was not noticed in any varieties. Vegetative growth performance was better in all varieties.

iii.) Date palm seedlings

Seeds of seven date palm varieties (Sayer, Zahidi, Braim, Khastavi, Khadrawy, Chip chap and Barhee) were procured from Iraq under germplasm exchange programme. Ninety per cent seeds were germinated in agroshade net when seeds were sown in the month of August. Survival and growth of seedlings was good under nursery conditions.

A. 1.6. Collection, conservation and evaluation of Date palm (*Phoenix dactylifera* L.) under hot arid environment.

i) Collection and evaluation of germplasm

A total of 50 indigenous as well as exotic germplasm were maintained in date palm repository. In Halawy and Saddami cultivars, spathe emergence/flowering was observed. However, proper pollination was not carried out due to unavailability of pollens and young stage of plants. After three year of planting, spathe emergence/flowering was recorded in a large number of genotypes viz. Halawy, Khardrawy, Zahidi, Dayari, Samran, Sevii, Medini, Sayer, Saddami, Sabiah and Umshok during the month of Feb./March, 2001. Further, evaluation work is in progress.

A.1.7 Collection, conservation and evaluation of *bael* (*Aegle marmalos*) genotypes.

Survey and collection of *bael* germplasm was initiated during the period.

A.1.8. Collection and evaluation of *Vitis* varieties and root stocks under arid ecosystem.

Work on germplasm collection and evaluation of *Vitis* varieties and rootstock was initiated after being approved in the Ist SRC held at Godhra during January, 2001. So far

five grapes varieties viz. Tas-A-Ganesh, Perlette, Anab-e-Shahi, Flame seedless, Pusa seedless and among root stocks ST. George, 110R, Dogridge, 1613 C, Salt crack and 1616 C have been collected from NRC on Grapes, Pune.

A. 1.9 Collection, conservation and evaluation of Cactus pear (*Opuntia ficus indica* L. Mill.) under hot arid conditions.

Total 107 cactus pear genotypes were maintained. In clone 1270 and clone 1271 flowering and fruiting initiated in multiplication block. Flowering and fruit setting was also observed in all indigenous types. Fruiting and size of fruits were inferior in quality in local types in comparison to exotic ones. Fruits of clone 1271 were sweet in taste, yellow in colour and seeds were present. The average fruit weight was 70 to 80 g, which were heavier in weight than the local types. Under multiplication studies, vegetable type (1308) showed vigorous growth and higher cladodes yield when it was maintained under irrigated conditions. Two exotics (introduced from Argentina) clone were multiplied in nursery. Both the types are growing well under nursery conditions.

A. 1.10 Introduction, evaluation and improvement of indigenous and exotic underutilized fruits of arid region.

The arid region of India, although characterized by sparse vegetation, abound invaluable germplasm of some of the most hardy fruits flora, which yield edible fruits rich in nutrition and medicinal values and have potential for commercial exploitation. There is lot of variability/diversity in fruit characteristics, production and quality. The work was started to identify suitable underutilized fruit crops for higher yield, quality and tolerance to biotic and abiotic stress under arid ecosystem. The further approach will be is improvement in indigenous and exotic less known fruits by exploiting variability.

i) Performance of existing germplasm Gonda or Lasora

In gonda (*Cordia myxa*), earlier local collection-I showed promising attributes for growth, fruit yield and quality characteristics. Observations recorded during 2000-2001 reveals that 4 years after planting this collection attained the height of 6.05 m, spread 6.0 x 6.30 m. The fruits were of light pink colour and average weight was 8.2 g.

Phalsa

Among existing germplasm, collection from Faizabad (during 1997) was found to flower and fruit better under arid climate of Bikaner.

ii) New collections Gonda or Lasora

32 genotypes of Gonda (*Cordia myxa*) having wide range of variability were collected under NATP program. Seedlings were raised in the nursery to study their germination and growth under arid ecosystem. These 32 types along with existing promising one will be planted in experimental block for field evaluation.

Phalsa

In addition to existing phalsa collections, 3 types collected from Rajasthan (2) and Gujarat (3) areas were raised in the nursery. In coming season, these seedlings will be planted in underutilized fruit block for field evaluation.

Pillu

One promising genotypes of pillu was collected during survey of Rajasthan under NATP program. The seedlings were raised in

nursery for planting in the experimental block of underutilized fruit crops.

iii) Effect of pruning on growth, fruiting and yield of phalsa

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

Three month after pruning it was noticed that pruning up to the height of 50 cm was most effective to produce maximum height of new growth. Flowering/fruiting was recorded early in case of pruning height of 40 cm and where no pruning was done (control).Flowering and fruiting was delayed by 7 days in case of 50-70 cm height of pruning. Maximum yield was recorded in case of pruning up to 50 cm.

A 2. Introduction, collection, characterization, conservation and evaluation in cucurbit vegetables under hot arid environment

Conservation and evaluation of cucurbit germplasm

Realising the potential of cucurbit vegetable in arid and semi arid regions, particularly in watermelon type mateera (*Citrullus lanatus*), kachari (*Cucumis* spp.), snapmelon (*Cucumis melo* var. *mamordica*), *kakdi* (*Cucumis* spp.) and muskmelon (*Cucumis melo*) research initiatives have been undertaken from 1994 at Bikaner. In this direction, a large number of germplasm of *Citrullus* and *Cucumis* group were collected, evaluated and are being utilized for the development of promising lines/varieties. As a results of surveys in target variability pockets and explorations during 1994 and1995, the active germplasm holding in watermelon type mateera (193), kachari (558), snapmelon (90) and kakdi (2) are being maintained.

i) Exploration for the survey and collection of muskmelon germplasm

Muskmelon (*Cucumis melo*) is an important vegetable grown widely in India. There are several specific locations in arid, semi-arid and sub humid regions including riverbeds in Rajasthan where several lands races/local cultivars have established themselves based on selection by the local growers in the past. An exploration for the survey and collection of muskmelon germplasm was undertaken during May, 2000 to collect local races and cultivated muskmelon types from parts of Sikar, Jaipur, Tonk, Ajmer, Bhilwara, Chittorgarh, Udaipur, Rajsamand, Pali, Jalore, Jodhpur, Nagour and Bikaner districts of Rajasthan under NATP on Plant bio diversity program. A total 55 open pollinated collections were made from different types of crop cultivation areas like riverbed, farmland and areas of dried water reservoir/dams in Rajasthan. During the course of survey, detailed observations related to the crop cultivation and data on crop growth, fruiting and yield, fruit type, size, shape, quality and seed characters were recorded. Besides, interactions were made with the farmers for production related problems, incidence of insect-pest, diseases and availability of quality seed. The variations were recorded for fruit weight (0.650-2.250 kg) fruit length (7.5-16.5 cm), fruit diameter (8.2-16.4 cm), number of seeds/fruit (82-611), length of seed (10-16 mm), weight of five seeds (62-307 g) TSS, fruit cavity, flesh colour, taste, rind colour, fruit strip/netting and shape.

All the 55 collections along with 7 check (5 indigenous and 2 exotic) have been sown as summer crop 2001 for the evaluation, characterization and multiplication of muskmelon germplasm.

ii) Evaluation for the maintenance and conservation of *Kachari* germplasm

A total 824 samples of kachari (*Cucumis* spp.) comprising collections/lines of year 1994, 1995, 1996 and 1997 were evaluated during *kharif* season of 2000 for the maintenance and conservation of germplasm. The detailed observations related to growth, flowering, fruiting, maturity, fruit yield, quality, resistance to fruitfly infestation, disease incidence and drought hardiness under field conditions were observed and recorded. A wide range of variability was observed for morphological characters of fruits and plant characteristics including vine length (1.05-3.2 m), number of branches (3.0-16.5), days to open first female flower (25.5-50.4 DAS), days to first harvest (55.5-95.2 DAS), fruits/plant (5.5-105.5), fruit weight (10.5-250 g), fruit length (2.5-12.5 cm), fruit diameter (2.25-7.25 cm) and flesh thickness (0.11-1.64 cm). Variability in fruit shape, size, colour of skin, flesh colour and content were also recorded. Genotypes have been identified possessing genes for desirable growth characters, maturity, flowering and fruiting, higher yield, fruit quality, resistant to biotic and abiotic stresses and also possessing multiple desirable traits. All the collections were also grouped according to their practical utility on the basis of fruit characters viz.- vegetable, salad, dehydration or multiple uses and promising genotypes having desirable fruit character have also been identified. The genotype AHK 5, AHK 26, AHK 109, AHK 119, AHK 155, AHK 200 and AHK 202 have been found most promising for commercial exploitation and serve as a reservoir for use in resistant breeding.

iii) Evaluation for the maintenance and conservation of snapmelon germplasm

Snapmelon or *phoot* (*Cucumis melo* var. *momordica*) is a popular cucurbit grown under acute water stress conditions in the arid regions. Considerable genetic variability was collected through intensive surveys in the arid region of Rajasthan. A total 215 samples comprising collections/lines of year 1994, 1995,1996 and 1997 were evaluated during the *kharif* season of 2000 for the maintenance and conservation of snapmelon diversity at CIAH, Bikaner. The detailed observations related to growth, maturity, flowering and fruiting behaviour, fruit yield and quality, resistance to biotic and abiotic stresses under field conditions were recorded. All the genotypes were grouped on the basis of earliness, yield, fruit quality, fruit fly infestation and incidence of diseases and promising lines were identified for number of desirable traits. A wide spectrum of variation was recorded in characters such as days to first female flower (30.2-55.2 DAS), node to first female flower (3.0-15.5), days to first harvest (58.2-95.4 DAS), fruits/plant (2.5-9.5), vine length (1.5-4.1 m), number of branches (2.5-10.5) per plant, fruit weight (0.180-3.258 kg), fruit length (8.5-37.5 cm), fruit diameter (5.95-13.85 cm), fruit cavity (3.25-8.88 cm) and flesh thickness (1.25-3.35 cm). Variability was also recorded in fruit size, shape and skin colour, flesh colour, taste and TSS, seed content and size. Most promising genotypes have been identified on the basis of maturity, yield and fruit quality characters and the genotypes, AHS 6, AHS 10, AHS 14, AHS 19, AHS 50, AHS 54, AHS 64 and AHS 82 were found to most useful for commercial exploitation and use in stress resistant breeding.

iv) Evaluation for characterization and multiplication of cucurbits under NATP on Plant bio-diversity

A total 76 collections of seven cucurbits comprising of *Cucumis callosus* (33), *Cucumis melo* var. *momordica* (12), *Cucumis melo* var. *agrestis* (12), *Cucumis* hardwickii (11), *Cucumis sativus* (4), *Cucumis prophatarum* (2) and one each of *Cucumis*

trigonus and *Luffa hermaphrodite* received from NBPGR, Regional Station, Jodhpur were evaluated during *kharif* 2000 under NATP on plant bio-diversity programe for the characterisation and multiplication of germplasm. The detailed observations were recorded on parameters related to growth, crop behaviour, flowering and fruiting, maturity, fruit shape, size, colour, yield, seed content, etc.(Table 4 and 5)

As per information gathered from passport data, it revealed that these collections were made from Southern parts of Rajasthan having sub humid to humid climatic condition. Therefore, on evaluation of these materials under extremes of arid climate, the performance and expression of characters were quite informative. There is a difference in growth, flowering, maturity, yield and quality parameters of *Cucumis callosus*, *C. melo* var. *agrestis* and *C. melo* var. *momordica* of sub humid to humid climate in comparision to cultivated types of arid climate. In case of *C. hadiwickii*, *C. sativus*, *C. prophatarum* and *C. trigonus*, the expression of characters was very poor for growth, flowering and fruit yield, even in most of collections there was no flowering or very few male flowers.

iv) Evaluation of muskmelon germplasm

Fifteen muskmelon varieties/ lines/exotic collections were evaluated during the summer 2000 for growth, flowering, earliness, fruit yield, quality and tolerance to fruit fly infestation, incidence of diseases, sun burn and fruit cracking under high temperatures. Among the varieties, higher early yield (82-85 days after sowing) was recorded in CHES 238 followed by Durgapura Madhu, MHY 5 and MHL 10. Among exotic lines flowering starts after 90 days of sowing and bear very small sized fruits (220 g weight) of very poor quality.

Table 4. Characteristics of minor cucurbits evaluated under NATP (PBD)

Species / Character	*Cucurmis callosus* (*Kachari*)	*Cucumis melo* var. agrestis (*Mat Kachari*)	*Cucumis melo* var. mamordica (Snapmelon)
First female flower (DAS)	38.1-52.4	38.5-56.2	38.5-52.7
First harvest (DAS)	56.5-81.2	67.5-95.8	66.5-78.2
Fruits/plant	12.1-46.2	6.1-14.5	1.5-7.4
Fruit weight (g)	55.1-285.1	230.2-830.5	157.8-925.5
Fruit length (cm)	3.4-7.2	4.4-12.5	6.5-9.6
Fruit diameter (cm)	2.8-4.6	3.5-6.8	3.6-7.9
Flesh thickness (cm)	0.32-0.68	0.55-1.94	0.51-1.52
Fruit cavity (cm)	1.21-2.75	2.45-4.50	2.5-5.5
Vine length (m)	0.35-1.62	0.75-1.78	0.65-1.78
Branches/plant	1.21-2.85	1.59-3.78	1.54-2.90
Fruit shape	Oblong, long, round, obovate, ovate	Oblong-round to long	Oblong-long to round
Fruit colours	Green, Dark green, Green-light green, Light yellow, stripped or mottled spoted	Yellowish to greenish yellow, brownish yellow	Greenish yellow, Light yellow to saffron, stripped or mottled
Remarks	Some collection were intermediate type (*Cucurmis melo* var. agrestis or *Cucurmis melo* var. *momordica*	Some collection were intermediate types (*Cucurmis melo* var. momordica	--

Table 5. Characteristics of some cucurbits species evaluated under arid environment

Species / Character	*Cucumis prophatarum*	*Cucumis trigonus*	*Luffa hermaphrodite*
First flower (DAS)	45.2-50.5	50.2-56.2	50.1-58.4
First harvest (DAS)	70.1-75.5	76.2-80.5	110.5-115.8
Fruit/plant	30.2-35.2	75.5-80.2	20.2-22.8
Fruit weight (g)	8.0-8.5	12.1-14.5	50.1-60.5
Fruit length (cm)	3.2-3.5	3.1-3.5	4.2-5.1
Vine length (m)	0.65-0.75	1.12-1.75	1.12-1.54
Branches/plant	15.5-16.5	6.1-7.2	3.7-5.2
Remarks	Plant monoecious, ovary 0.8 cm, spiny, long, highly susceptible to fruit fly, fruit oblong in shape, green to yellowish green, poor seed formation under arid climate	Ovary one cm long, plant gynoecious, therefore no seed setting, susceptible to fruit fly, unfertilised fruits are oblong in shape and light yellow in colour	Flower bisexual, 3-5 flowers/cluster, ovary 2-2.2 cm long, 10 ridges on fruit and green leaf 9x7 cm size, highly susceptible to fruitfly.

At CHES, Godhra

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

1. Ber

Existing germplasm lines were evaluated for growth, fruit set and fruit retention .The data recorded on vegetative growth characters viz. plant height, stock and scion diameter and plant spread revealed that there were significant differences amongst the varieties in respect of all the vegetative growth characters. Maximum plant height was recorded in Chuhara and it was least in Maharwali. Highest stock diameter was recorded in Umran and it was least in Maharwali. Similarly maximum scion diameter was observed in Gola. Plant spread was maximum in Gola and it was least in Chonchal.

Shoot growth observations revealed that it initiates on the onset of monsoon and continues up to middle of October. Shoot length was maximum in Illaichi and was least in Maharwali. Maximum shoot diameter was recorded in Umran and was minimum in Maharwali. Data recorded on number of seconderies / shoot revealed that maximum number of seconderies were observed in Tikdi and was least in Guli.

Data recorded on number of flowers per cluster revealed that maximum flowers per cluster were recorded in Chinese and was least in Shamber. As regards to number of fruit set per cluster Vilaiti had maximum fruit set per cluster. It was least in Guli. As regards fruit set and fruit retention per shoot, this year though fruit set was normal but fruit retention was adversely affected by drought condition prevalent in the year for the second consecutive year and hence, no further observations could be recorded.

2. Pomegranate

Growth observations on ten lines of Anardana type collected from IIHR Bangalore were recorded for the third year of growth. The results revealed that there were significant differences in respect of all the vegetative growth parameters. Maximum plant height was recorded in line E (3.27 m). It was least in line H (1.43m). Diameter of the stem was highest in E (36.03 mm) and was closely followed by line A. It was least in Line D (16.90 mm). As regards plant spread, North South spread was highest in line E (2.37m) and was least in line H (1.07m). East West spread was highest in line E closely followed by A and was least in line H (1.01 m). Though there was profuse flowering however, fruit set and development was adversely affected because of 2ndconsecutive year of drought and hence, no further observations could be recorded.

3. Custard apple

Custard apple germplasms collected at the center was evaluated for the fifth year of their growth and fruit set only, as further growth and development of fruit was severely hampered due to 2nd consecutive year of drought and no fruits could be harvested. In respect of all the vegetative growth characters Atemoya x Balanagar was found to be most vigorous among all. Maximum fruit set per plant was observed in local sitaphal closely followed by Atemoya x Balanagar.

4. Aonla

Further evaluation of plus trees resulted in identification of total of 7 trees. They were evaluated for their performance. It was observed that in respect of vegetative growth characters, there were no significant differences. However, in respect of mean number of female flowers per cluster it was maximum in plant No.5 (13.77female flowers/

cluster) closely followed by plant No. 2 (12.77 female flowers / cluster). In standard check it was just (5.63 female flowers/ cluster). Data recorded on percent cluster having female flowers as compared to clusters having no female flowers revealed that plant No. 5 had maximum cluster having female flowers per shoot as compared to other plants. Data on percent empty cluster i.e. cluster without female flowers revealed that it was highest in standard check (64.47 %) and was minimum in plant 5(29.42 %). Maximum number of fruit shoot were set in plant no. 2 (930.67) in standard check it was 339.33 only. Data on number of fruit retained /shoot also showed similar trend.

5. Sapota

Evaluation of sapota gremplasm during the year revealed that variety Kalipatti was the most vigorous of all in respect of all the vegetative characters recorded. Maximum number of fruits set/ shoot counted revealed that maximum number of fruits/shoot were set in variety Jhumukhia (88 no). It was least in Co. 1 (14.66 no). Due to 2nd consecutive year of drought no further observations could be recorded.

Genetic improvement

Mission B: Genetic Improvement in arid horticultural crops.

At CIAH, Bikaner

B.3 Improvement in cucurbit vegetables under hot arid environment

(i) Evaluation of advanced lines in *mateera* (watermelon).

Summer-2000: On the basis of results of earlier work done in *mateera* and there after hybridisation to improve drought hardy *mateera* selections for higher TSS and acceptable higher quality fruit yields under extremes of arid climate, in continuation of this, during the summer season of 2000, five parental lines (*Mateera* AHW-19, *Mateera* AHW-65, Sugar Baby, Charleston Local and Mahabobi) alongwith eight progenies of F3 and seven progenies of F2 generation were evaluated. The characters related to agro-morphology, earliness, fruit yield, quality tolerance to fruit cracking, reaction to insect pest and diseases, flowering and fruiting behaviour under high temperatures were recorded. The parental lines *mateera* AHW-19 and mateera AHW 65 out yielded as far as earliness and yield among the parents. The average yield, potential number of fruits and TSS of mateera AHW 19 (425 q/ha, 3.2 fruits/plant and 8.1 °Brix TSS) and mateera AHW 65 (390 q/ha, 4.1 fruits/plant and TSS 8.1 °Brix) respectively. Sugar Baby, Charleston and Mahobobi gave 1.2-1.5 fruits per plant weighing 0.75 to 2.10 kg after 110-115 days after sowing and very few fruits were marketable owing to cracking.

In F_3, progenies of mateera AHW 19 x Sugar Baby showed desirable trends in earliness, fruit yield, number of fruits/plant, fruit size, flesh content, colour, firmness and also for TSS, seed content and seed size. In F_2, seven progenies (Mateera AHW 19 x Charleston Local, Sugar Baby x Mateera AHW 19, Sugar Baby x Charleston Local, Sugar Baby x Mateera AHW 65 and Mateera AHW 19 x Mateera AHW 65) were evaluated and variable trends for growth, earliness, fruit yield and quality parameters were recorded. Single plant selections have been made on the basis of fruit quality characters (flesh colour, firmness and TSS) alongwith early higher yield contributing traits for further advancement of generations.

Rainy 2000: Like wise, during *kharif* 2000, (a severe drought year), four parental lines mateera AHW 19, mateera AHW 65, Charleston local and Sugar Baby along with 18 advanced progenies of F_4 generation, 5 bi-parental progenies and three F_3 generation progenies were evaluated for growth, flowering, fruiting behaviour, earliness, fruit yield and quality parameters. Observations were also recorded for incidence of insect pest and diseases, fruit cracking and marketable yield/plant to screen out the desirable lines. On evaluation of parental lines, in conclusion the variety mateera AHW 19 and mateera AHW 65 are most suitable for two season cultivation (i.e. summer and rainy season crop) where as the cultivar Sugar Baby and Charleston Local performed very poorly in rainy season (on the basis of days to harvest, number of marketable fruits/plant and quality of summer and rainy season).

In F_4 generation, out of 18 progenies (Mateera AHW 19 x Sugar Baby) evaluated, twelve progenies depicted trends for high quality yield (3-4 fruits/plant and 10-12 °Brix TSS) characters where as progenies from bi-parental mating of above cross and F_3 progenies of Mateera AHW 19 x Charleston

Local and Charleston Local x Sugar Baby performed poorly not only for higher early yields but also for fruit quality parameters (8.2 °Brix TSS). Therefore, single plant selections have been made only among F_4 generation on the basis of fruit quality (flesh firmness, colour and sweetness), earliness and number of marketable fruits/plant for further evaluation.

ii) Yield performance of advanced kachari lines

Advanced lines of *kachari* selections AHK 119 and AHK 200 were tested in replicated trial during summer and rainy season of 2000. The detailed observations related to growth, flowering and fruiting behaviour, marketable yield along with infestation to fruitfly and incidence of disease and fruit bearing capacity under drought conditions were recorded to assess the yield potential of these selections. On an average, the *kachari* selection AHK- 119 bears 18-22 fruits/plant which account to yield potential of 90 q/ha. The selection AHK 200 depicted earliness (65 DAS) with 18-20 fruits/plant and yield potential of about 100 q/ha in both the seasons.

iii) Yield performance of advanced snapmelon lines

Advanced line of snapmelon selections AHS 10 and AHS 82 were tested during summer and rainy season of 2000. The selection AHS 10 bears 4-5 fruits during summer and 3.8-4.2 fruits/plant in rainy season with an average yield potential of 217 and 202 q/ha, respectively. The selection AHS 82 performed well with average yield potential 225 q/ha in both the season having desirable fruit quality, earliness (first harvest 66 DAS) and more number of marketable fruits (5-6 plant).

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

As a result of exploration, 132 collections were made during 1998 and evaluated at Bikaner. On evaluation, data revealed that there are four local (on the basis of fruit characters) types i.e. *Mathania* or *desi*, *Haripur-Raipur*, *Mehsana* and *Mandoria* in cultivation and all the genotypes performed well under arid conditions. In this context, the main reason for adoption of popular land races of adjoining areas in mathania type chilli growing areas might be due to non-availability of seeds of pure mathania type and/or low productivity and high incidence of viral diseases and use of poor quality seeds of mathania type. Besides these, it is also clear that the varieties of adjoining areas are high yielding under arid conditions.

Although, there is no comparison for fruit quality of original *mathania* type chilli to the other popular types presently in cultivation. The fruits of *mathania* type are attractive, very long, fleshy, mild pungent, bright red coloured, less seeded and in great demand. Therefore, on the basis of phenotypic characters of fruit, earliness and incidence of diseases and yield contributing traits single plant selections were made from the promising genotype to raise advance generation. During the *kharif*, 2000, a total 75 lines were evaluated alongwith 15 lines of Guntur type chillies collected from Andhra Pradesh and Tamil Nadu states. Detailed observations were recorded related to growth, earliness, fruit yield and quality characters, incidence of diseases, tolerance to high temperature and frost. The seeds of selected plants of promising germplasm were harvested for further evaluation.

B. 1 Improvement in pomegranate by selection and hybridization

i) Evaluation of seedlings

During the exploration of seedling originated orchards of pomegranate var. Jalore seedless during 1998, 55 open pollinated seedling progenies (AHP/OP/JS/98) were collected, developed and planted at CIAH at closer spacing (2 x 1 m) for evaluation. Besides, 5 seedling progenies (OP/AHPG/98/53/54a, 54b, 55, 56) developed through open pollination high quality fruits collected from Iran were also planted and evaluated for growth, flowering and fruiting and fruit quality attributes and periodically observations were being recorded for the characterization.

ii) Evaluation of hybrids

On evaluation of pomegranate varieties, it was observed that exotic varieties from temperate regions failed to express their characters for commercial cultivation. They are acidic, hard seeded with low productivity. However, colour of the aril was dark red in most of the collections. Therefore, on the basis of work conducted under AICRP (AZF) and preliminary information in arid region, hybridization work was initiated at NRCAH, Bikaner in 1997 and 1998, making selective simple and complex crosses with the aim to infuse blood red colour in popular cultivars. As a result, fifteen hybrid cross combination were planted at close spacing (2 x 1m) for evaluation. Detailed observations were recorded for plant growth, foliage colour, flowering and fruiting behavior. The F1 progeny DKS/H/97/003 cross combination (Jalore seedless X Mridula) showed promising attributes for high quality fruit having desirable blood red, bold and soft aril of > 20 °Brix TSS, after two years of planting (Table 6).

B.2 Improvement in Ber

BC1 generation of Seb x F1 (Seb x Tikadi) is being evaluated for resistance to fruit fly infestation. It was observed that infestation of fruitfly varied between 5 to 20.65%.

Table 6. Plant growth and fruit characteristics of some pomegranate hybrids and seedling progenies (2 years old plant)

Genotype	Plant Height (cm)	Sucker/ plant	Stem dia. (cm)	Fruit weight (g)	Fruit Length (cm)	Fruit dia. (cm)	Weight of 10 arils (g)	Aril length (cm)	TSS (° Brix)	Aril Colour
DKS/H/97/001	148.5	10.4	1.65	84.51	6.12	5.47	3.19	0.61	21.4	Red
DKS/H/97/003	131.5	11.8	1.58	44.47	4.95	4.41	2.31	1.01	19.5	Red
DKS/H/97/005	151.1	6.8	1.79	30.28	3.91	4.32	2.92	0.79	17.1	Pink
DKS/OP/97/006	161.8	7.2	1.89	51.58	4.38	4.57	1.44	1.0	15.8	Red
DKS/H/98/007	115.5	6.5	1.44	71.48	5.65	4.82	2.37	0.98	17.6	Red
DKS/H/98/010	117.1	5.1	1.48	63.70	6.12	5.73	2.63	1.00	18.8	Pink
DKS/H/98/013	92.5	5.2	1.51	87.06	6.74	5.42	1.37	1.01	13.0	Pink

Vegetative propagation

Mission C: Rapid multiplication of propagules of fruit crops.

At CIAH, Bikaner

Propagational studies in arid fruits

To standardize vegetative propagation in arid fruits some experiments were initiated on aonla and *lasora* through budding and pomegranate and *ker* through cuttings. In case of *lasora* (*Cordia myxa*), budding was done at 15 days interval on the *desi* rootstocks raised in nursery. Data presented in table 7 indicated that the 15th August is the best time for budding followed by July, 30th August, 15th September, 30th September, respectively. The highest percentage success was obtained at the middle of August (93.5%), though budding can be done starting from middle of July to end of August with more than 80% success. The length of sprouts and number of shoots were also better at 15th August budding. Thus, it is recommended that the promising *lasora* types can be propagated by budding in the middle of August.

Table 7. Effect of time of budding on the percentage success, length of sprout and number of shoots in *lasora* at 90 days after budding.

Time of budding	Budding success (%)	Length of sprout (cm)	Number of shoots
15th July	82.26	15.33	3.00
30th July	82.26	15.00	3.00
15th August	95.59	15.67	3.00
30th August	80.04	13.33	2.33
15th September	35.57	8.67	1.67
30th September	11.12	7.67	1.33

In case of *ker* (*Capparis deciduas*), attempts were made to propagate them by semi hard wood cutting with the use of different growth hormones under shade net house. It was found that about 50% success can be obtained when cutting were treated with 7000 ppm IBA+1000 ppm Thymine in the month of September.

The experiment was also laid out in case of aonla (*Emblica officinalis*), to see the effect of different filling mixtures i.e. sandy soil (control), sandy soil + sheep manure, sandy soil + FYM, sandy soil + compost, sandy soil + pond soil + compost in different ratios and different size of polycontainers i.e. 8x15 cm, 25x15 cm., 10x25 cm and 10x25 cm (tube) on budding success and establishment under field conditions. The experiment is under progress. Similarly, in case of pomegranate (*Punica granatum*) the cutting were planted at monthly intervals by treating with 2500 ppm and 5000 ppm IBA as quick dip and 50, 100 and 200 ppm IBA as prolonged dip method. The observations are under progress.

Growth and development

Mission D. Growth and development of horticultural crops under abiotic stresses

At CIAH, Bikaner

D.1 Studies on growth and development of some cucurbit crops under water stress

D.1.1 Effect of water stress on growth and development of *mateera* and watermelon

i) Dry matter allocation under water stress

An experiment was planted in field, using randomized block design, to evaluate the effect of water stress on growth and development of mateera and watermelon. In all 4 irrigation treatments were given viz. 2,4,6 and 8. Observations on plant dry matter distribution was recorded at periodic interval viz. 45, 60, 75 and 90 days after sowing. The data is presented in Table 8 & 9.

Perusal of data reveals that dry matter partitioning to root was more under 8 irrigations at 45 days after planting. This is illustrated by the fact that under 8 irritation the dry matter allocated to root was 20.07 and 21.76% respectively in AHW-65 and AHW-19. However, under other irrigation levels, the allocation to root was less at same day of harvesting.

Perusal of tables reveals that 90 days after sowing more dry matter is allocated to leaves under different irrigation treatments in both the cultivars of mateera. The allocation is as high as 45-60% whereas root gets the lowest allocation amounting to 3-8%. The characteristic feature encounter here is that under water stress (2 irrigation) more dry matter is allocated to root (6.01% in AHW-65 and 8.69% in AHW-19) (Table 8).

Similar comparison in water melon demonstrates that at full maturity (90 days) maximum share of dry matter is allocated towards leaves. It ranges between 54-67%. The root gets very less share (2-8%). The root dry matter remains fairly constant under different treatments (Table 9).

Table 8. Percentage dry matter distribution in mateera under different levels of irrigation

Varieties	8 Irrigation				6 Irrigation				4 Irrigation				2 Irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
AHW-65																
Stem	29.28	31.77	25.71	44.88	34.98	33.26	31.44	50.04	18.63	32.15	31.87	27.45	36.09	33.63	35.31	42.23
Leaf	50.64	62.45	70.99	50.11	40.73	62.26	64.45	45.76	56.60	61.91	64.34	66.70	58.74	57.06	61.95	51.74
Root	20.07	5.76	3.29	5.00	24.28	20.49	4.10	4.18	24.75	5.93	3.78	5.83	5.15	9.30	2.73	6.01
AHW-19																
Stem	13.70	35.05	35.71	40.93	29.71	41.30	31.96	46.79	31.70	27.51	34.75	45.38	27.76	36.69	29.00	46.37
Leaf	64.53	61.85	61.99	55.70	65.32	53.76	65.84	50.09	56.09	66.93	62.50	49.78	64.14	58.82	66.32	44.92
Root	21.73	3.09	2.31	3.35	4.95	4.93	2.29	3.10	12.19	5.55	2.77	4.71	8.08	4.48	4.67	8.69

*Days after sowing

Table 9. Percentage Dry matter partitioning in Watermelon under different levels of irrigation

Varieties	8 Irrigation				6 Irrigation				4 Irrigation				2 Irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
MHW-102																
Stem	21.69	-	34.25	39.29	26.37	28.91	31.41	34.15	38.88	34.81	-	36.16	33.42	30.85	28.76	38.21
Leaf	73.57	-	60.50	57.66	70.43	68.29	64.48	63.25	54.32	51.16	-	61.48	58.69	64.05	67.34	58.34
Root	4.73	-	5.25	3.03	3.18	2.78	4.10	2.57	6.79	14.01	-	2.41	7.88	5.08	3.76	3.48
Sugar Baby																
Stem	20.27	26.21	28.72	27.61	28.45	31.97	43.20	43.90	22.50	26.83	28.19	28.14	20.90	26.31	21.07	21.07
Leaf	75.94	70.51	69.20	70.26	64.25	62.34	54.21	53.29	72.31	68.49	69.34	69.60	62.05	69.89	76.58	76.58
Root	3.63	4.28	2.60	2.12	7.3	5.68	2.59	2.80	5.19	4.66	2.46	2.25	17.03	3.80	2.34	2.34

*Days after sowing

ii) Photosynthetic activity under water stress

In the same experiment, the rate of photosynthesis, transpiration rate and water use efficiency was estimated using LICOR 6200 Infra Red Gas Analyzer. It was observed that at full irrigation level, the rate of photosynthesis is higher in water melon than in mateera. However, with the imposition of water stress, the magnitude of photosynthesis decline in both, but the decrease in rate of photosynthesis is much higher in water melon than that in mateera. This is illustrated by that fact that in water melon the rate of photosynthesis, drops to 0.94 mg CO_2/m^2/Sec under 2 irrigation. Similarly, in mateera the rate of photosynthesis was 1.175 mg CO_2/m^2.sec under 8 irrigations which dropped to only 0.74 mg CO_2/m^2/sec. Similar trends were observed in transpiration rates too (Table 10).

Table 10. Photosynthesis, transpiration and water use efficiency in mateera & watermelon.

Irrigation	Mateera			Water melon		
	Pn	Tr.	WUE	Pn	Tr.	WUE
8	1.175	0.966	1.21	1.84	1.407	1.31
6	0.927	0.552	1.67	1.31	0.733	1.78
4	1.023	0.608	1.68	0.82	0.475	1.73
2	0.740	0.480	1.54	0.94	0.529	1.77

Pn= mg CO_2/m^2/s., Tr.= mg/m^2/s.

iii) Identification of screening parameters

An attempt was made to identity & develop screening parameters for drought resistance. Among large number of parameters available to screen the germplasms 2 viz. plant height stress index (PHSI) and dry matter stress index (DMSI) was tested. It was noted that both the parameters hold good in screening germplasm for drought resistances. For instance in mateera (drought resistant material) the value remained more than 90% whereas it dropped to less than 57% in watermelon (drought susceptible cultivars). Thus, by using either of these parameters, the germplasm can be screened (Table 11).

Table 11. Plant height stress index (PHSI) and dry matter stress index (DMSI) in different cultivars of mateera and water melon

Lines	PHSI	DMSI
Mateera		
AHW-19	96.55	98.63
AHW-61	97.01	85.62
Water melon		
MHW-102	48.24	29.46
Sugarbaby	46.81	57.44
MHW-11	36.65	31.11

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

Analysis of photosynthetic parameters was undertaken in 30 cultivars of ber. The observations were recorded at 11 AM, 1PM and 3 PM and parameters studied were relative water content, stomatal conductance, transpiration, Internal CO_2 concentration, photosynthetic rate, carboxylation efficiency and physiological water use efficiency. Based on the values obtained on above parameters, the cultivars were classified variously. On the basis of photosynthetic activity, the cultivars were divided into 2 groups viz. i) showing mid day depression and, ii) do not show mid day depression (Table 12). Perusal of table reveals that cvs. Kathali, Narma, Katha phal, Sanaur 5, Luddu, Seo, Khark 1, Bedami etc. shows mid day depression whereas most of the commercial cultivars such as Gola, Umran, Seb, Banarsi pewandi, Banarsi kadaka, Mundia, Kakrol Gola, Dandan, Alwar desi, Noki, etc. do not exhibit mid day depression.

Similarly, the cultivars under study were also classified on the basis of carboxylation efficiency into high and low groups. Based on this cultivars such as Seb, Banarsi pewandi, Banarsi kadaka, Kaithali, Mundia, Dandan, etc. has high carboxylation efficiency. Whereas cvs. Such as Gola, Umran, Narma etc. had low efficiency (Table 13).

Similarly, on the basis of water use efficiency, the cultivars were divided into 3 groups viz. low, medium and high. Among the cultivars studied, Ladu, Alwar desi, Manuka, Govind garh, Kakrol gola, Noki etc. had high water use efficiency whereas Seo, Reshmi, Badami, etc. had low (Table 14).

The cultivars which rated best on the basis of above classification were further plotted on Venne diagram to select the cultivars which are best on all above parameters. It was observed that cvs. Seb, Banarsi pewandi, Banarsi kadaka, Mundia, Dandan, Alwar desi, Govind garh, special, and Kala gola were best on the basis of above parameters. It is was therefore suggested that these cultivars may prove to be ideal for arid ecosystem (Fig. 1).

Table 12. Classification of ber cultivars on the basis of photosynthetic activity

Showing mid day depression	Kathali, Narma, Katha Phal, Sanor 5,Laddu,Manuki, Maharwali, Thornless, Khira, Gularvasi, Seo, Kharki 1, Badami
Don not show mid day depression	Gola, Umran, Seb, Banarsi Pewandi, Banarsi Kadaka, Mundia, Kakrol Gola, Dandan, Alwar Desi, Govindgarh Special, Kala Gola, Gola Hisar, Noki, BS 75-1, B-51, Gola Gurgoan, Chonchal, Illaichi, Chhuhara, Bagwadi, Reshmi

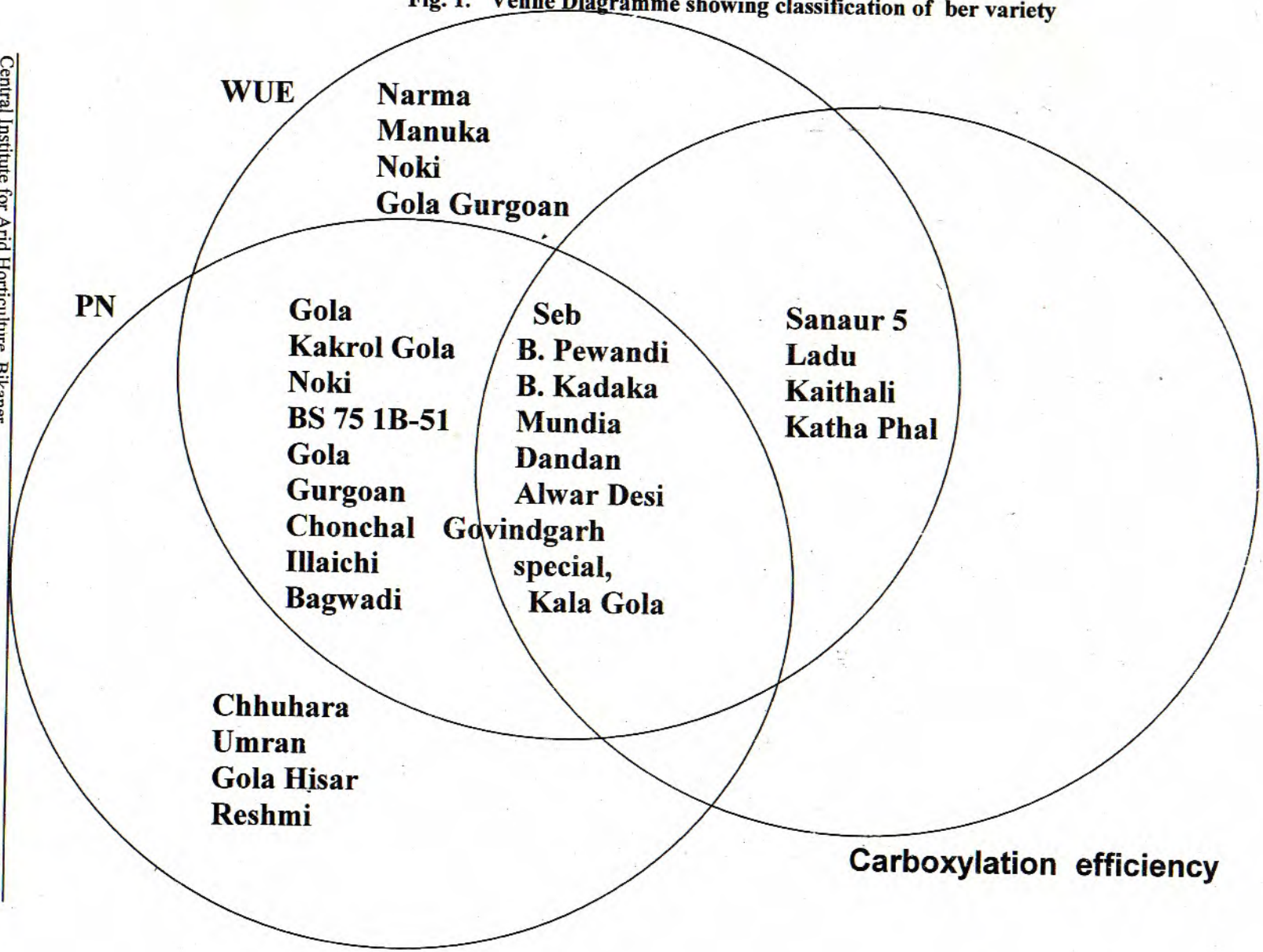
Table 13. Classification of ber cultivars on the basis of Carboxylation efficiency

High (more than 0.1)	Seb, Banarsi Pewandi, Banarsi Kadaka, Kaithali, Mundia, Katha Phal, Dandan, Sanor 5, Laddu, Alwar Desi, Govindgarh Special Kala Gola
Low (Less than 0.1)	Gola, Umran, Narma, Kakrol Gola, Manuki, Maharwali, Thornless, Khira, Gularvasi, Gola, Gola Hisar, Seo, Noki, BS 75-1, B-51, Gola Gurgoan, Chonchal, Kharki No1, Badami, Illaichi, Chhuhara, Bagwadi, Reshmi

Table 14. Classification of ber cultivars on the basis ofWater use efficiency

Low (less than 1.0)	Umran, Maharwali, Thornless, Khira, Gularvasi,Gola Hisar, Seo, Kharki No. 1, Badami,Chhuhara, Reshmi
Medium (1.0-2.0)	Gola, Seb, Banarsi Pewandi, B. Kadaka, Kathali, Mundia, Narma, Kakrol Gola, Katha Phal, Dandan, Sanor 5, Illaichi, Bagwadi
High (More 2)	Laddu, Alwar Desi, Manuki, Govindgarh Special, Kala Gola, Noki, BS 75-1, B-51, Gola Gurgoan, Chonchal

Fig. 1. Venne Diagramme showing classification of ber variety



Water management

Mission E: Water management in arid horticultural crops

At CIAH, Bikaner

E. 1. Standardization of technique for measuring plant water status and evaluation of water requirement of different horticultural crops.

During the period 2000-2001, confirmation of last year 1999-2000 results was undertaken. The same experiment was repeated using plants of pomegranate var. *Jalore seedless*. Only three techniques viz. thermocouple psychrometer method, liquid equilibration technique and relative water content methods were used for measuring plant water status during the month of June and October. 2000. The plants were fully irrigated and from 3rd day onwards observation were recorded at an interval of 3 days. The results that obtained are presented in Table 15. During June, 2000 thirty days drying cycle, the predawn leaf water potential declined from –0.92 to –1.44MPa in psychrometric method while it declined from –1.05 to –1.40 MPa in liquid equilibration method. During this period, in initial phase (3rd to 9th) the change in leaf water potential (Ψleaf) was very slow, and thereafter it demonstrated steep fall in the magnitude. The change in relative water content was slow in initial stage (3rd to 9th) subsequently, there was reduction in RWC and it declined from 78.4 to 63.1% during the whole experimental period.

In the month of October 2000, the decline in leaf water potential (Ψleaf) was – 0.86 and –1.05 to –1.25 and 1.40 MPa in psychrometer and liquid equilibration methods, respectively. During this month, the change in leaf water potential (Ψ leaf) was gradual in psychrometric method throughout the experimental period when the same was estimated through liquid equilibration method, minor fluctuation were recorded during experimental period. The RWC dropped from 77.6% to 65% during the 30 days drying cycle.

Thus, comparison of three methods viz. thermocouple psychrometer, liquid equilibration and relative water content method demonstrated that psychrometric method is more sensitive and easy to measure. It was observed that leaf water potential lowers with increase in duration of drought period. However, magnitude of decrease in water potential was more in summer month as compared to winter. On re-watering, leaf water potential and relative water content recovered fully in both the months.

Table 15. Plant water status in pomegranate (Cv. Jalore Seedless) as measured by different techniques during drying cycle in the month of June and October, 2000

Techniques	June, 2000									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
Psychrometer method (MPa)	-0.92	-0.94	-0.98	-1.04	-1.18	-1.28	-1.32	-1.33	-1.39	-1.44
Liquid equilibration method (MPa)	-1.05	-1.10	-1.10	-1.15	-1.20	-1.20	-1.20	-1.30	-1.40	-1.40
Relative water content (%)	78.6	76.5	75.8	72.5	70.0	69.5	66.2	64.3	64.0	63.1

Techniques	October, 2000									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
Psychrometer method (MPa)	-0.86	-0.91	-0.92	-0.95	-1.05	-1.09	-1.20	-1.22	-1.24	-1.25
Liquid equilibration method (MPa)	-1.05	-1.10	-1.10	-1.20	-1.20	-1.20	-1.25	-1.30	-1.40	-1.40
Relative water content (%)	77.6	76.5	74.8	73.5	72.0	70.5	69.2	68.3	66.0	65.1

Integrated nutrient management

Mission F: Integrated nutrient Manage- ment in horticultural crops

At CIAH, Bikaner

F.1 Response to substitution of manures and fertilizers with vermi-compost in the growth and production of fruit crops.

F 1.1 Growth and production of pomegranate (*Punica granatum*) fruit crop with organic and inorganic farming.

The recommended doses of NPK (500g N, 200g P and 100g K) per plant per year were applied through 10 treatments along with control (N_0, P_0, K_0). The treatments comprised of i) sheep manure (SM) @ 16 kg/plant; ii) cattle manure (CM) 22 kg/plant; iii) vermi-compost @ 10 kg/plant; iv) inorganic fertilizers (IF) through urea, single super phosphate and muriate of potash; v) CM:SM in 50:50 ratio; vi) CM:VC in 50:50 ratio; vii) CM:IF in 50:50 ratio; viii) SM:VC in 50:50 ratio ix)SM:IF in 50:50 ratio; x) VC:IF in 50:50 ratio and xi) control (NoPoKo) in the month of May, 2000. The growth parameters like plant height, plant spread and tree volume was recorded in every month. The leaf sample for nutrient analysis were collected in the month of August, 2000 and analyzed for N, P, K, Ca, Mg, Zn, Cu, Mn & Fe nutrients following the standard procedures. The physiological activities of the plant were measured during fruiting stage and soil moisture contents were measured to monitor the moisture retention in different treatments.

Plant growth

Although growth data was measured every month but in report the data measured in the month of July and October 2000 have been presented. In the month of July 2000, the mean plant height data was in the range of 0.90 to 1.55 m and maximum plant height was recorded in T_3 treatment and it was statistically at par with T_1, T_5, T_6, T_8 and T_{10} treatments, while in the month of October, 2000, the maximum plant height (1.69 m) was recorded in T_{10} treatment and this plant height was statistically at par with T_1, T_2, T_3, T_5, T_6, T_7, T_8 and T_9 and only in T_4 and T_{11} the growth was not much good as in others.

The tree volume was also measured in every month and in report the data pertain to July and October, 2000 months have been given. The data presented in table 13 revealed that maximum tree volume (2.25 m^3) was recorded in T_{10} followed in T_1, T_3 while in other treatments tree volumes were in lower side during the month of July, 2000. In the month of October 2000, the tree volume was in the range of 0.90 to 2.54m^3 and maximum tree volume was estimated in T_{10} and followed in T_3, T_6 and T_1, respectively (Table 16).

Fruit yield

The data pertain to average fruit yield $plant^{-1}$ have been presented in Table 16. The data revealed that fruit yield was found in the range of 2.3 to 5.5 kg $plant^{-1}$. The maximum and significantly higher fruit yield was recorded in T_3 treatment and which was statistically at par in T_8, T_{10} treatments and minimum fruit yield was recorded in control treatments.

Leaf mineral composition

The data regarding leaf mineral composition are given in Table 17. The data revealed that the nitrogen content was in the range of 1.50 to 2.25% and maximum N content was recorded in T_{10} and minimum in T_{11} treatment. The P content was in the range of 0.18 to 0.28%. The maximum P content was estimated in T_3, T_6 and T_8 treatments. Except control treatment, other treatments were having the P content near to the maximum P content. The K content was found in the range of 1.30 to 1.54% and maximum K content was recorded in T_3 treatment and minimum K content was estimated in control treatment. The calcium and magnesium contents were not differed much with regards to different treatments, however, calcium was in the range of 2.00 to 2.71% and magnesium was in the range of 0.20 to 0.31%. Among the micronutrients, Zn, Cu, Mn and Fe contents were measured and data presented in Table 17 revealed that zinc was in the range of 23 to 35 ppm and maximum Zinc content was measured in T_5 and T_8 treatment and minimum in control (T_1) treatment. The copper contents were more or less same in all treatments. The manganese contents were in the range of 38 to 52 ppm and iron was in the range of 50 to 72 ppm. The maximum iron content was observed in T_{10} and T_7 treatment while minimum was in control treatment.

Physiological activity

The physiological parameters like photosynthetic activity, transpiration rate, water use efficiency, stomatal conductance and stomatal resistance were measured during fruiting stage. Data given in Table 18 revealed that photosynthetic activity (P_N) was recorded in the range of 0.3584 to 0.5800 mg CO_2 m^{-2} s^{-1}. The maximum P_N activity was recorded in T_8 followed in T_6 (0.5762 mg CO_2 $m^{-2}s^{-1}$), T_3 (0.5756 mg CO_2 $m^{-2}s^{-1}$). The minimum activity (0.3256 mg CO_2 m^{-2} s^{-1}) was recorded in T_4 treatment.

The transpiration rate was recorded in the range of 1.100 to 1.460 mg H_2O m^{-2} s^{-1}. The mean maximum transpiration rate (1.440 mg H_2O $m^{-2}s^{-1}$) was recorded in T_{11} treatment followed in T_1 (1.382 mgH_2O $m^{-2}s^{-1}$) and T_8 and T_6 treatments (Table 15) and minimum water transpired (1.12 mg H_2O m^{-2} s^{-1}) was in treatment T_{10} followed in T_2 and T_6 treatments. The maximum water use efficiency (45.78%) was estimated in T_{10} treatment followed in T_3, T_6, T_8 and T_1 treatments. The minimum water use efficiency was found in T_{11} control treatment.

The stomatal resistance was found in the range of 0.446 to 0.570 s cm^{-1}. The minimum stomatal resistance was observed in T_3 followed by T_8 and T_{10} treatment and maximum resistance was found in T_4 followed by T_9 treatments. Stomatal conductance was in the inversely proportionate to resistance values and stomatal conductance was observed in the range of 1.75 to 2.24 cm s^{-1}.

Soil moisture status

The soil moisture status was measured in different treatments on 3rd, 5th and 7th day after irrigation on alternate months. The mean moisture data have been presented in Table 19. It was noticed that on 3rd day after irrigation soil moisture was in the range of 11.2 to 18.2% and maximum moisture content was measured in T_6 followed in T_8 and T_1 treatment while minimum soil moisture content was observed control T_{11} treatment. On 5th and 7th day trend in soil moisture content with respect to different treatments was almost same as it was on 3rd day and on 7th day and the soil moisture content was in the range of 8.1 to 12.5%. The depletion in moisture was more and fast in control and inorganically fertilized treatments while in organically treated cases, the depletion was slow and gradual. Thus organic material

helped in checking soil moisture losses especially in root zone.

Physico-chemical properties of Pomegranate fruits

The fruit weight, total soluble solids (TSS), acidity and TSS/acidity parameters of mature fruits were recorded at harvesting time. Data related to these parameters are presented in Table 20. The fruit weight was recorded in the range of 90 to 220 gm/fruit and maximum fruit weight was recorded to T_3 followed in T_8 and T_{10} treatments and minimum fruit weight was observed in control treatment. The total soluble solid (TSS) did not differed much in different treatment and found in the range of 13.00 to 14.00 °Brix. The acidity of fruit juice was in the range of 0.16 to 0.25% and minimum acidity was measured in T_3 and T_{10} treatments and maximum acidity was in control treatment. TSS/Acidity ratio was also calculated and maximum ratio (93.33) was observed in T_6 and T_8 treatment followed in T_3 and T_{10} treatments and minimum ratio (48.0) was calculated for T_{11} (Control) treatment.

Table 16. Effect on plant growth to different sources of manures and fertilizers

Treatment	Plant height (cm)		Tree volume (m^3)		Fruit yield (kg $plant^{-1}$)
	July	October	July	October	
SM	1.48	1.65	2.20	2.40	4.0
CM	1.29	1.48	1.68	1.85	3.8
VC	1.55	1.72	2.20	2.55	5.5
IF	1.20	1.32	1.25	1.45	3.0
CM:SM	1.38	1.54	1.80	2.00	4.0
CM:VC	1.43	1.58	2.28	2.45	4.8
CM:IF	1.26	1.48	1.70	1.88	3.5
SM:VC	1.36	1.58	1.68	2.06	5.3
SM:IF	1.29	1.50	1.60	1.88	3.8
VC:IF	1.49	1.69	2.25	2.54	5.2
Control	0.90	1.00	0.75	0.90	2.3
SE±	0.09	0.10	0.12	0.13	0.20
CD (5%)	0.20	0.24	0.28	0.34	0.54

Table 17. Effect on plant growth to different sources of manures and fertilizers

Treatment	Macronutrients					Micronutrients			
	N	P	K	Ca	Mg	Zn	Cu	Mn	Fe
	(%)					(ppm)			
SM	1.85	0.24	1.42	2.50	0.25	31	4	48	62
CM	1.78	0.24	1.38	2.45	0.23	28	4	42	59
VC	2.10	0.28	1.54	2.71	0.31	34	4	54	70
IF	1.70	0.26	1.40	2.25	0.23	30	3	35	60
CM:SM	1.80	0.24	1.40	2.45	0.26	32	4	42	70
CM:VC	1.98	0.28	1.49	2.65	0.30	35	4	49	58
CM:IF	1.74	0.25	1.38	2.45	0.28	30	3	40	72
SM:VC	2.12	0.28	1.48	2.68	0.31	35	4	52	58
SM:IF	1.80	0.23	1.40	2.45	0.24	28	3	42	45
VC:IF	2.25	0.25	1.45	2.55	0.30	32	4	50	72
Control	1.50	0.18	1.30	2.00	0.20	23	3	38	50

Table 18. Effect of manure and fertilizers on physiological activity of pomegranate plant

Treatments	PN ($mgCO_2m^{-2}s^{-1}$)	Transpiration rate ($mg\ m^{-2}\ s^{-1}$)	Water use efficiency (%)	Stomatal resistance ($s\ cm^{-1}$)	Stomatal conductance ($c\ ms^{-1}$)
SM	0.5698	1.382	41.23	0.522	1.92
CM	0.5023	1.268	39.61	0.528	1.89
VC	0.5756	1.272	45.25	0.446	2.24
IF	0.3256	1.320	24.67	0.574	1.74
CM:SM	0.5368	1.350	39.76	0.540	1.85
CM:VC	0.5762	1.335	43.16	0.468	2.14
CM:IF	0.4405	1.265	34.82	0.570	1.75
SM:VC	0.5800	1.354	42.84	0.462	2.16
SM:IF	0.4875	1.258	38.75	0.542	1.85
VC:IF	0.5164	1.128	45.78	0.462	2.16
Control	0.3584	1.440	24.89	0.552	1.81

Table 19. Soil moisture pattern as influenced by different treatments

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

Table 20. Physico-chemical properties of pomegranate as affected by different treatments

Treatment	Fruit weight (g)	TSS (°brix)	Acidity (%)	TSS/Acidity ratio
SM	160	13.00	0.18	72.22
CM	150	13.00	0.18	72.22
VC	220	14.00	0.16	87.50
IF	120	13.00	0.22	59.09
CM: SM	160	13.00	.18	72.22
CM:VC	190	14.00	0.15	93.33
CM:IF	140	13.00	0.20	65.00
SM:VC	210	14.00	0.15	93.33
SM:IF	150	12.00	0.19	63.16
VC:IF	210	14.00	0.16	87.50
Control	90	14.00	0.25	48.00

At CHES, Godhra

F. 2 Standardisation of agro-techniques of some semi arid fruits

F. 2.1 Effect of organic and inorganic source of N on growth, yield and quality of pomegranate cv. Ganesh.

Fertilizer doses as per treatment details were applied during third year of growth of plants. Data was recorded on various aspects of plant growth and Nitrogen content of leaves revealed that there were significant differences amongst the treatments. Maximum plant height (1.52m) was recorded in application of Nitrogen 100 % in the form of castor cake. It was least in control (1.22m) one month after application of the dose. Similar trend was observed in case of stem diameter. It was 20.64mm in 100% N in organic farm and 15.18 mm in control. North-South plant spread was however, highest in 50% organic N and 50% inorganic N (1.42m). East-West plant spread was maximum (1.38m) in 75% organic and 25% inorganic N after one month of fertilizer application. Similar results were obtained after 3 month of fertilizer application. Recording of data on growth parameters after three months of fertilizer application showed non significant differences in respect of plant height and stem diameter, However, significant differences were observed in respect of North-South and East- West plant spread.

Leaf N content was found to increase one month after fertilizer application however, it was reduced after 3 months. Leaf Nitrogen content analysis carried out one month after application was found to be significantly influenced by the treatments. N content was minimum in control (1.86 %) and was maximum in 25 % FYM + 25 % Organic and 50 % Inorganic (2.67 %).

F 2.2 Effect of bio-fertilizers on growth yield and quality of pomegranate cv. Ganesh.

Experiment on Bio-fertilizer application was initiated during the year by application of differential doses of Bio-fertilizers. Observations recorded on three year old plant revealed that plant height and plant spread was significantly influenced by application of different doses of Bio-fertilizers. However, plant diameter was found to be non significant. Plant height was maximum in phosphate culture (1.46 m) and was least in control (1.21 m) one month after application of bio-fertilizers.

Plant diameter though non-significant was maximum in Phosphate culture and was least in control. Plant spread was significantly influenced by differential doses. It was maximum in Phosphate culture and was least in control in both North-South and East-West spread. Similar trend was recorded after three month of growth in respect of all characters.

Nitrogen content of Phosphate leaves sampled one month after application of Bio-fertilizers showed that Nitrogen content ranged from 2.16% to 2.59 %. Leaf analysis carried out three month after Bio-fertilizer application was found to be significant and maximum N content 2.3% was recorded in Azospirillium culture closely followed by Phosphate culture.

F 2.3 High density planting in ber

Data recorded on high-density plantation with four varieties of *ber* viz. Umran, Gola, Seb, Mundia with 3 spacing reveled that there were significant difference in respect of varieties with regard to plant height. It was maximum in Seb (2.99m) and was least in Mundia (2.46m). Spacing did not had effect on the height of the plant. Also

interaction was found to be non-significant. Scion diameter was found to be not affected by varieties however, spacing had significant effect. It was maximum in 10x10 m spacing and was least in 5x5 m spacing. Interaction of variety and spacing was non-significant. Stock diameter was found to be not affected by either variety or spacing. However, it was maximum in 10x10 m spacing and least in 5x5 m spacing. Plant spread both North-South and East-West was found to be significantly affected by varieties. In respected of spacing, East-West spread was significantly affected. Maximum East-West spread was recorded in Gola (4.92 m) and minimum in Mundia (3.61 m). It was maximum (4.53m) in 10x10 m spacing and minimum(3.97 m) in 5x5 m spacing. In case of North-South spread only varieties influenced the spread. It was maximum in Gola (4.77 m) and was least in Mundia (3.73 m).

Yield / plant was found to be influenced by both variety and spacing. Maximum yield per plant was recorded in Umran (35.70 kg) and was least in Mundia (26.88 kg). Maximum yield per plant was obtained in 10x10 m spacing. It was 28.70 kg in 5x5 m spacing. Fruit weight was found to be not affected by either variety or spacing. However, it was maximum in Seb in 10x10 m spacing. Maximum fruit length was observed in variety Mudia (37.24 mm). It was least in Gola (29.25 mm). Fruit diameter was found to be not influenced either by variety or by spacing. it was maximum in Gola and least in Mundia. pulp stone ratio and T.S.S. were significantly influenced by varieties and not by spacing . Pulp stone ratio was maximum in Umran (19.81) and was least in Seb (8.50).Total Soluble Solid content was maximum in Umran (20.78) and was least in Seb (15.62).

F 2.4 Nutrient management in fruit crops Aonla & Sapota.

A leaf sampling survey has been carried out in Gujarat for establishing DRIS norms. Apart from this an experiment consisting of various doses of N, P and K on sapota variety Kalipatti is in progress.

Plant protection

Mission I. Integrated pest and disease management in arid zone horticultural crops

At CIAH, Bikaner

I.1 Studies on biological control of major diseases in arid fruits and vegetables

In continuation of works in this project, different substrates were evaluated for the growth and multiplication of different isolates of *Trichoderma* spp. The overall results revealed that the *Trichoderma* isolate CIAH-225 followed by CIAH-240 were grown rapidly in irrespective of substrates tested (Table 21). Maximum growth and sporulation of different isolates of *Trichoderma* spp were observed in soil incorporated with *Prosopis* pod powder. Liquid phase of *Prosopis* pod power was also highly favorable for mycelia growth and sporulation of some of the isolates and the results were comparable with the standard medium i.e potato dextrose broth (Table 22 & Fig 2). The dry weight of mycelium was ranging from 268mg to 1028mg per 100ml. Quantitative assessment of conidial population of *Trichoderma* isolates depicted that the powder form of Prosopis yielded maximum number of conidia ($53x10^4$ cfu/g of soil) of isolate CIAH-225 while isolate CIAH-142 was poor in growth and sporulation. *Trichoderma* isolates were also tested for their growth performance under different levels of pH and it is clear from table 23 that the alkali levels (pH 8 to 9) were most suitable for the growth and sporulation of CIAH-142 and CIAH-186 than CIAH-181a. This unique advantage of alkali loving native isolates of *Trichoderma* would be useful for managing the diseases under similar conditions.

Table 21. Quantitative assessment of *Trichoderma* spp isolates in different substrates

Substrates	Isolates of *Trichoderma* spp							
	89	142	149	151	181a	186	255	240
Farm Yard Manure	--	--	--	6.8	7.2	--	8.7	11.6
Sheep Manure	5.0	4.2	--	--	16.0	3.3	11.8	15.1
Vermicompost	--	9.0	--	3.1	34.4	5.3	29.0	7.9
FYM+Vermicompost	--	--	--	5.0	13.3	--	13.6	11.0
Sand Maize	28.4	13.5	29.3	26.0	42.0	31.5	41.0	24.0
Soil+Prosopis	36.9	15.0	15.0	32.3	40.5	48.0	53.0	18.6

Value are means of 4 replicates; Values are colony forming units x 10^4 per gram of soil

Table 22. Growth of *Trichoderma* spp isolates in different Media

Trichoderma isolates	Potato Dextrose Broth		Potato Prosopis Broth	
	Dry weight (mg/100ml)	Sporulation	Dry weight (mg/100ml)	Sporulation
CIAH-89	623	+++	413	+
CIAH-142	443	-	416	++
CIAH-149	268	++	205	-
CIAH-151	565	++	515	++
CIAH-181a	711	++	732	+++
CIAH-186	1028	++	779	-
CIAH-225	612	+++	662	+++
CIAH-240	592	+++	658	+

Values are means of 4 replicates + : Less ; ++ : Moderate; +++ : High

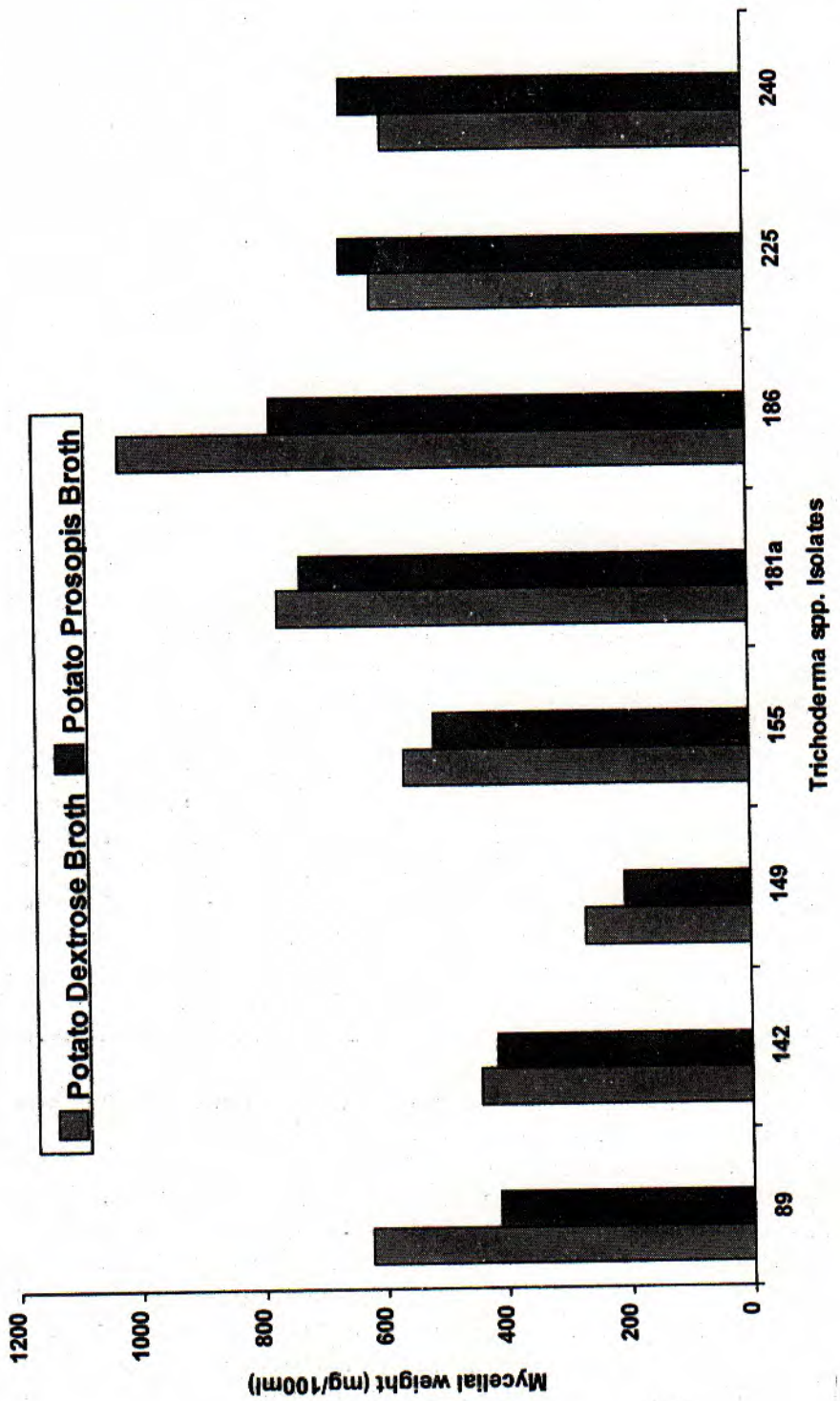


Fig 2. Growth of *Trichoderma* spp Isolates in Liquid Media

Table 23. Growth and sporulation of *Trichoderma* isolates in different pH levels

	Trichoderma isolates					
	181a		186		142	
PH levels	Growth	Sporulation	Growth	Sporulation	Growth	Sporulation
4	40	+	105	+	60	+
5	58	+	138	+	88	+
6	115	+	186	+++	85	+
7	139	+++	214	+++	153	++
8	85	+++	210	+++	160	++
9	76	++	231	++	111	-
10	62	-	190	-	96	-

Values are menas of 4 replicates : +: Less ; ++: Moderate; +++ : High

I. 2. Introduction, collection, conservation, characterization and evaluation of fruits and vegetable crops in hot arid environment.

I. 2.1 Ber

Powdery mildew of *ber* was not recorded during last three years due to unfavorable environmental conditions. Therefore evaluation of *ber* genotypes against this major disease has not been carried out. However, fruit rots of *ber* were found an emerging problem in *ber* orchards under arid regions of Rajasthan. Consistent observations on natural incidence of fruit rots in *ber* germplasm repository revealed varying proportion of fruit rot incidence. Out of 315 genotypes evaluated, 62 were having less than 5% incidence followed by 50 genotypes with 5-10% incidence. One hundred and sixty genotypes were free from fruit rot infection and 43 genotypes were not evaluated due to lack of fruits. Similarly out of 18 lines of *ber*, 14 were free from fruit rot infection and 2 were not attained fruiting. Further studies are under progress to combat this disease through integrated disease management strategies.

I. 2.2 Pomegranate

Evaluation of pomegranate germplasm showed that out of 47 genotypes, none of them was found to be resistant against leaf spots under natural incidence. Conversely, there was no highly susceptible genotypes also. Nineteen genotypes were susceptible and 28 were moderately susceptible to fungal leaf spots. There was no incidence of bacterial leaf spot during the reporting period.

I. 3 Evaluation of chilli lines against diseases

Chilli lines including 41 lines of AHM, 3 lines from Guntur Mathania and 7 lines from Aruppukottai were evaluated against diseases. All lines of chilli from AHM and Guntur Mathania were infected by viral diseases. Lines 1 and 2 from Aruppukottai were also affected by this disease. Line AHM 89a was completely affected by leaf curl virus

and lines AHM-33 showed 50% incidence. Minimum percent incidence (9.3) of virus diseases was recorded in line AHM-59. In some lines there was mixed infection of chilli mosaic and leaf curl virus. Root rot was also found in almost all lines except AHM-57, AHM-80 and AHM-89a of chilli. However, the percent incidence of this disease was less than 30% except AHM-131 having 44% incidence (Table 23).

Table 24. Per cent disease incidence in chilli lines

Chilli Lines	Root Rot (%)	Virus Diseases (%)
AHM-15	7.7	12.8
AHM-24	3.9	21.6
AHM-25	6.7	21.6
AHM-27	9.8	12.2
AHM-28	11.1	18.5
AHM-31	7.6	33.0
AHM-33	15.6	50.0
AHM-35	6.7	40.0
AHM-37	3.8	25.0
AHM-39	7.4	22.2
AHM-56	1.9	20.4
AHM-57	0.0	14.8
AHM-58	10.3	18.9
AHM-59	11.3	9.3
AHM-63	16.0	20.0
AHM-64	25.0	19.4
AHM-65	14.7	26.4
AHM-75a	3.8	19.2
AHM-76	20.0	40.0
AHM-80	0.0	33.3
AHM-82a	12.5	18.8
AHM-82b	3.7	22.2
AHM-84	12.5	37.4
AHM-86	4.4	29.0
AHM-87	18.0	16.6

AHM-88	29.2	25.0
AHM-89	21.8	20.0
AHM-89a	0.0	100
AHM-90	22.2	33.3
AHM-91	12.5	25.0
AHM-92	4.0	24.0
AHM-93	11.3	18.3
AHM-94	25.0	33.0
AHM-97	14.2	28.5
AHM-101	18.1	45.5
AHM-103 .	13.3	40.0
AHM-104	30.0	25.0
AHM-113	16.7	27.8
AHM-114	5.9	17.6
AHM-116	8.8	17.4
AHM-131	44.0	33.3
Guntur Mathania		
L-1	7.1	21.0
L-2	14.2	14.2
L-3	22.0	22.0
Aruppukottai		
1	16.7	33.3
2	20.0	10.0
3	20.0	0.0
4	16.6	0.0
5	14.3	0.0
6	28.6	0.0
7	12.0	0.0

At CHES, Godhra

I. 4 Studies on the fungal diseases of semi-arid fruit crops (Ber, Pomegranate, Aonla and Custard apple.)

Studies on the multiplication of the VAM fungus : *Glomus mosseae* was grown on roots of various hosts. The results indicated that maize was the most suitable host which colonised about 70 per cent roots in pot culture.

Studies on mass multiplication of antagonistic fungal organisms(bio-control agents) belonging to *Trichoderma viridae,* and *T. harzianum,* groups revealed the suitability of powdered cowdung supplemented with 2 % jaggery.

Powdery mildew of *ber* was effectively controlled by two applications of Bayleton (0.1%), Karathene (0.1%) or Benomyl (0.1%) followed by three sprays with Sulfex (0.25%).

Two fortnightly sprays with Thiphanate mehtyl (0.1%) during September and October gave the best control of cercospora leaf spot of pomegranate. Botanicals were inconsistent in their efficacy.

I. 5 Investigations on fungal, viral and mycoplasma diseases of solanaceous and cruciferous vegetables.

Two fortnightly application of mancozeb (0.2 %) during September coupled with non-chemical control methods *viz.* Selection of disease-free seedlings from nursery followed by incorporation of *T. viridae* spores in soil (rhizosphere) and removal of infected lower leaves gave best control of Alternaria leaf spot of tomato.

Alternaria leaf spot of chilli var. Pusa Jwala was effectively controlled by two sprays with mancozeb(0.2 %).

I. 6 Pest management in ber, pome-granate, aonla and sapota.

Ber

Schedule involving application of fenvelrate (0.005 %), Decamethrine (0.0015%) and Acephate (0.05 %) commencing from second fortnight of September followed by NSKE (5.0 %) at 10 days interval effectively checked the incidence of fruitfly and fruit borer.

Pomegranate

Fortnightly application of Acephate (0.05%), Dimethoate (0.05%), Fenvelrate (0.005%) or Decamethrine (0.0015) followed by sprays with NSKE (5.00 %) at weekly interval not only suppressed the population of thrips but also reduced the incidence of anar butter fly.

Aonla

Almost all varieties of *aonla* were found to be susceptible to the incidence of borer complex *viz. Virichola isocrates* and *Meridarchis* spp.

I. 7 Pest management in chilli and brinjal.

Chilli

Fortnightly application of Mono-crotophos (0.05%), dimethoate (0.05%), acephate (0.05%) followed by weekly sprays with NSKE (5.0%) effectively suppressed the population of thrips in chilli cv. Pusa jawala and G-4 indicating the reduced incidence of leaf curl.

Brinjal

Effective control of jassid and fruit borer was achieved by fortnightly application of acephate (0.05%), monocrotophos (0.05%), endosulfan (0.07%) & fenvalerate (0.07%).

Plant production

Mission K: Production of planting materials

At CIAH, Bikaner

K. 1 Establishment of Progeny Block

Two hectare area has been developed as "Progeny Block" by planting different arid fruit types, which will also serve as conservatory for demonstration purpose of the fruit types suitable under arid ecosystem. So far, 60 varieties/strains of different fruit trees accommodating 21 genera have been collected from different places in India and abroad (Table 25).

Before planting in the field, proper acclimatization and hardening of new introductions are very essential for better establishment of precious materials. For the purpose, two growing structures have been developed. Fine nozzle sprinkler system has been installed for irrigation purpose. These structures are also being utilized for multiplication of fruits, vegetables and ornamental plants. As new introduction during 2000, 03 types of mulberry from Bawal, Faizabad and Jodhpur; 02 fig from Rahuri and Bikaner; 01 jangal jalebi from Jaunpur; 01 Jamun from Pratapgarh and 02 ker from Bikaner have been collected and maintained. Some materials of date palm have also been obtained through NBPGR, New Delhi.

Table 25. Status of Progeny Block at CIAH, Bikaner

Fruit type	Yr. of collection	No. of collection	Place of collection
1. Ber	September, 1998	05	Jodhpur, Godhra
2. Aonla	July, 1997	06	Faizabad
3. Bael	August, 1997	08	Pant Nagar, Faizabad
4. Guava	September, 1997	05	Hisar, Kaimganj, Aurangabad, Faizabad, Pant Nagar
5. Citrus	August, 19997	08	Godhra, Abohar, Aurangabad, Pant Nagar, Bharatpur
6. Phalsa	August, 1997	02	Faizabad, Godhra
7. Kronda	August, 1997	06	Faizabad, Godhra, Bharatpur, Udaipur, Pant Nagar, Baster
8. Lasoda	August, 1997	05	Bikaner, Bharatpur
9. Tamarind	July, 1997	03	Bikaner, Rahuri, Baster
10. Khejri	August, 1997	03	Bikaner
11. Carob	July, 1997	01	Israel
12. Marula nut	July, 1997	01	Israel
13. Chinese ber	March, 1998	01	Simala
14.Boardi	July, 1997	01	Saudi Arabia
15. Khirni	August, 1997	01	Godhra
16. Pomegranate	March, 1998	04	Jodhpur, Rahuri
17. Ker	July, 2000	02	Bikaner
18. Fig	July, 2000	02	Rahuri and Bikaner
19. Mulberry	July, 2000	03	Bawal, Faizabad, Jodhpur
20. Jamun	July, 2000	01	Pratapgarh
21. Jangal jalebi	July, 2000	01	Jaunpur

K. 2 Evaluation of fruit trees

The fruit plants maintained under Progeny Block are also under evaluation to see their performance under irrigated arid ecosystem. The management practices were similar for all the varieties of a particular fruit type. The irrigation , fertilization, intercultural operations, training and pruning etc. were based on the recommendations already available. Most of the fruit plants did not come in fruiting so far, only some plants of guava, pomegranate, citrus, bael and mulberry started fruiting during this year. The data on vegetative vigour and fruit yield have been presented in table 26.

Table 26. Vegetative vigour and fruit yield of some arid fruits, Sept., 2000

Fruit type/ cultivar	Yr.of plantation	Vegetative vigour		Fruit yield (kg/tree)
		Plant height (m)	Crown spread (m^2)	
Bael				
Pant Aparna	August, 1997	2.75	9.25	--
Pant Sujata	August, 1997	4.16	13.80	--
Pant Swarna	August, 1997	5.25	16	3.0
Pant Shivani	August, 1997	5.00	12.5	--
Pant Urvashi	August, 1997	5.16	7.00	--
NB 5	August, 1997	5.13	20.50	--
NB 7	August, 1997	4.35	13.25	--
NB 9	August, 1997	2.60	12.5	15.2
Ber				
Mundia	Sept., 1998	1.70	3.75	--
Umran	Sept., 1998	1.30	1.89	--
Seb	Sept., 1998	1.72	4.04	--
Gola	Sept., 1998	1.21	4.97	--
Goma Kirti	Aug., 1999	0.94	1.08	
Citrus				
Sweetorange: Mosambi	August, 1997	2.25	5.94	2.0
Mandarin: Kinnow	August, 1997	2.80	5.20	--
Malta	August, 1997	2.77	5.87	--
Grapefruit:Marsh Seedless	August, 1997	2.50	5.25	--
Red Blush	August, 1997	2.20	4.95	--
Lemon: Pant 1	August, 1997	3.45	10.78	--
Godhra	August, 1997	2.40	6.60	--
Abohar	August, 1997	3.55	5.73	--
Guava				
Allahabad Safeda	Sept., 1997	2.53	9.59	-
L 49	Sept., 1997	1.70	1.50	2.5
Karonda				
KS 1	July, 1997	1.30	2.21	--
KS 2	July, 1997	1.27	3.02	--
KS 3	July, 1997	1.00	1.86	--
KS 4	July, 1997	1.12	2.49	--
KS 5	July, 1998	1.08	0.87	--
***Lasoda**				
LS 1	July, 1997	3.68	15.08	
LS 2	July, 1997	5.50	40.30	4.5
LS 3	July, 1997	6.08	40.97	8.9
Pomegranate				
Ganesh	July, 1997	2.05	5.14	1.2
G 137	July, 1997	2.15	4.05	1.7
Jalore Seedless		1.80	3.10	0.5
Mulberry	July, 1998	3.00	12.00	0.7

*Tender fruits for vegetable purpose

K. 3 Multiplication of planting materials

The fruit trees of commercial significance like; ber, aonla and pomegranate have been multiplied through vegetative means for distribution of true-to-type of planting materials among farmers and also for experimental purpose (Table 27). Some ornamental plants were also multiplied by seeds/ cuttings/ suckers under growing structures for the purpose of campus beautification. Besides vegetative propagation, 2000 seedlings of desi ber were raised for hedge row plantation around experimental blocks. 2500 aonla seedling rootstocks were also raised for gap filling in establishing aonla block and also for budding purpose. As a source of revenue generation, Rs. 10,000/- have been generated by on-spot selling of above mentioned planting materials and guarpatha leaves for vegetable purpose to the farmers.

Table 27. Production of planting materials (2000)

Fruit types	Variety	Propagation method	Plant material produced (No.)	Purpose	
				Experimental	For sale
Ber	Gola	Patch budding	700	400	300
	Seb	Patch budding	200	150	50
	Umran	Patch budding	50	30	20
	Kaithali	Patch budding	150	-	150
	Mundia	Patch budding	150	-	150
	Others	Patch budding	100	100	-
	Seedling	Seeds	2000	2000	-
Aonla	NA 6	Patch budding	200	25	175
	NA 7	Patch budding	175	25	150
	Seedling	Seeds	2000	2000	-
Pomegranate	Jalore Seedless	Cutting	210	200	10
	Ruby	Cutting	25	25	--
	G 137	Cutting	30	30	--
Indian Aloe	Local Selection	Sucker	1025	1000	25

K. 4 Nursery Structures

The climatic conditions of Experimental Farm at CIAH, Bikaner are very harsh and highly unfavorable for establishment of plantations. Conservation of valuable introduction under open conditions are not conducive. Considering these requirements, one shade net house (60x20 ft.) and one high-tech nursery green house (48x27 ft.) have been installed in the progeny block. The shade net house having provision of controlled misting while high-tech nursery green house having complete automatic control system including temperature, humidity, photoperiod and misting systems. These growing structures can be mainly utilized for conducting different experiments particularly on propagational studies and hardening of micropropagated planting materials.

Externally funded projects

A. National Agricultural Technology Project

Project 1. Collection, evaluation and maintenance of arid horticultural crops under NATP on sustainable management of plant bio-diversity (B.B. Vashishtha and D.K. Samadia)

Lead Centre : NBPGR, New Delhi
Cooperative Centre :CIAH, Bikaner

Central Institute for Arid Horticulture, Bikaner is one of the co-operative center under NATP on Plant bio-diversity for collection, evaluation and maintenance of arid horticultural crops. Besides, the CIAH is also one of the identified National Active Germplasm Site (NAGS) for maintenance and conservation of plant bio-diversity of arid zone horticultural crops. In pre-NATP era, under mission mode approach of NRCAH (CIAH) , this centre has made excellent growth in plant genetic resource management particularly in arid zone fruits and vegetable. As a result of massive germplasm collection programme, this centre has developed national level field repository of *ber* (300), pomegranate (150), date palm (47), *aonla* (19) where as in vegetable a collection of 193 in watermelon type *mateera*, 558 of *kachari* and 90 of snapmelon and are being maintained.

During the year 2000-2001, three exploration were undertaken for the survey, identification and collection of horticultural plant bio-diversity from parts of Rajasthan and Gujarat. As a result of this explorations collection in *ber* (15), *aonla* (5), *ker* (32), *lasora* (32), muskmelon (55) and Indian bean (18), germplasm collections have been made in during the year under NATP.

a) Identification and collection of *ber* and *aonla* germplasm from parts of Rajasthan and Gujarat

This exploration was undertaken in July 26-31, 2000 for collection of bud wood of the identified elite plants of *ber* (15) and *aonla* from Sirohi (Rajasthan), Patan, Mehsana, Anand, Panchmahal and Sabarkata (Gujarat) districts and collected genotypes are being maintained in the field gene bank at CIAH, Bikaner for evaluation.

b) Exploration for the survey, identification and collection of *ker* (*Capparis deciduas*) and *lasora* (*Cordia myxa*) bio-diversity from parts of Rajasthan

This exploration was undertaken during May, 25-31, 2000 in arid and semi-arid region covering Bikaner, Nagour, Ajmer, Jaipur, Sikar, Churu, Pali and Jodhpur districts of Rajasthan under NATP on Plant Bio-diversity. Enormous variability exists in growth habit, flowering and fruiting behaviour, fruit quality and yield contributing characters. A wide range of diversity have been explored and recorded. As a resul, 32 collections each in *ker* and *lasora* were made. Promising elite plants have been identified and seedling progenies have been developed at CIAH, Bikaner for field planting and evaluation.

In ker, considerable variations were recorded for plant height (1.0-5.3 m), plant spread (2.04-12.25 sq. m), fruit weight (1.25-3.15 g), fruit diameter (1.12-1.94 cm), fruit length (1.41-2.38 cm), weight of ten seeds (0.256-0.410 g) and fruit shape (round, oblong and long). Where as in *lasora*, fruit samples were collected from approximately 10-40 year age old seedling plants. The plant height ranged from 4.5-10.52 metres. The variability

was observed for number of fruits per cluster (3.5-7.8), fruit weight (6.53-11.54 g), fruit diameter (1.23-2.93 cm), fruit length (2.02-3.02 cm) and TSS (5.1-8.2 °Brix).

c) Exploration for the survey and collection of muskmelon (*Cucumis melo*) germplasm from parts of Rajasthan

This exploration was under taken during May, 2000 to collect local land races and cultivated types of muskmelon from arid, semi-arid and sub-humid parts of Rajasthan. A total 55 open pollinated samples were collected from different cultivated areas like riverbed, farm land and land areas of dried water reservoir dam in Rajasthan and wide range of variations were observed and recorded.

d) Collection, evaluation and characterization of Indian bean (*Dolichos lablab* L.)

Indian bean, *sem* or *Dolichos* bean is one of important drought tolerate perennial legume of Indian origin. Eighteen collection of *Dolichos* bean were made during January, 2000 by visiting farming villages of tribal dominating areas of South Rajasthan and Northern Gujarat, where it is grown by farmers as a security crop.

Eighteen diverse collections of *Dolichos* bean were grown during July, 2000 as *kharif* season crop at CIAH, Bikaner and detailed information have been compiled related to plant growth and its behaviour, flowering and fruiting, pod and seed yield, quality attributes under arid conditions. All the collections were grouped according to harvest/maturity (early, mid and late), length of fruiting period, nature of plant growth (viny, semi erect, erect), pigmentation on foliage and pods, flower colour, pod quality, tenderness and seed characters. Among the viny type genotype AHDB 16 and AHDB 15 where as dwarf erect type AHDB 7 showed promising characters for higher early yield.

Project 2. Household food and Nutritional security for tribal, backward and hilly areas. (B.G.Bagle)
Centre: CHES, Godhra

Experiments under NATP-JVG-HFNS on *in-situ* budding in *ber* revealed that cv. Goma Kirti performed better in respect of survival percentage, plant height, stem girth and plant spread as compared to Umran and Gola. The treatment 600 ppm GA + 6% sucrose was found better than other treatments for enhanced germination in *ber*.

Project 3. Develop sustainable agri-silvi horti production system for marginal lands under arid conditions (S.S. Hiwale and P.L.Saroj).

Lead Centre: CHES, Godhra
Cooperative Centre:CIAH, Bikaner

At CHES, Godhra

The initial soil samples were collected from experimental plots and analysis was carried out which revealed that the soil is low in organic carbon, N, P and K content and high in Ca and Mg content. The pH of the soil ranged from 7.22 to 8.12.

Vegetative growth parameters recorded in all tree species at four years of age revealed that plant height (5.2 m) & stock diameter (156.6mm) was maximum in Neem. However, plant spread, both North-South and East-West, was maximum in *Aonla* (4.20 and 4.05 m, respectively).

Custard apple recorded the least growth compared to neem and aonla. Leaf litter production was highest in neem (5.3kg / plant / year) and was least in Custard apple (1.1 kg). With regard to recycling of nutrient,

however, Subabool recycled maximum Nitrogen (84.26 g) closely followed by Neem. Maximum phosphorus (26.22 g) and potassium (218 g) was recycled by Aonla and minimum by Subabool (3.30 g and 27.06 g, respectively). Though, intercropping with various intercrops was undertaken but due to consecutive second year of drought, growth and production of crop was hampered and hence, no observation could be recorded .

At CIAH, Bikaner

The field work was initiated during Sept., 2000. The experimental site was highly undulating with rolling topography, hence proper leveling was essential. The soil sample of experimental side were collected at 4 depths before and after leveling. These samples were analyzed to see the initial fertility status of experimental site. After leveling the pits of two cubic ft. were dugout at 6x6 m, 8x8 m and 16x4 m spacing and filled with soil and FYM (3:1). The budded plants of *ber* cultivar gola was planted at desired spacing followed by irrigation. The *ber* plants are established well with 90% plant survival under field conditions.

B. Network Project on Drip Irrigation System in Perennial Horticultural Crops

Project title	**National Network for Drip Irrigation System in Perennial Horticultural Crops**
Total outlay:	Rs. 74,85,100.00
CIAH Center:	Rs. 9,11,700.00

Progress of Research

Pomegranate:

In pomegranate crop, the plant height, and plant spread were measured at monthly intervals. The leaf tissue analysis was done at flowering and fruit set stage. The fruit yield and yield attributing characters were also recorded at harvest time. The total water applied in each treatment was also calculated.

Plant height: The plant height in each treatment was measured in each month but in report the data pertain to the months of October, 2000 and February 2001 have been presented (Table 28). The data in table 28 revealed that plant height responded to irrigation levels and for nitrogen fertilizer doses through drip and bubbler system. In the month October 2000, the maximum plant height (1.64 m) was observed in 0.75 CPE irrigation level through drip and statistically at par with 0.90 CPE through drip and minimum height was recorded in 1.00 CPE through bubbler. The N fertilization did not responded much to plant height.

In the month of February 2001, the maximum plant height (1.75 m) was measured in 0.90 CPE through drip and statistically at par with 0.75 CPE through drip (1.72 cm) while minimum height (1.23 m) was recorded in 1.00 CPE through bubbler irrigation system. In this month, the response of N fertilization was seen and significantly higher plant height (1.66 m) was observed in 75% recommended dose of nitrogen over control (1.41 m). However, irrigation and N fertigation did not show interaction effect.

Plant spread: The plant spread was also measured as per standard procedure in each month. In report, data for the month of October, 2000 and February 2001 have been presented (Table 29). Data of table 29 revealed that plant spread responded to irrigation levels and N fertigation. In the month of October, 2000, maximum plant spread (1.83 m^2) was recorded in 0.75 CPE through drip treatment which was statistically at par with 0.90 CPE irrigations level (1.75 m^2) and minimum spread (1.00 m^2) was recorded in 1.00 CPE through bubbler irrigation. Application of N @ 75%

recommended doses of N through drip gave maximum plant spread (1.62 m^2) over control (.37 m^2). However no interaction effect was observed.

In February 2001, maximum plant spread (1.88 m^2) was observed in 0.75 CPE through drip and statistically at par with 0.90 CPE (1.85 m^2) and they were significantly higher over 1.00 CPE bubbler irrigation treatment (1.10 m^2). The maximum plant spread (1.78 m^2) was recorded in 75% RD of N treatment which is significantly higher over control (1.40 m^2).

Leaf mineral composition: The leaf samples were collected is the month of July 2000 and analysed form macro and micro-nutrients. The data pertain to N, P, K, Zn, Fe and Cu has been presented in Table 30. The nitrogen content was maximum (1.75%) in 0.90 and 0.75 CPE water through drip system followed in 0.50 CPE through drip and minimum content was estimated in leaves collected from 1.00 CPE irrigation water through drip. The N fertigation increased the N content in leaves and maximum N content (1.75%) was determined in 75% RD of N treatment and minimum N content (1.46%) in no nitrogen (control) treatment. The phosphorus content ranged from 0.18 to 0.25% but values were at statistically at par in all irrigation as well as fertigation treatments. The potassium content responded to irrigation levels and maximum K content (1.52%) was estimated in 0.90 CPE water through drip treatment and statistically at par with 0.75 and 0.50 CPE irrigation treatments and significantly higher over 1.00 CPE through bubbler irrigation treatment. The K content did not change significantly in different N fertigation treatments. The Zinc, iron and copper content did not change much due irrigation and fertigation treatment.

Fruit, fruit yield and TSS: The data pertain to fruit weight and fruit yield has been presented in table 31. The *mrig bahar* crop was taken for yield purposes. On an average twenty fruits were on each plant since they were young. The average fruit weight and fruit yield were recorded and data revealed that fruit weight did not differ much with regards to irrigation levels as well as nitrogen fertigation treatments.

The data reveled that the maximum fruit yield (7.90 q ha^{-1}) was recorded in 0.90 CPE through drip treatment which was statistically at par with 0.75 CPE irrigation level (7.78 q ha^{-1}) and minimum fruit yield was estimated in 1.00 CPE through bubbler irrigation system treatment. The nitrogen fertilization responded to fruit yield and maximum fruit yield (7.50 q ha^{-1}) was estimated in that treatment where 75% recommended dose of nitrogen has been given and it was significantly higher over control (6.00 q ha-1). The interaction effect between irrigation and fertigation was also observed. The total soluble solids (TSS) were also measured with hand refractometer and it was in the range of 14.00 to 15.00 and no significant differences were observed among the treatments

Moisture Distribution Pattern

The moisture contents were measured at different vertical and horizontal distances from the main trunk of the plant under different irrigation treatments. The distribution pattern is being presented in fig 3. In drip irrigation treatments the pattern was more or less but quantum of water at different vertical and horizontal distances are different in different levels of water but in bubbler system, the pattern was different.

In drip irrigation treatments the maximum moisture content was measured at 30 cm horizontal distance while at 30-45 cm vertical depths, the moisture content was maximum. In bubbler system the maximum moisture was recorded at 15-20 cm horizontal

distance while at 30-45 cm vertical depths the maximum moisture (7.5%) have been recorded. In drip irrigation system, water was applied at subsurface layers while in bubbler the water was applied at surface in basin.

Quantity of water: Considering the daily pan-evaporation, crop spacing (6 m x 4m), crop factor (0.6) and crop wetting area 20% the total amount of water given in different irrigation levels were worked out. The amount of water given in different treatments in different months have been calculated. Data revealed that total amount of water applied was 2726, 2453, 2045 and 1363 litres/year/plant in 1.00 CPE through bubbler and 0.90, 0.75 and 0.50 CPE through drip irrigation treatments, respectively (Table 32).

Ber:

The experiment was undertaken on Gola cultivar of *Ziziphus mauritiana* (var. rotundifolia). The plants were pruned in the last week of May 2000 and new flush emerged out in the last week of June 2000. The flowering was started in the month of September 2000 and fruit set was occurred in the month of October. The fruit harvesting has been started in the month of January and end up in the first week of February 2001. The growth and spread data was recorded from the month of August onwards. In this report, the plant height and spread recorded in the month of October 2000 have been presented (Table 33).

Plant height and spread: The maximum plant height (2.18 m) was recorded in those plants where irrigation was given @ 0.75 CPE through drip and this treatment was statistically at par with 0.90 CPE through drip where average plant height was 2.15 m and minimum plant height (1.50 m) was recorded in 1.00 CPE through bubblier. The plant height also influenced by N fertigation and maximum plant height (2.10 m) was recorded in 75% recommended dose of N followed by 50% RD of nitrogen over control treatment (Table 33).

The maximum plant spread (12.50 m^2) was recorded in 0.90 CPE through drip and statistically at par with 0.75 CPE through drip irrigation treatment. The plant spread were statistically lower and at par in 0.50 CPE through drip and 1.00 CPE through bubbler treatments. The increase in N application through drip increased the plant spread and maximum plant spread (12.5 m^2) was recorded in 75 % RD nitrogen through drip followed in 50% recommended doses of nitrogen.

Leaf Tissue Content: The leaf tissue samples were collected in the month of September 2000 and analyzed for N, P, K, zinc and copper content. The data pertains to these elements have been presented in Table 34. The maximum (2.25%) N content was recorded in 0.90 CPE through drip treatment and statistically at par with 0.75 CPE through drip (2.20%) followed to 0.50 CPE and minimum (1.50%) in 1.00 CPE through bubbler irrigation treatment. The doses of N application through drip responded to N content and maximum N content (2.22%) was estimated in 75% RD of nitrogen and minimum (1.80%) in control treatments. The phosphorus content did not change much in irrigation and fertigation treatments and found statistically same irrespective of the treatment. The maximum potassium content (1.72%) was recorded in 0.75 CPE followed in 0.90 CPE treatments. The fertigation also could not change the K content significantly in different treatments. The zinc and copper content were in the range of 35-40 PPM and 345 to 360 PPM, respectively. Irrigation and N fertigation treatments could not change the zinc and iron content.

Fruit yield: The total fruit yield was recorded during the harvesting period. The fruits were grouped into marketable and non marketable

on the basis of insect pest infection, immature and small fruits fallen. The maximum total fruit yield (62.50 q ha^{-1}) was recorded in 0.90 CPE irrigation treatment which was statistically at par with 0.75 CPE irrigation treatment followed by 0.50 CPE treatment (48 q ha^{-1}) and minimum (32.00 q ha^{-1}) in 1.00 CPE through bubbler irrigation treatment (Table 32). N fertigation also affected the fruit yield and maximum (58 q ha^{-1}) was recorded in that treatment where 75% of recommended dose of nitrogen was given followed by 50%RD of N treatment and minimum (42.00 q ha^{-1}) in control treatment. In 0.90 and 0.75 CPE through drip treatments, marketable fruits were 85% while these were 70% in 0.50 CPE through drip and 1.00 CPE through bubbler treatments. The inverse values were found for non -marketable fruits in respective treatments. N fertigation did not show any significant effect on share of marketable and non-marketable fruits (Table 35).

Fruit quality: The mature fruits were analysed for acidity, total soluble solids (TSS) and pulp/stone ratio. Data presented in table 36 revealed that minimum acidity was estimated in 0.90 CPE irrigation level followed by 0.75 CPE through drip but differences were not statistically different. The N fertigation did not show any significant response in the fruit acidity. The total soluble solids were in the range of 12.5 to 14.0°Brix. The pulp/stone ratio was maximum in 0.90 and 0.75 CPE through drip irrigation treatments and minimum (8.5) was in 1.00 CPE through bubbler. N fertigation increased the pulp/stone ratio and maximum was observed in 75% recommended dose of nitrogen and minimum (5.5) in control treatment.

Pruned wood: The plants were pruned in the last week of May 2000. The dry pruned wood weight was recorded. The pruned wood weight in different treatments has been presented in Table 37. The maximum dry twig weight (29 kg/plant) was recorded in 0.75 CPE treatment followed in 0.90 CPE (28 kg $plant^{-1}$) and minimum pruned wood weight (7.5 kg $plant^{-1}$) in 1.00 CPE through bubbler irrigation treatment. N fertigation also increased the phytobiomass and accordingly dry pruned wood was maximum (28 kg $plant^{-1}$) in 75% recommended dose of N treatment and

Relative water content: The pomegranate leaves were analyzed for turgidity in different irrigation treatments and it was found that leaves were most turgid in 0.90 and 0.75 CPE through drip irrigation treatments and relative water content was 86.21% and 84.50%. It was only 70% in 1.00 CPE through bubbler irrigation treatment (Table 38).

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

Quantity of water: From the March 2000 to June 2000 watering was with held for defoliation and pruning. From the month of July 2000 to February 2001. The watering was given as per technical programme. Considering the rainfall, the total was applied to each plant was 1325, 1100, 735 and 1470 litres in 0.90, 0.75, 50 CPE through drip and 1.00 CPE through bubbler irrigation treatment (Table 39). The meteriological data of Bikaner is given in Table 40.

Total amount sanction/spent during report.

Head	Amount sanctioned (RS.)	Amount spent (RS.)
Establishment	121440	132039
RC include TA	55000	53927
Non RC	Nil	Nil
Institute charges	10300	Nil
Total	186740	185966

Table 28. Effect of irrigation levels and N fertilization on plant height (m) of pomegranate

Treatment	Months	
	October, 2000	February, 2001
A. Irrigation		
0.90CPE through drip	1.62	1.75
0.75 CPE through drip	1.64	1.72
0.50 CPE through drip	1.30	1.42
1.00 CPE through bubbler	1.17	1.23
SEm ±	0.12	0.13
CD (5%)	0.31	0.34
B. Fertigation		
75% RD of Nitrogen	1.48	1.66
50% RD of Nitrogen	1.45	1.55
No Nitrogen (control)	1.42	1.41
SEm ±	0.08	0.10
CD (5%)	NS	0.22
A x B		
CD (5%)	NS	NS

Table 29. Effect of irrigation levels and N fertilization on plant spread (m^2) of pomegranate

Treatment	Months	
	October, 2000	February, 2001
A. Irrigation		
0.90 CPE through drip	1.75	1.85
0.75 CPE through drip	1.83	1.88
0.50 CPE through drip	1.47	1.55
1.00 CPE through bubbler	1.00	1.10
SEm ±	0.15	0.17
CD (5%)	0.38	0.44
B. Fertigation		
75% RD of Nitrogen	1.62	1.78
50% RD of Nitrogen	1.55	1.65
No Nitrogen (control)	1.37	1.40
SEm ±	0.09	0.11
CD (5%)	0.22	0.27
A x B		
CD (5%)	NS	NS

Table 30. Effect of irrigation levels and N fertilization on leaf mineral composition in Pomegranate

Treatment	N	P	K	Zn	Fe	Cu
	%			Ppm		
A. Irrigation						
0.90 CPE through drip	1.75	0.23	1.52	42	375	5
0.75 CPE through drip	1.75	0.21	1.48	45	370	6
0.50 CPE through drip	1.68	0.20	1.48	45	372	5
1.00 CPE through bubbler	1.55	0.19	1.26	40	370	5
SEm ±	0.06	-	0.08	-	-	-
CD (5%)	0.17	NS	0.19	NS	NS	NS
B. Fertigation						
75% RD of Nitrogen	1.75	0.23	1.52	45	375	5
50% RD of Nitrogen	1.65	0.23	1.45	43	372	5
No Nitrogen (control)	1.46	0.15	1.38	41	368	5
SEm ±	0.11	-	-	-	-	-
CD (5%)	0.26	NS	NS	NS	NS	NS
A x B						
CD (5%)	0.25	NS	NS	NS	NS	NS

Table 31. Effect of irrigation levels and N fertilization on fruit, fruit yield and total soluble solids of pomegranate

Treatment	Average fruit weight (g)	Fruit yield (q ha^{-1})	TSS (°Brix)
A. Irrigation			
0.90 CPE through drip	275	7.90	14.5
0.75 CPE through drip	270	7.78	14.5
0.50 CPE through drip	270	6.20	14.5
1.00 CPE through bubbler	265	5.10	15.0
SEm ±	-	0.31	-
CD (5%)	NS	0.86	NS
B. Fertigation			
75% RD of Nitrogen	275	7.50	15.00
50% RD of Nitrogen	270	6.75	14.00
No Nitrogen (control)	265	6.00	14.00
SEm ±	-	0.42	-
CD (5%)	NS	1.06	NS
A x B			
CD (5%)	NS	NS	NS

Table 32. Water application (liters) to pomegranate plant per year

Months	Irrigation levels			
	0.90 CPE	0.75 CPE	0.50 CPE	1.00 CPE
January	65	55	35	71
February	113	95	62	125
March	155	130	90	175
April	285	235	160	315
May	340	285	190	380
June	350	290	190	385
July	260	218	145	290
August	235	195	130	260
September	235	195	130	262
October	220	185	125	248
November	120	100	65	135
December	75	60	40	80
Total	**2455**	**2045**	**1363**	**2726**

Table 33. Effect of irrigation levels and N fertilization on plant height (m) and spread (m^2) of ber

Treatment	October, 2000	
	Plant height (m)	Plant spread (m^2)
A. Irrigation		
0.90 CPE through drip	2.15	12.50
0.75 CPE through drip	2.18	12.00
0.50 CPE through drip	1.70	9.50
1.00 CPE through bubbler	1.50	7.00
SEm ±	0.15	0.90
CD (5%)	0.41	2.76
B. Fertigation		
75% RD of Nitrogen	2.10	12.50
50% RD of Nitrogen	1.95	11.00
No Nitrogen (control)	1.60	8.00
SEm ±	0.13	0.80
CD (5%)	0.34	2.42
A x B		
CD (5%)	NS	NS

Table 34. Effect of irrigation levels and N fertilization on nutrient content in leaves of ber

Treatment	N	P	K	Zn	Fe
		%	ppm		
A. Irrigation					
0.90CPE through drip	2.25	0.19	1.65	38	360
0.75 CPE through drip	2.20	0.18	1.70	40	360
0.50 CPE through drip	1.75	0.18	1.62	40	350
1.00 CPE through bubbler	1.50	0.15	1.58	35	348
SEm ±	0.13	-	-	-	-
CD (5%)	0.34	NS	NS	NS	NS
B. Fertigation					
75% RD of Nitrogen	2.22	0.18	1.65	40	350
50% RD of Nitrogen	2.20	0.18	1.63	40	350
No Nitrogen (control)	1.08	0.16	1.60	35	345
SEm ±	0.12	-	-	-	-
CD (5%)	0.33	NS	NS	NS	NS
A x B					
CD (5%)	NS	NS	NS	NS	NS

Table 35. Effect of irrigation levels and N fertilization on fruit yield of ber

Treatment	Yield (qha-1)	% Marketable fruits	%Non marketable fruits
A. Irrigation			
0.90 CPE through drip	62.50	85.00	15.00
0.75 CPE through drip	60.00	85.00	15.00
0.50 CPE through drip	48.00	70.00	30.00
1.00 CPE through bubbler	32.00	70.00	30.00
SEm ±	4.34	3.00	3.12
CD (5%)	12.00	8.75	9.00
B. Fertigation			
75% RD of Nitrogen	58.00	85.00	20.00
50% RD of Nitrogen	50.00	82.00	20.00
No Nitrogen (control)	42.00	75.00	18.00
SEm ±	2.82	3.50	2.50
CD (5%)	7.50	10.70	7.00
A x B			
CD (5%)	NS	NS	NS

Table 36. Effect of irrigation levels and N fertilization on fruit quality of ber

Treatment	Acidity (%)	T.S.S (°Brix)	Pulp/Stone ratio
A. Irrigation			
0.90 CPE through drip	0.18	13.00	8.00
0.75 CPE through drip	0.20	13.00	8.00
0.50 CPE through drip	0.22	13.50	7.50
1.00 CPE through bubbler	0.24	14.00	5.50
SEm ±	-	-	1.20
CD (5%)	NS	NS	3.1
B. Fertigation			
75% RD of Nitrogen	0.22	12.50	8.00
50% RD of Nitrogen	0.24	13.00	8.50
No Nitrogen (control)	0.24	13.50	5.50
SEm ±	-	-	1.00
CD (5%)	NS	-	2.15
A x B			
CD (5%)	NS	NS	NS

Table 37. Effect of irrigation levels and nitrogen fertigation on pruned wood of ber

Treatment	Pruned wood (kg plant^{-1})
A. Irrigation	
0.90 CPE through drip	28
0.75 CPE through drip	29
0.50 CPE through drip	20
1.00 CPE through bubbler	7.5
SEm ±	1.46
CD (5%)	5.04
B. Fertigation	
75% RD of Nitrogen	28
50% RD of Nitrogen	20
No Nitrogen (control)	15
SEm ±	2.05
CD (5%)	5.95
A x B	
CD (5%)	NS

Table 38. Effect of irrigation levels on Relative Water content in pomegranate and ber

Treatment	Relative water content (%)	
	Pomegranate	Ber
Irrigation levels		
0.90 CPE through drip	86.21	85.00
0.75 CPE through drip	84.50	83.50
0.50 CPE through drip	75.00	84.00
1.00 CPE through bubbler	70.00	78.00

Table 39. Water application (liters) to ber plant per year

Months	Irrigation levels			
	0.90 CPE	0.75 CPE	0.50 CPE	1.00 CPE
January	65	55	35	71
February	113	95	62	125
March	-	-	-	-
April	-	-	-	-
May	-	-	-	-
June	-	-	-	-
July	260	218	145	290
August	235	195	130	260
September	235	195	130	262
October	220	185	125	248
November	120	100	65	135
December	75	60	40	80
Total	**1325**	**1105**	**735**	**1471**

Table 40. Meteriological data of year 2000 at Bikaner

Months	Max.Temp.(°C)	Min. Temp.(°C)	RH I (%)	RH II (%)	Evaporation (mm)
January	23.7	7.1	77.2	49.9	77.00
February	24.4	8.9	65.1	43.1	125.00
March	32.8	14.7	48.8	21.0	117.00
April	41.6	24.4	44.7	17.7	250.00
May	42.9	29.3	47.5	19.9	385.00
June	41.5	29.6	53.0	28.2	426.00
July	38.1	28.5	67.9	47.7	213.50
August	37.2	27.6	70.0	47.1	220.00
September	37.9	25.5	64.6	32.2	240.00
October	39.6	19.8	46.8	18.8	220.00
November	32.3	13.0	56.2	24.3	150.00
December	27.4	9.1	47.7	23.4	93.00

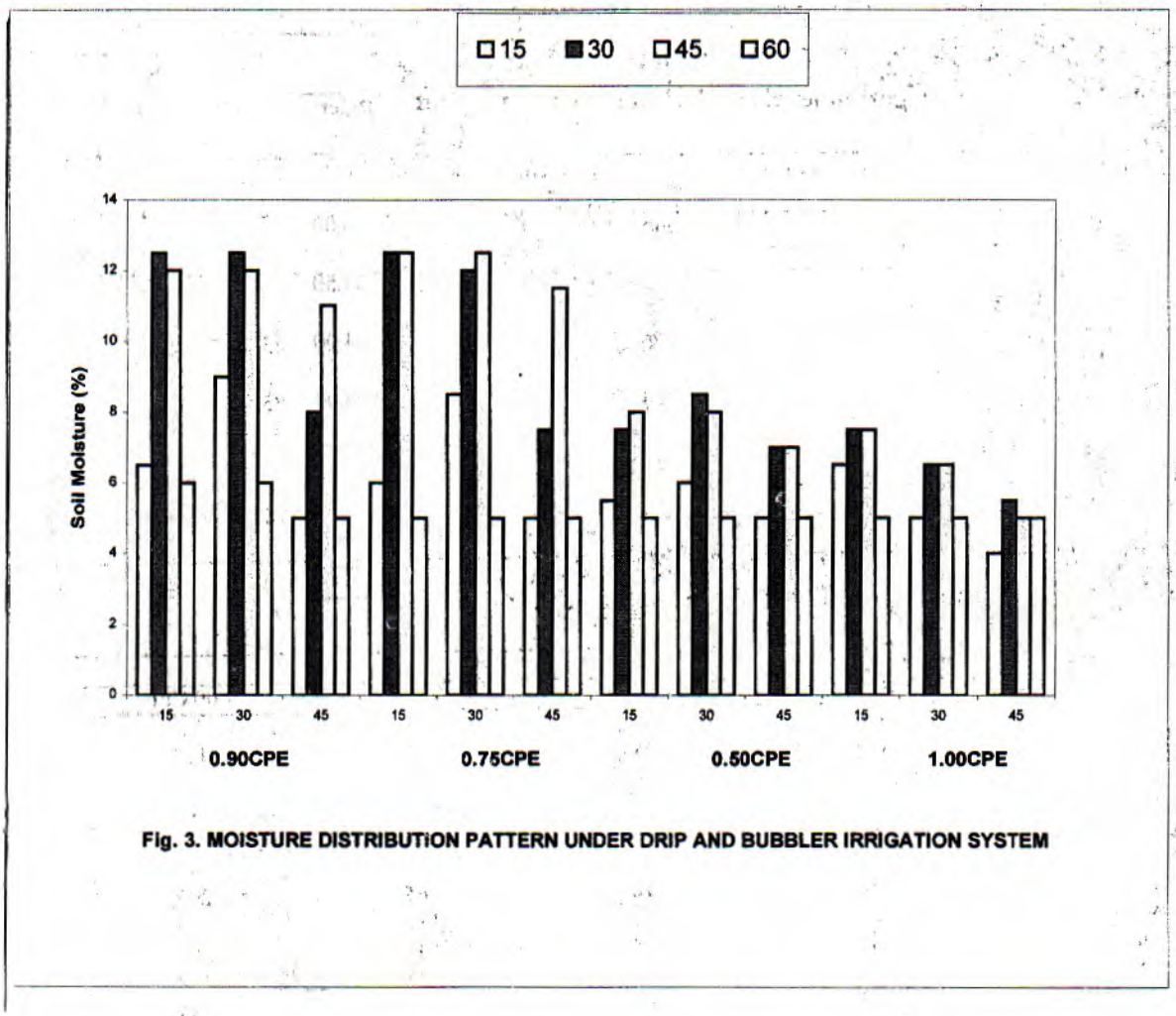


Fig. 3. MOISTURE DISTRIBUTION PATTERN UNDER DRIP AND BUBBLER IRRIGATION SYSTEM

C. Adhoc Scheme

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

1. Survey

Leaves and fruits samples of different varieties of *ber* infected by powdery mildew were collected from various locations viz., Hissar (Haryana), Udaipur (Rajasthan), Rahuri (Maharastra), Faizabad, Lucknow and Jhansi (Uttar Pradesh) and Detia (Madhya Pradesh) and the variability in pathogen was investigated.

2. Variability Studies on Powdery Mildew Isolates of Ber

2.1 Conidiophores and Conidia

Powdery mildew samples from different locations of the Country were observed under light microscope and the details of the variability on conidial shape, size, characteristics of conidiophores and presence of cliestothecia of the test pathogen. It was clear that the size and shape of the asexual structures are variable in ber varieties grown in different locations. The conidiophores of the pathogen were simple, hyaline and relatively short ranging from 38 -57.5 x 3.75-5.0µm. Conidia were hyaline but the size and shape were varied in response to different varieties and locations. The size of the conidia was 42.5 x 14.5µm on variety Sua collected from Haryana Agricultural University, Hissar where as the size was slightly small on Gola and Seb varieties from the same location (36.5x 16.5; 36 x11). However the conidial size of the pathogen infected in other varieties viz. Umran, Kaithali, and Illachi (31x15;30x11;32x14.5) was not much varied. Conidial size of the pathogen on Umran variety was 31x16µm (Udaipur, Rajasthan) .The shape of the conidia observed was mostly ellipsoidal in the samples collected from Hissar and Udaipur.

Conidial size was maximum of 31x20µm on variety Chhuhara (fruits) and minimum of 20x10.5µm on Kaithali (leaves) in samples collected from Rahuri (Maharastra). While on Umran variety the conidial size was ranging from 24.2x12.2µm to 27x12µm. Similarly on Seb (leaves) and Karaka (fruits) varieties the size was 27x14µm and 25x12.5µm respectively. Samples from Faizabad also showed larger size conidia (27x16µm) on Illachi (fruits) and minimum of 21.5x12.5µm on leaves of line R3P1. Conidia were long and narrow in most of the ber varieties grown in Rahuri and Faizabad. Conidial size of Kumarganj selection was similar with common varieties of ber.

Variability in morphological characters was also observed in samples from Jhansi. Conidial size was relatively small (14x 7.5µm) on Gola variety (leaves) while larger size (26x13µm) of the conidia was observed on fruits of local variety. In other varieties like Seb and Banarasi Karaka the conidial size was varied 16.5x8; 19x11.5µm. Samples from Detia showed formation of small conidia (15x13µm) on variety Seb while in case of variety Amarawathi, conidial size was 26x12µm. Generally conidia were oval in shape and size was also small in rest of the varieties collected from Jhansi & Detia . The variation in different samples of *ber* powdery mildew pathogen may be due to extrinsic factors but the influence of intrinsic/ genetic factors of *ber* genotypes also cannot be ruled out.

Present observation also depicts that cliestothecial (sexual fruiting structures) formation was mostly observed in ber leaves than fruits (Plate 1). Out of various samples analyzed cliestothecial formation was seen in leaves of Chhuhara variety collected from Rahuri and leaves of Gola collected from Faizabad & Jhansi. The sexual fruiting bodies observed were dark brown, globose/round with a measure of 60 µm in diameter

comprised with appendages having different length ranging from 75-200 µm on Chhura variety leaves, 70 µm diameter with length of appendages 80-120 µm in Gola leaves (Faizabad). 150 µm diameter with length of appendages 100 –125 µm on gola leaves (Jhansi). In general cleistothecial formation was only in Central zone, where the relative humidity and rainfall are higher than Western zone of the Country. Ber orchard in Bikaner and near by locations were absolutely free from powdery mildew incidence for the last three years. Conclusively, it can be summarized that the extrinsic or environmental factors might have played very critical role for the occurrence of *ber* powdery mildew as well as formation of fruiting structures. During adverse conditions the said pathogen can survive in the form of cliestothecia in dried leaf tissues and in soil as well. Survival of pathogen during the off seasons is further evidenced by observing pathogen's mycelia in intercellular spaces of dried leaf tissues.

3. Hypersensitive Reactions

Hypersensitive reaction is another kind of defense reactions expressed by the host plants in response to pathogens invasion. In present investigations such resistance reactions have been noticed in cellular level in some of the samples (Plate 2). In case of fruit samples of *ber* varieties viz., Illachi, Sakari Hathed and Umran accumulation of red pigments in response to powdery mildew infection was visualized under light microscope. Further studies are under progress to correlate this reactions in artificial inoculation of powdery mildew fungus in ber genotypes.

4. Establishment of Powdery Mildew Incidence

Budded plants of *ber* genotypes viz., Gola, Umran, Kaithali, Seb and Illachi were planted in medium size pots and artificially inoculated with conidial mass of the powdery mildew fungus collected from different locations (Rahuri,Hissar, Jhansi, Lucknow, Udaipur, Faizabad and Detia). Inoculated plants were observed for disease appearance under natural conditions. Powdery mildew conidia could not infect the leaves of *ber* genotypes due to erratic environmental conditions in arid regions However, this experiment will be conducted in controlled conditions.

D. Revolving fund scheme on commercial propagation of fruit crop.

Location: CHES, Godhra

During the year in revolving fund nursery scheme large scale raising root stock seedlings of Aonla, Mango, Ber and their vegetative propagation was under taken. Apart from this large scale propagation of Pomegranate, Sapota, Custard Apple was also undertaken. During last year a revenue of Rs 5.52 lakhs was realized from RFS nursery (Table 41).

Table 41. Sale of plants during 2000-2001 (Revolving Fund Scheme Nursery Scheme)

Sr. No.	Plant type	Total no. sold	A.	Revenue realized
1.	Mango	5014		1,75,480
2.	Aonla	7423		1,11,330
3.	Sapota	6460		2,26,100
4.	Ber	1979		0,24,397
5.	Pomegranate	1679		0,11,753
6.	Guava	126		0,00,630
7.	Kagzi lime	384		0,01,992
8.	Custard apple	242		0,01,210
		Total		5,52,892

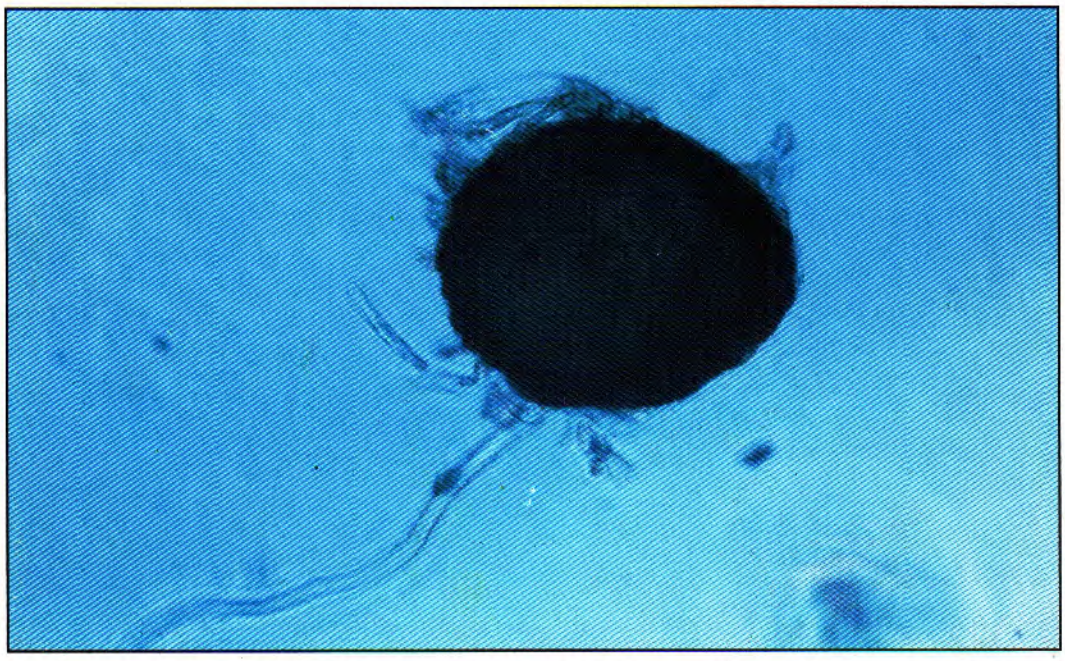


Plate 1. Cleistothecium with appendages of powdery mildew fungus on ber leaves.

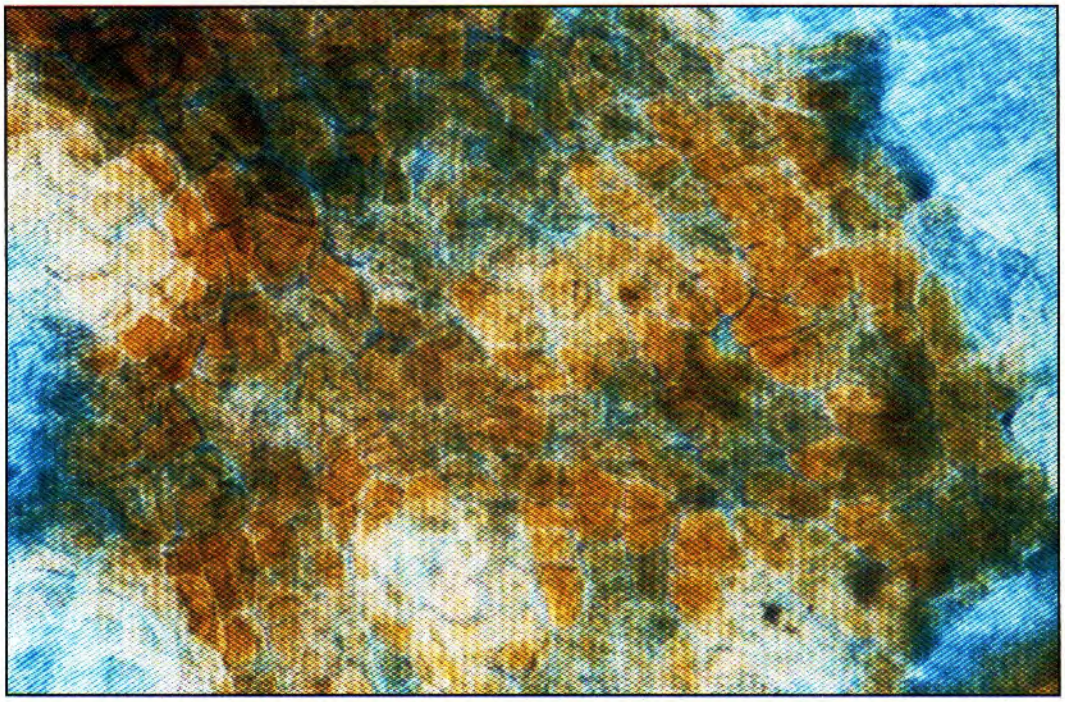


Plate 2. Hypersensitive reaction in tissue of ber fruits (var.)

Farm development

At CIAH, Bikaner

Land Development and Utilization

Up to March,2001, 50 hectare farm area has been developed. Out of which, 12 ha area has been developed under massive land levelling works during summer-2000 for extension of plantations and resulted to this addition of twelve hectare area under new field fruit crops comprising kinoow (1 ha), ber-agroforestry (2 ha), ber varieties (2 ha), pomegranate cultivars (2 ha), date palm (2 ha), khejri (1) and plant pathology block (1 ha). Besides this, maintenance and management of existing field cropped area of ber (8 ha), pomegranate (4 ha), date palm (3 ha), aonla (2 ha), vegetables (4 ha) and nursery and progeny block (4 ha) as field germplasm repositories and experimental crops. Cultivation of arid legumes not only helps in improving soil fertility but also useful for steady field development in phase manner, therefore, ten ha area was taken for rainfed clusterbean crop during *kharif* season but failure of monsoon resulted to very poor crop. More than 1500 saplings of neem, lasora, ashoka and number of ornamental species are being maintained as a shelter belt or wind break plantation along farm fencing, irrigation channels and also near farm complex areas. Land development and levelling work is continue to develop sites as per master plan.

Shelterbelt and landscape plantation

More than 1500 neem and other ornamental species are being maintained as a shelterbelt/wind break plants or land scape. Land development and lay-out works are in progress to develop landscape sites near laboratory cum office building and farm complex. About 1200 running metre staggered close *bordi* hedge row has been developed by planting rootstocks at 0.5 metre distance to protect experimental crops from attack of wild animals.

Seed production and revenue generation

Seed production of eight varieties of cucurbits and some promising advance lines of tinda, bottlegourd, clusterbean, cowpea, brinjal, and *Moringa* has been started. About 500 kg cluster bean and 15 kg vegetable seeds have been produced. During the year about Rs. 25,000/- were generated through sale of farm produces like seeds, fruits, vegetables and grasses.

Irrigation system

To provide irrigation water in newly developed 6 ha fruit orchards of ber and pomegranate and also water facilities in 15 ha areas from Nursery block to office cum laboratory building, a detailed irrigation plan was prepared and implemented by extending 1200 m PVC main water supply pipe line during 2000 and resulted to inter connection of all the water sources in the farm area i.e. IGNP irrigation water, tube wells (2) and pipe line net work. Now, present functional irrigation system consists, water supply through IGNP and two tube well inter connected with diggi, storage tank and main PVC supply pipe line (3 km in length) in farm to cover more than 50 ha cropped area either through open channels, controlled by point valves, lines (sprinklers 4 set inclusing guns) or drip system (11 ha.).

Landscaping

The institute is in establishment phase, hence creation of aesthetic and ecofriendly environment inside the campus is very essential. As a first step of campus beautification, about 2 ha area at front of main

office-cum-laboratory building and 2.5 ha area near electric sub-station have been leveled properly on contract basis. Some paths and beds were made as per need of the site after removing the bushes and stones. Thereafter, pits were dug out for plantation of perennials. The land leveling work is also under progress around residential quarters.

From main gate to residential quarters, avenue trees were planted. A hedge row of *Tecoma* was also developed along the main road. Along the inner side of the boundary wall different colour of *Bougainvillea* have been planted. Check basin has been made to facilitate irrigation of the new establishing plants. At present, all the fifty plants are alive and some of them have started flowering. Some shrubs were also planted as specimen plants in the lawn area. Along the fencing boundary, some neem plants were planted, all the plants are alive and growing well. For the beautification and to protect the land against wind erosion, a small piece of land out side the main building was converted into grassy land.

To create live aesthetic out look inside the office-cum laboratory building, some shade loving ornamental plants were planted in the earthen pots filled with proper growing media. The main indoor plants used for the purpose are; Chinese palm, *Snsevieria*, *Asparagus*, Fan palm, *Crinum*, *Aralia*, *Monstera deliciosa*, Rubber plant, *Bryophyllum*, *Croton*, *Crysanthemum* etc. These plants are being managed by the landscaping unit and replaced as and when desired either after repotting or by planting with new types.

At CHES, Godhra

CHES,Vejalpur(Godhra) : A total of 110 ha. area has been planted with various horticultural and forest plants which include mango, ber, citrus, neem, aonla, mahua, phalsa, badam, behada, aritha, some vegetables, ornamental plants and avenue trees . At Block No.III & IV, layout of new plots, pit digging, planting and gap filling work with mango, pomegranate, aonla, ber, custard apple and some forest species were completed during the year. New area under cultivation included 5 ha. under aonla, 1 ha. under ber, 1 ha. under moringa, 1 ha. under pomegranate and 2 ha. under mango.

Deepening of a check dam in Block-IV is completed. Deepening of existing open well in block-IV was also carried out. Two underground water tank in Block-III were also constructed to facilitate spraying and irrigating the young plantations. A bore-well was also dug at blcok-III.

Drip irrigation system has been installed under NATP in blcok –III for citrus and pomegranate crops.

Agricultural extension

At CIAH, Bikaner

Field visit

During period under report, 10 farmers, two agri-horticultural workers and two scientific groups visited experimental farm of the Institute. Incharge Farm and farm technicians attended these groups and technology in arid horticultural crops, activities related to plant genetic resources and development of varieties and technology and farm irrigation system.

At CHES, Godhra

Strategies for adoption of integrated horticulture technologies.

The technologies generated by Central Horticultural Experiment Station, Vejalpur were collected, listed, documented and finalized. Interview schedule is prepared. *Aonla* farmers of Panchmahal and Vadodara districts were surveyed. Statistical analysis is in progress.

Changing Scenario in Arid Horticulture

Short Course

A short course on "Changing Scenario in Arid Horticulture" has been organized successfully at CIAH, Bikaner from 20-29 Sept., 2000. Twenty five participant from 08 States of the country representing 15 organizations have been participated. The level of participation was Scientist/ Assistant Professors and above grade. The course comprised of 30 theory and 08 field practicals run for 10 days. The course covered broadly on status of genetic resources of arid horticulture, crop improvement, crop production, plant protection, nursery management, integrated nutrient and water management, agro-meteorology, management of biotic and abiotic stresses, bio-technology, value addition etc. Apart from own faculty of CIAH, Bikaner, 18 worthy guest speakers were invited to share their experiences in field of arid horticulture.

Staff position

Table Cadre Strength of the Institute as on 31.03.2001:

Category	Present strength
Scientific	37
Administrative	31
Technical	45
Supporting	42
Total	**155**

Staff under A and B as on 31.03.2001

A. Headquarter

S.No.	Name	Designation/Discipline
I.	**Scientific**	
1.	Dr. G.B.Raturi	Director
2.	Dr. B.B.Vashishtha	Principal Scientist (Hort.)
3.	Dr. B.D.Sharma	Sr. Scientist (Soil. Sci.)
4.	Dr. P.L. Saroj	Sr. Scientist (Hort.)
5.	Dr. R. Bhargava	Sr. Scientist (Plant Physiology)
6.	Dr. O.P.Awasthi	Sr. Scietnist (Hort.)
7.	Dr. R.S. Singh	Scientist Sr. Scale (Hort.)
8.	Dr. D.B. Singh	Scientist Sr. Scale (Hort.)
9.	Dr. D.K. Samadia	Scientist Sr. Scale (Hort.)
10.	Mr. P. Nallathambi	Scientist (Plant Pathology)-on study leave
11.	Mrs. C. Umamaheswari	Scientist (Plant Pathology)
12.	Dr. Anil Kumar Shukla	Scientist Hort. (Fruit crop)
13.	Mr. Sumer Singh Meena	Scientist Hort. (Vegetable crop)
14.	Dr. Arun Kumar Shukla	Scientist Hort. (Fruit crop)
15.	Mr. A. Nagaraja	Scientist (Hort.)
16.	Dr. S.R. Meena	Scientist (Agril. Extension)
II.	**Administrative**	
1.	Mr. Ayaz Ahmed	Asstt. Fin. And Accounts Officer
2.	Mr. V.K. Pandey	Asstt. Admn. Officer
III.	**Technical**	
1.	Mr. M.K.Jain	T-4 (Sr. Computer)

B. Regional Station (CHES, Vejalpur)

S.No.	Name	Designation/Discipline
I.	**Scientific**	
1.	Dr. B.G. Bagle	Sr. Scientist (Ento.) & I/c Head
2.	Dr. Sanjay Singh	Sr. Scientist (Hort.)
3.	Dr. S.S. Hiwale	Scientist (Sl. Grade) Hort.
4.	Dr. H.K. Joshi	Scientist (Sr. Scale) Plant Pathology
5.	Dr. V.V. Appa Rao	Scientist (Soil Science)
6.	Mr. V. Lenin	Scietnist (Extension)
7.	Dr. A.K. Singh	Scientist (Hort.)
8.	Mr. Raja Shankar	Scientist (Hort.)
II.	**Administrative**	
1.	Mr. J.B. Saxena	Asstt. Admn. Officer
III.	**Technical**	
1.	Mr. D.K. Saraswat	T-8 (Technical Officer) Farm
2.	Mr. Nihal Singh	T-5 (Technical Officer) Field
3.	Sh. G.U. Trivedi	T-4 (Librarian)
4.	Sh. A.V. Dhobi	T-4 (Overseer)

Finances

Budget allocation and expenditure incurred during 2000-01 are given in table below.

Table 38: Budget allocation and expenditure incurred during 2000-01

S.No.	Head	Plan		Non-Plan	
		Allocation	Expenditure	Allocation	Expenditure
1.	Establishment Charges	6.00	5.49	124.85	123.27
2.	Labour Charges	6.40	6.40	25.00	26.39
3.	T.A.	3.75	3.75	2.00	1.98
4.	O.T.A.	0.25	0.25	-	-
5.	Works	78.35	78.35	6.00	6.00
6.	Other Charges	94.25	94.25	21.35	21.04
7.	One time catchup grant	11.00	10.76	-	-
	Total	**200.00**	**199.25**	**179.20**	**178.68**

Publications

A. Research papers

Samadia, D.K. (2000). Improvement of arid vegetables. *In:* Short Course on "Changing Scenario in Arid Horticulture", NRCAH, Bikaner, Sept. 20-29, 2000, pp 104-121.

Samadia, D.K.; B.B.Vashishtha and P. Nallathambi (2000). Genetic diversity in red pepper (*Capsicum annuum* L.) under hot arid environment (Symp. Abst.). Impact of human activity on T*har* desert environment, Feb., 15-17, 2001, Jodhpur, pp. 73-74.

Vashishtha, B.B.; D.K.Samadia and P. Nallathambi (2000). Collecting pomegranate germplasm from arid region. (Sym. Abst.) Impact of human activity on T*har* desert environment. Feb. 15-17, 2001, Jodhpur, pp. 99.

Dwivedi, N.K., D.C. Bhandari, Neelum Bhatnagar and D.K. Samadia (2000). Collecting diversity of kachari (*Cucumis callosus*) and mateera (*Citrullus lanatus*) from arid regions of Rajasthan. (Sym. Abst.). Impact of human activity on Thar desert environment. Feb., 15-17, 2001, Jodhpur, pp. 77.

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B. Popular/Technical Articles

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C. Book Chapters

Pareek, O.P., R.S.Singh, Vishal Nath and B.B. Vashishtha (2001). "The Prickly Pear", Agro- bios (India), Jodhpur, p. 76.

D. Extension/Lecture delivered

I. During short course on "Changing Scenario in Arid Horticultre", during 20-29 Sept., 2000, following scientists of CIAH gave lectures:

- Arid Horticulture- Concept and Challenges- Dr. O.P. Pareek
- Conservation of genetic resources of arid fruit in India- Dr. G.B. Raturi
- "Introduction of Exotics" by Dr. R.S. Singh.
- "Approaches for Improvement of Arid Fruits" by Dr. B.B.Vashishtha and Dr. Anil Kumar Shukla
- "Breeding for Bitotic Stress in Arid Fruits" by Dr. B.B. Vashishtha and Dr. Anil Kumar Shukla
- "Improvement of Arid Vegetables" by Dr. D.K.Samadia
- "Integrated Nutrient Management in Arid Horticultural Crops" by Dr. B.D.Sharma
- "Nursery Management in Arid Horticulture" by Dr. P.L.Saroj and Dr. Arun Kr. Shukla
- "Date palm Research in India" by Dr. O.P.Pareek
- "Physiological Adaptation to Water Stress" by Dr. R. Bhargava
- "IPM in Horticultural crops" by Dr.B.G.Bagle, Sr.Scientist
- "Aonla - A potential crop for arid ecosystem" by Dr. S. Singh.

II. " Nursery management in arid fruits" in a National Workshop at RAU, Bikaner dated 15-02-2001 (Dr. P.L.Saroj)

III. " Utilization of degraded lands for fruit production" in a National level training on fruit cultivation at RAU, Bikaner dated 27.3.2001 (Dr. P.L. Saroj).

F. Radio Talk

Dr. P.L. Saroj delivered a radio talk on "Phal vrikshon ke sath vaniki vrikshon ki kheti (Hindi)" , All Indian Radio, Bikaner dated 27.9.2000.

Dr. O.P.Awasthi delivered radio talk on topic " Shusk Chetra mein Bagwani" broadcasted by AIR, on 09.03.01.

Human Resource Development

A. Additional Qualification Acquired

Dr. R.S. Singh awarded Ph.D. degree in Horticulture from Dr. B.R. Ambedkar University, Agra (UP).

Dr. Anil Kumar Shukla awarded Ph.D. Horticulture from Division of Fruits and Horticultural Technology, IARI, Pusa, New Delhi-12.

Dr. Arun Kumar Shukla awarded Ph.D. (Horticulture), Institute of Agril. Science, BHU, Varanasi, U.P.

B. Training programme attended

1. By Dr. Anil Kumar Shukla
Short course on " Changing Scenario in Arid Horticulture" during Sept. 20 to Sept. 29, 2000 at CIAH, Bikaner.

72nd " Foundation Course for Agricultural Research Service" during Ist December, 2000 to March, 2001 at NAARM, Hyderabad (A.P.)

2. By Dr. Arun Kumar Shukla
Short course on changing scenario in Arid Horticulture during Sept., 20 to Sept. 29, 2000 at NRC for Arid Horticulture, Bikaner (Raj.).

72nd Foundation course on agriculture research service during Ist Dec., 2000 to 30th March, 2001 at NAARM, Hyderabad.

3. By Sh. S.S. Meena
Short course on changing scenario in Arid Horticulture during Sept., 20 to Sept. 29, 2000 at NRC for Arid Horticulture, Bikaner (Raj.).

72nd Foundation course on agriculture research service during Ist Dec., 2000 to 30th March, 2001 at NAARM, Hyderabad.

4. By Sh. A. Nagaraja
72nd Foundation course on agriculture research service during Ist Dec., 2000 to 30th March, 2001 at NAARM, Hyderabad.

5. By Dr. S.R. Meena
72nd foundation course for Agricultural Research Service from Dec. 1, 2000 to March, 2001 at NAARM, Hyderabad.

6. By Dr. D.B. Singh
Training on *MS-Office Professional and Window* Sept. 3rd to Sept. 5th 2000. held at NIIT Bikaner. Rajasthan.

Short course on " *Changing scenario in Arid Horticulture*" from Sept. 20 - 29, 2000 at NRC for Arid Horticulture, Bikaner, Rajasthan. Sponsored by **ICAR,** N. Delhi

C. Special assignment

Dr. P.L.Saroj, Sr. Sci. was nominated as editor for the Journal *Progressive Horticulture* by Hill Horticulture Development Board, Ranikhet (Uttranchal)

D. Participation in Teaching and Guiding M.Sc. (Ag.), Horticulture Students at College of Agriculture, RAU, Bikaner.

Dr. D.K.Samadia, Scientist (SS) Horticulture, involved in teaching andguiding M.Sc. (Ag.) Horticulture, as faculty members i.e. Ist Semester (Summer Vegetable Production 2000-2001) and IInd Semester (Breeding Vegetable Crops 2002-2002) courses.

Meeting /Seminars/Symposium

Name of Meeting /Seminars/Symposium	Scientist participated
Xth Research Workers Group Meeting of AICRP on AZF held at ANGRAU, Hyderabad from 13-15 November, 2000.	Dr. G.B. Raturi, Director Dr. B.B. Vashishtha, PS Dr. B.D.Sharma, Sr. Sci. Dr. P.L. Saroj, Sr. Sci. Dr. R. Bhargava, Sr. Sci. Dr. R.S. Singh, Sci. Sr. Scale Dr. D.B. Singh, Sci. Sr. Scale
Research Degree Committee Meeting as external expert (Horticulture) at CCS University of Meerut dated 2.3.2001	Dr. P.L. Saroj, Sr.Sci.
The project review meeting on "Women and Child Malnutrition Project", Govt. of Rajasthan, as a member of core team at Collectorate, Bikaner dated 17.5.2000 and 29.3.2001.	Dr. P.L. Saroj, Sr. Sci.
ZREAC meeting of Zone IC ARS, RAU, Bikaner dated 19-20 Feb., 2001.	Dr. P.L. Saroj, Sr. Sci.
Second Zonal Workshop for Co-operators working for conservation of Agrobiodiversity in arid region. Feb 28th- March 1 2001 held at CIAH, Bikaner..	Dr. D.B.Singh, Sci. Sr. Scale
Participated in a National Symposium on "Resource Management and Environment Conservation through Agroforestry" at NRCAF, Jhansi, dated 12-14 Sept., 2000.	Dr. P.L.Saroj, Sr. Sci.
National Seminar on Hi-Tech Horticulture at IIHR,Bangalore during 24-29 June, 2000	Dr. G.B. Raturi, Director Dr. B.B. Vashishtha, PS Dr. B.D.Sharma, Sr. Sci. Dr. R. Bhargava, Sr. Sci.
Symposium on Impact of human activities on Thar Desert environment on 15th-17th Feb., 2001 at CAZRI, Jodhpur	Dr. B.D.Sharma, Sr. Sci.
National Seminar on Developments in Soil Science-2000 during Nov. 14-18, 2000, NBSSLUP, Nagpur	Dr. B.D.Sharma, Sr. Sci.
Participated in two days Jojoba cultivation programme held at RAU, Bikaner organized jointly by AJORP, Jaipur and RAU, Bikaner from 29-30 Nov., 2000.	Dr. P.L.Saroj, Sr. Sci. Dr. R.S. Singh, Sci. Sr.Scale Dr. D.B.Singh, Sci. Sr. Scale Dr. B.D.Sharma, Sr. Sci.
Hindi Training-cum-Workshop at NAARM, Hyderabad	Dr. P.L.Saroj, Sr. Sci.

Promotions

> Sh. B.V. Rathva, T-1 (Lab. Tech.) promoted to the post of T-2 (Lab.Tech.) w.e.f. 10.11.1999.

Foreign Visits

> Dr. B.B. Vashishtha, Principal Scientist (Hort.) visited Arab Republic of Egypt under Indo-Egypt Work Plan (1999-2000) from Sept. 23-28, 2000

> Dr. D.K.Samadia, Scientist (Sr. Scale) Horticulture, deputed Israel to attend International Post Graduate Course on "Protected Agriculture in Arid and Semi-arid Regions" from January, 29 to March, 08, 2001 at the Division for External Studies, Faculty of Agricultural, Food and Environmental Quality Sciences, Hebrew University of Jerusalem, Rehovot, Israel.

Joining

* Sh. A. Nagaraja, Scientist joined at Bikaner on 03.05.2000.

* Dr. S.R. Meena, Scientist (Agri.Extn.) joined at Bikaner on 14.09.2000.

* Dr. O.P. Awasthi, Sr. Scientist joined at Bikaner on 23.10.2000.

Transfer

* Dr. S.K. Malhotra, Sr. Scientist (Hort.) relieved alongwith post on 04.07.2000 (A.N.) from CHES, Vejalpur to NRCSS, Ajmer.

* Sh. Surender Singh, T-5 (Tech. Officer) transferred to NRC on Seed Spices, Tabiji, Ajmer on 3.6.2000.

* Smt. Mehjabin Bilgrami, LDC, transferred to HSADL (IVRI), Bhopal on 17.6.2000

Visitors

❖ Dr. G.L. Kaul, Chairman-RAC and Vice-Chancellor, Assam Agricultural University, Jorhat on dated 24-02-2000.

❖ Dr. R.K.Pathak, Member-RAC and Director, CISH, Lucknow on dated 24.02.2000.

❖ Dr. V.S.Sheshadri, Member-RAC and Ex-Head, Division of Vegetable Crops, IARI, New Delhi on dated 24.02.2000.

❖ Dr. S. Chaudhari, Member-RAC and Professor, Deptt. of Plant Pathology, BCKVV, Nadia, W.B. on dated 24.02.2000.

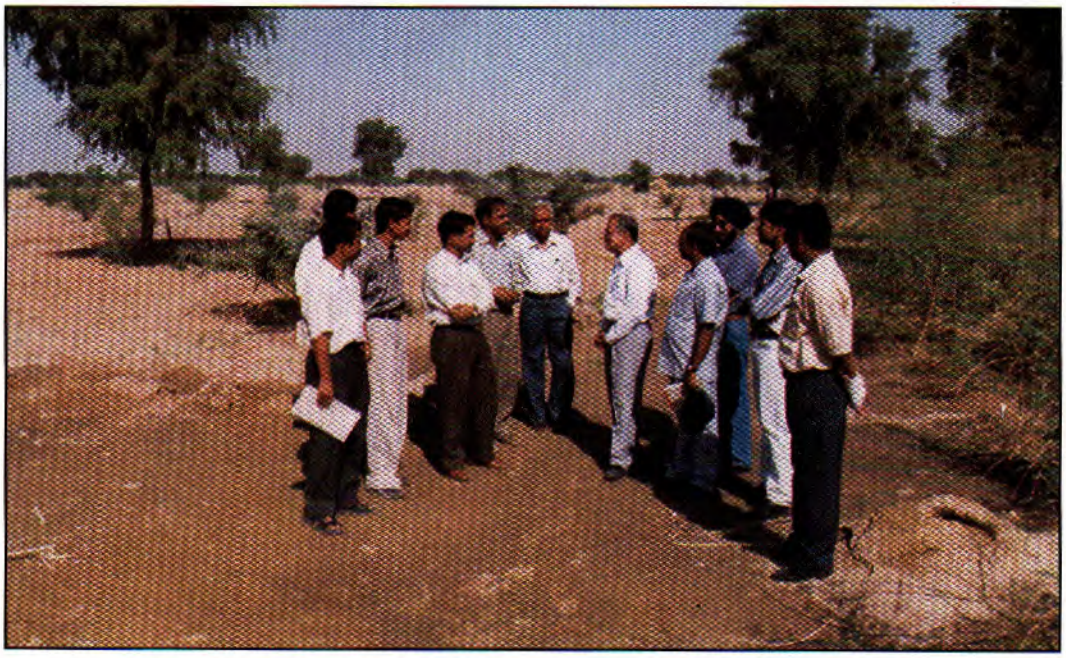
❖ Dr. S.R.Poonia, Member-RAC and Professor, CCS HAU, Hisar on dated 24-02-2000.

❖ Mr. D.Pradhan, State Minister, Ministry of Agriculture, Govt. of India, New Delhi on dated 23rd Aug., 2000.

❖ Dr. Om Prakash, Project Coordinator (STF) and Drip Net, CISH, Lucknow on date 11th Sept, 2000.

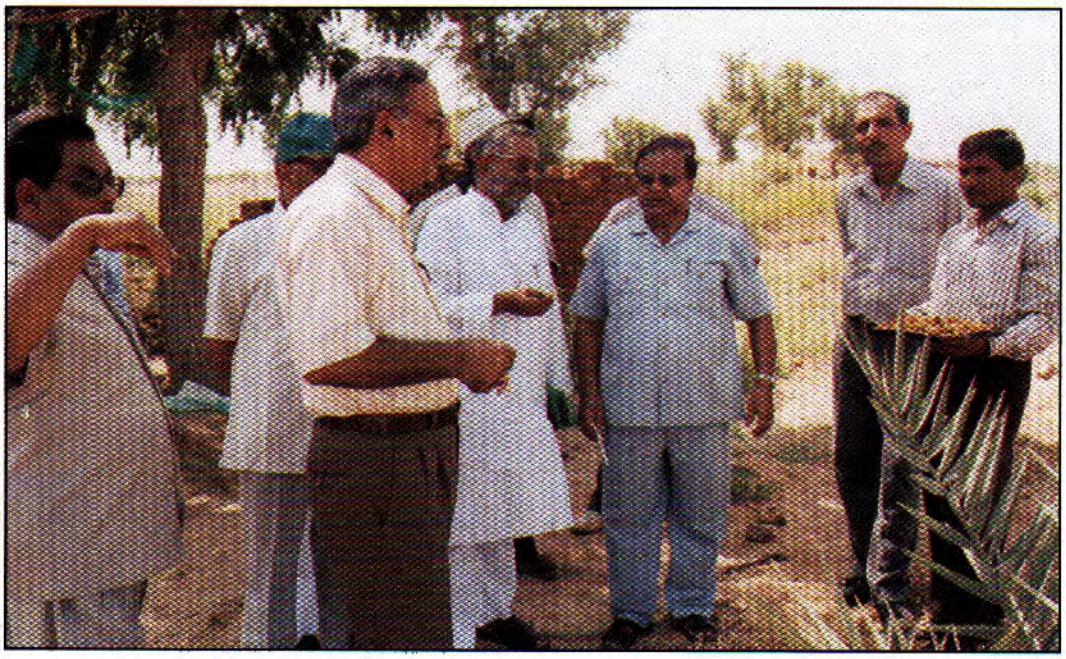
❖ Dr. A.G. Sawant, Chairman, ASRB, New Delhi on dated 06.11.2000

Sh Devendra Pradhan, Hon. Minister of State, Agrculture, Govt. of India, New Delhi during his visit at CIAH, Bikaner



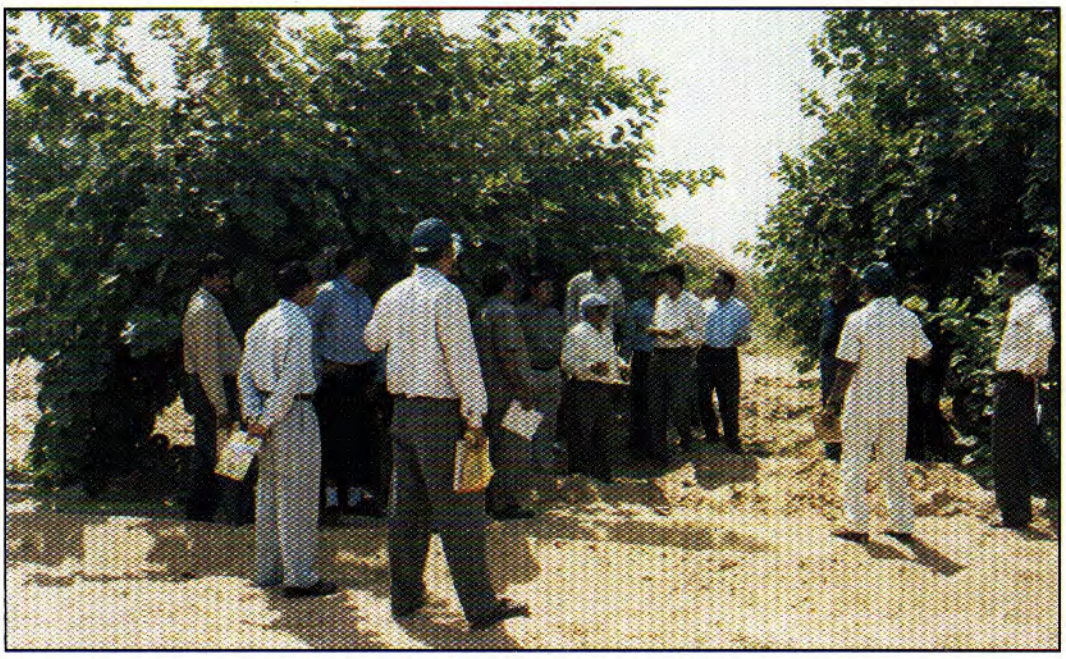
Dr. A. G. Sawant, Ex-Chairman, ASRB, New Delhi discussing research programmes with scientists

RAC meeting in progress at CIAH, Bikaner



Chairman and members of RAC discussing the experiments with scientists.

Inaugural Function of a short course on changing scenario in Arid Horticulture



Participants of short course during field visit.

वार्षिक प्रतिवेदन सारांश

कृषि के वर्तमान परिदृश्य में जहां बढ़ते हुए शहरीकरण के कारण कृषि योग्य भूमि का आकार सिकुड़ता दृष्टिगत होता जा रहा है, वहां उष्मीय शुष्क क्षेत्र में कृषि उत्पादन को विकसित करने के बहुत विकल्प हैं। शुष्क क्षेत्र भारत के कुल क्षेत्रफल के लगभग 12 प्रतिशत भूभाग में फैला है। यह क्षेत्र राजस्थान, हरियाणा, पंजाब, गुजरात, महाराष्ट्र, आन्ध्रप्रदेश तथा कर्नाटक राज्यों में है। अब, लगभग यह निश्चित हो गया है कि बहुवार्षिक उद्यानिकी फसलें न केवल यहां के निवासियों की पोषण व आर्थिक स्थिति में सुधारने में सफल रही है वरन् उष्मीय जलवायु के प्रभाव को भी सीमित करने में महत्वपूर्ण भूमिका निभा रही हैं। यद्दपि इन कठोर जलवायविक परिस्थितियों में इनको उगाने सम्बन्धित तकनीकियों को और अधिक विकसित करने की आवश्यकता है। इन्हीं उद्देश्यों को फलीभूत करने हेतु राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान की स्थापना 1993 में की गई जो बाद में केन्द्रीय शुष्क उद्यानिकी संस्थान में कमोन्नत कर दिया गया।

मुख्य ध्येय

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

उद्देश्य

1. शुष्क परिस्थितियों में उद्यानिकी फसलों की जैवविविधता की पहचान करना, संग्रह, संरक्षण, मुल्यांकन तथा वर्गीकरण करना।
2. लक्षित फल–फसलों जैसे– बेर, अनार, आंवला, खजूर एवं खीरावर्गीय, फलीदार एवं फलदार (सौलैनीसियस कुल) सब्जियों को उपलब्ध जैव विविधता के प्रयोग द्वारा उच्च गुणवत्ता, उत्पादकता तथा जलवायु के अनुरूप विकसित करना।
3. यथा स्थापित एवं नवीन उद्यानिकी फसलों में द्रुत प्रवर्ध्यगुणन से सम्बन्धित तथ्यों एवं उनकी बढ़वार तथा फल विकास की समस्याओं का अध्ययन करना।
4. पोषक तत्वों, जल एवं मृदा का उद्यानिकी फसलों की शुष्क जलवायु के अनुरूप उत्पादकता बढ़ाने के लिए समुचित उपयोग करने की कृषि तकनीकीयों का विकास कर उनका मानकीकरण करना।
5. उच्चताप एवं विकिरण संसाधनों के उपयोग हेतु उद्यानिकी फसल–चक्र पद्धतियों के पारिस्थितिजन्य परिमापकों का अध्ययन करना।
6. शुष्क क्षेत्रीय उद्यानिकी फसलों के उत्पादों की सर्वउपलब्धता हेतु कटाई उपरान्त तकनीकियों का विकास करना।
7. शुष्क परिस्थितियों में उद्यानिकी फसलों हेतु समाकलित कीट एवं व्याधि प्रबन्ध की तकनीकियों का विकास करना।

वर्ष 2000.2001 के मध्य अनुसंधान क्षेत्र में अर्जित महत्वपूर्ण उपलब्धियों का संक्षिप्त विवरण :

1. प्रतिवेदन की अवधि में संस्थान की संचित निधि में निम्नलिखित जननद्रव्यों का संचय और किया गया– बेर में 15, आंवले के 05, गूंदा में 32, फालसा के 03 तथा पीलू का 01, इस प्रकार संस्थान की कुल संचित निधि बढ़कर इस प्रकार है– बेर में 300, अनार में 150, आंवला में 22, कैक्टर पीअर में 106, खजूर में 47, काचरी में 558, मतीरा में 193, स्नेपमेलन में 90, मिर्ची में 132, खरबूजे में 55 एवं 60 किस्में अन्य विभिन्न फलों को जो तालिका कमांक 22 में दिये गए हैं।
2. बेर में *फ्लोरल बायोलोजी* अध्ययन किया गया। इसमें यह पाया गया कि आफेनथेसिस समय एक प्रजातिगत लक्षण है।
3. शुष्क क्षेत्रीय स्थानीय व एक्जोटिक अवप्रयोगी फलों पर चिन्हित कर चयनित करने का कार्य आरम्भ किया गया है।
4. तरबूज में मतीरे के शुष्क वातावरण वाले गुणों को सम्मलित करने के प्रयास में मतीरे की एफ 3 प्रोगेनी ए.एच.डब्ल्यू. 19 को तरबूज को सूगरबेबी किस्म से मिलान करवाया गया। यह फलाकार, मिठास, गूदे की मात्रा व रंग, फल उत्पादन, कठोरता आदि गुणों में सामन्जस्य स्थापित करती दर्ज की गई।

5. 7000 पी.पी.एम. आई.बी.ए. के साथ 1000 पी.पी. एम. थाईमीन के मिश्रण से उपचारित कैर (केपरिस डेसिडुआ) की कलमों में सितम्बर माह में नवांकुर स्टन दर्ज किया गया।
6. बेर में किए गए प्रकाश संश्लेषण अध्ययन में यह पाया गया कि बेर की किस्मों को नेट प्रकाश संश्लेषण, कार्बोलेक्सी प्रभाव, मध्य दिवस प्रकाश संश्लेषण प्रभाव एवं जलोपयोग के आधार पर समूह में बांटा जा सकता है।
7. खीरावर्गीय फसलों में सुखे के परिमापकों को निश्चित करने में पौधों में बढ़त पर दबाव एवं सूखे की स्थिति का दबाव दोनों प्रकारों को प्रयोग में लाया जा सकता है।
8. अनार में अकार्बनिक उर्वरक एवं कार्बनिक खाद को देने की तुलना की गई। वर्मीकम्पोस्ट व अकार्बनिक उर्वरक देने पर पौधे की ऊंचाई व डब्ल्यू.यू.ई. अच्छी दर्ज की गई। वर्मीकम्पोस्ट को स्वतन्त्ररूप में अथवा अकार्बनिक उर्वरकों के साथ देने से पौधे में नत्रजन की मात्रा बढ़ती जाती है।
9. शुष्क क्षेत्रीय फलों एवं सब्जियों में प्राप्त मुख्य रोगों की रोकथाम जैविक नियंत्रण की संभावनाओं को खोजने हेतु ट्राईकोडरमा प्रजाति का गुणन व बढ़त को विभिन्न आयामों से परखा गया। इसमें दर्ज किया गया कि खेजड़ी (प्रोसोपिस) की फलियों (सांगरी) के चूर्ण को मिट्टी में मिलाकर देना विभिन्न छितराए ट्राइकोडरमा में स्पोमलेशन हेतु अच्छा रहा।
10. संस्थान के वैज्ञानिकों एवं तकनीकी तथा प्रशासनिक अधिकारियों ने अन्य सहयोगी व रचनात्मक कार्य कलापों में सहयोग किया। संस्थान के वैज्ञानिकों ने विभिन्न किसान मेलों व अन्य किस्तार गति विधियों में सकिय भाग लेकर किसानों को नई प्रोद्योगिकियों से अवगत कराया। कृषि विश्वविद्यालय एवं अन्य कृषि संबंधी संस्थाओं के साथ सहयोग में प्रशिक्षण व अध्ययन कक्षाएं आयोजित कर कृषि विद्यार्थियों व किसानों को उचित मार्गदर्शन प्रदान किया।