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NATIONAL RESEARCH CENTRE FOR ARID HORTICULTURE
BIKANER-334006, INDIA

Annual Report
1999-2000

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BEECHWAL, BIKANER-334 006, INDIA

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Director,
NRC for Arid Horticulture,
Beechwal, Bikaner-334 006 (Rajasthan) India.
Phone : 0151-250147, 250960
Fax : 0151-250145
E-mail : ciah@hub1.nic.in

Compiled and Edited

Dr. G.B. Raturi
Dr. B.B.Vashishtha
Dr. R. Bhargava

Computerized

Mr. M.K.Jain
Mr. B.R. Khatri

Photography

Mr. Sanjay Patil

Hindi Version

Mr. P.P.Pareek

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Cover

Front : *Ber* cultivars

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INTRODUCTION

The hot arid region occupies nearly 12 per cent land surface of India in the States of Rajasthan, Gujarat, Haryana, Punjab, Andhra Pradesh, Karnataka and Maharashtra. The production of horticultural crops in this region is confined to a few small pockets having irrigation water. It is now realised 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, the geophysical and agro-climatological constraints for production of these crops in arid areas necessitated development of special production technologies. Since the available research set up for this purpose in the State Agricultural Universities and in the Institutes of the ICAR was inadequate, the Indian Planning Commission, as recommended by the Working Group on Agricultural Research and Education, approved the establishment of National Research Centre for Arid Horticulture (NRCAH) during the Seventh Five Year Plan. To make the Centre functional, Project Coordinator, All India Coordinated Research Project on Arid Zone Fruits (AICRP on AZF) located at CCS HAU, Hisar was assigned additional duties of its Officer on Special Duty (OSD) in November, 1990. After identification of land for the establishment of NRCAH, the Project Coordinator along with Coordination Unit was shifted from Hisar to Bikaner in March, 1993 and merged with NRCAH.

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 Centre during 1999-2000 were:

1. During the period under report 15 promising strains of *ber*, 5 of *aonla* were collected and 2 cultivars of pomegranate have been introduced from Argentina. With this, a total

of 300 germplasm of *ber*, 150 of pomegranate, 19 of *aonla*, 106 of cactus pear, 47 of date palm, 558 of *kachari*, 192 of *mateera*, 90 of snapmelon, 132 of chillies and 55 of muskmelon are being maintained at the centre.

2. In a persuit to incorporate drought hardy character of *mateera* in water melon, crosses between AHW 19 x Sugar baby, AHW 19 x Durgapura meetha, AHW 19 x AHW 65, AHW 65 x Sugar baby, AHW 65 x Durgapura meetha, Sugar baby x AHW 19 were attempted. The F1 of AHW 19 x Sugar baby gave promising results.
3. It was observed that the sprouting of *Prosopis cineraria* cuttings are achieved during the month of February.
4. Studies on growth and development of *mateera* and watermelon under water stress reveals that *mateera* is drought hardy and can give good growth even under 4 irrigations whereas watermelon can not tolerate water stress.
5. Studies on photosynthetic parameters in 10 cultivars of *ber* reveal that cultivars such as Narma, Kakrol Gola, Katha Phal, Dandan demonstrate mid day depression.
6. Studies on pit size and filling mixture for moisture conservation during establishment of fruit crops reveals that plant growth and survival was best in pit size 60 x 60 x 60 cm.
7. 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.
8. 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 biodiversity.

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

During Jan., 2000, an exploration was under taken in the parts of Rajasthan and Gujarat. Fifteen strains have been identified (Table 1) i.e. 4 from Sirohi district of Rajasthan, 3 from Patan, 3 from Mehsana, 2 from Anand, 2 from Panchmahal and 1 from Sabarkata district of Gujarat. The bud wood of these identified elite strains will be collected in the month of August, 2000.

Table 1. Details of *ber* germplasm collected from Rajasthan and Gujarat

Strain No.	Site of collection	Plant age (year)	Fruit weight (g) (five fruits)	TSS (°Brix)
NRCAH-31	Sirohi (Rajasthan)	50	65.42	18
NRCAH-32	Sirohi (Rajasthan)	50	55.49	16
NRCAH-33	Sirohi (Rajasthan)	50	79.37	16
NRCAH-34	Sirohi (Rajasthan)	50	85.82	16
NRCAH-35	Patan (Gujarat)	60	10.45	19
NRCAH-36	Patan (Gujarat)	60	11.31	17
NRCAH-37	Patan (Gujarat)	20	57.33	16
NRCAH-38	Mehsana (Gujarat)	40	-	-
NRCAH-39	Mehsana (Gujarat)	20	82.84	18.5
NRCAH-40	Mehsana (Gujarat)	20	115.48	14.9
NRCAH-41	Anand (Gujarat)	40	24.58	18
NRCAH-42	Anand (Gujarat)	15	21.56	20.0
NRCAH-43	Panchmahal (Gujarat)	10	32.13	19.0
NRCAH-44	Panchmahal (Gujarat)	20	21.35	18.0
NRCAH-45	Sabarkata (Gujarat)	30	25.00	17.0

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

22 genotypes of boardi have been identified and are being maintained at NRCAH.

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

Five promising strains at Anand and four at Sabarkata district of Gujarat have been identified (Table 2). The bud wood of these identified elite strains will be collected in the month of August, 2000.

At present 19 genotypes of *aonla* are being maintained in the germplasm block.

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

Table 2. Details of aonla germplasm collected from Rajasthan and Gujarat

Strain No.	Site of collection	Plant age (year)	Fruit weight (g) (five fruits)	TSS (°Brix)
NRCAH-1	Anand (Gujarat)	10	-	-
NRCAH-2	Sabarkata (Gujarat)	13	24.91	12
NRCAH-3	Sabarkata (Gujarat)	13	40.08	10
NRCAH-4	Sabarkata (Gujarat)	13	41.43	12
NRCAH-5	Sabarkata (Gujarat)	13	20.75	11

Field repository: The work on collection of genetic diversity of pomegranate was started in 1995 with a view to develop a "National Repository" under arid environment. To date, 150 genotypes have been collected and are being maintained and evaluation is under way. Of these, only 22 collections which fruited were evaluated for fruit quality and yield potential. Four pomegranate germplasm introduced from Iran, in 1997 in the form of cuttings by the NRCAH, are being maintained under field repository for evaluation. Besides, 250 seedlings have been raised from open pollinated fruits from Iran and planted for evaluation at closer spacing. Seven pomegranate cultivars introduced from Iran in collaboration with NBPGR, New Delhi in 1998 and two more introductions from Argentina in 1999 are being maintained for multiplication and field evaluation.

About 1500 seedlings of 52 open pollinated single plant collections from seedling orchards of pomegranate cultivar Jalore Seedless were planted in field at closer spacing of 2.0x1.0 meter for evaluation.

A 1.5 Collection, conservation and evaluation of date palm *(Phoenix dactylifera)*

Thirty one date palm germplasm collected from indigenous as well as exotics are being maintained at the centre. In addition to this, performance of few tissue cultured plants are also being evaluated under field conditions.

A. 1.6 Collection, conservation and evaluation of prickly pear

Cactus pear *(Opuntia ficus indica* (L.) Mill) genotype was introduced from Argentina during the year 1999.

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

Evaluation of cucurbit germplasm : Realising the potential of cucurbits in the arid region, especially watermelon type *mateera (Citrullus lanatus), kachari (Cucumis callosus),* snapmelon *(Cucurmis melo* var. *momordica), salad kakdi* and muskmelon (*Cucumis* spp.) research initiatives have been undertaken from 1994. In this direction, during 1998 some watermelon and muskmelon varieties were introduced from Iran and were evaluated alongwith adapted varieties and local strains at NRCAH, Bikaner (Table 3).

Evaluation of exotic muskmelon germplasm (Summer and Rainy season, 1999)

Six exotic muskmelon genotypes introduced from Iran were evaluated alongwith check (adapted to arid eco-system) during the summer season of 1999 (Table 4). In all the genotype the fruit setting was observed at more than

90 days after sowing and at harvest the fruits were very small (150-300 g weight) with very poor quality under arid conditions. The same material was re-evaluated in rainy season and only two genotypes bear fruits (after 95 days of sowing) with heavy fruit fly infestation.

Table 3. Evaluation of watermelon varieties (Summer and Rainy Season, 1999)

Name of variety	Days to first female flower (DAS)	Days to first harvest (DAS)	No. of marketable fruits/plant	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	TSS (oBrix)	Per cent fruit cracking	Over all fruit quality rating
Charleston Local (EC 420977)	80.20	120.5	1.3	3.54	30.54	58.52	8.2	20.5	A
Mahabobi (EC 420978)	83.50	117.2	1.7	2.85	24.67	58.21	8.8	38.5	B
Sugar Baby	74.3 0	105.8	1.2	2.89	26.54	60.52	9.1	72.8	A
Durgapura Meetha	70.80	102.9	1.5	3.25	24.6 7	68.2 5	9.2	65.5	A
Mateera-AHW 19	47.25	79.1	3.8	3.80	25.5 4	67.12	8.0	0.0	B
Mateera-AHW 65	42.50	76.2	4.9	2.96	17.51	57.84	8.1	0.0	B

Table 4. Evaluation of exotic muskmelon germplasm (Summer and Rainy Season, 1999)

EC Number	Name of variety	Node to first female flower	Days to first female flower (DAS)	Days to first harvest (DAS)	No. of fruits/ plant	Fruit weight (g)	Fruit length (cm)	TSS (°Brix)	Vine lengt h (m)
EC 420979	Samsuri	8.5	94.5	119.8	3.2	154.5	15.4	4.3	1.05
EC 420980	Darehgaz	11.7	97.2	127.5	4.2	237.2	15.5	4.2	0.80
EC 420981	Karzaba	21.8	93.5	120.2	2.8	160.5	14.3	3.5	1.10
EC 420982	Lang-e Round	12.7	91.3	122.4	4.1	293.8	11.4	4.7	1.08
EC 420983	Khaghany	12.8	92.5	125.3	3.5	210.5	16.2	2.8	0.75
EC 420984	Zard-E-Isfhan	8.2	93.2	121.1	4.2	305.2	17.5	5.4	1.18
	CHES-238	6.5	81.2	105.0	4.5	890.0	15.2	12.4	2.17

GENETIC IMPROVEMENT

Mission B: Genetic Improvement in arid horticultural crops.

B.1 Improvement in cucurbit vegetables under hot arid environment

B. 1.1 Evaluation of advance lines of *mateera* (Summer and Rainy Season, 1999)

Twenty high yielding and quality fruit (on the basis of firm flesh and high TSS) advance single plant progenies of *mateera* selection AHW 19 and AHW 65 were evaluated in RBD. Growth, yield and fruit quality parameters were taken into consideration for evaluation and screening of these high yielding lines. On an average, all the progenies were good yielder with uniform in fruiting. All the single plant progenies of AHW 19 and AHW 65 showed similar varietal trend in respect of fruit yield and quality characters. The average yield potential and TSS of AHW 19 (445.2 q/ha and 8.2 % respectively) and AHW 65 (395.8 q/ha and 8.2%) respectively. On the basis of TSS, flesh quality of fruit, overall rating, single plant selection have been made for further evaluation.

B. 1.2.Genetic improvement in watermelon through hybridization (Summer and Rainy Season, 1999)

On the basis of the results of work done on drought hardy *mateera* as well as varietal evaluation of watermelon at the centre, it was realised that there is a need to improve the drought hardy *mateera* selections for higher TSS and acceptable fruit quality alongwith higher yields for commercial cultivation under hot arid environments. Therefore, hybridization programme was initiated with the above objectives involving *Mateera* AHW 19, *Mateera* AHW 65, Sugar Baby, Durgapura Meetha, Charleston Local and Mahabobi as a parents.

F1 generation: During summer 1999, four parents (AHW 19, AHW 65, Sugar Baby and Durgapura Meetha) alongwith ten F1 hybrid AHW 19 x Sugar Baby, AHW 19 x Durgapura Meetha, AHW 19 x AHW 65, AHW 65 x Sugar Baby, AHW 65 x Durgapura Meetha, AHW 65 x AHW 19, Sugar Baby x AHW 19, Sugar Baby x AHW65, Durgapura Meetha x AHW 19 and Durgapura Meetha x AHW 65 were evaluated. Observations related to plant growth, earliness, flowering and fruit setting, fruit yield and quality attributes were recorded (Table 5-6). During the summer season, one F1 cross combination i.e. AHW 19 x Sugar Baby expressed highly desirable characters for growth, flowering, fruit setting, earliness and yield attributing traits. The flesh firmness and colour was extremely desirable except TSS (5 ^{0}Brix) in this combination. All the F1's were selfed for generating F2 populations.

During rainy season of 1999, some more F1 cross combinations were incorporated for evaluation. A set of 16 cross combinations alongwith six parents (AHW 19, AHW 65, Durgapura Meetha, Sugar Baby, Charleston Local and Mahabobi) were evaluated for growth, yield and fruit quality parameters under arid condition. Two F1 cross combinations expressed highly desirable attributes i.e. AHW 19 x Sugar Baby and AHW 19 x Charleston Local. On the basis of performance, some F1's were selfed for generating F2 population.

F2 generation: A set of 10 advance lines in

F2 generation were evaluated for fruit yield and quality parameters and wide variability was recorded for growth, flowering, fruit setting, yield and fruit quality characters. In F2, progeny of AHW 19 x Sugar-Baby showed highly desirable characters for earliness and fruit yielding attributes. There was huge variability in fruit shape, size and skin colour, seed size, flesh colour (dark red, red, pink, saffron, yellowish to whitish), flesh firmness and TSS (10.5-13.5 °Brix). No fruit cracking was recorded in this progeny.

Single plant selections were made on the basis of fruit quality (flesh colour, firmness and TSS) and yield contributing traits and were selfed for generating the F3 progenies for further evaluation and selections.

Table 5. Evaluation of advance lines of *mateera* (Summer and rainy season, 1999)

Variety	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (kg)	Yield (q/h a)	Rating		
						Line code	Flesh	TSS (°Brix)
Mateera	43.5	79.4	3.8	3.58	445.2	a,b,e,f	very good	8.3-8.5
AHW -19						c,d,j,k,o,p	good	8.1-8.3
						g,h,i,l,m,n,q,r,s,t	Mediu m	7.9-8.1
Mateera	41.7	75.4	4.5	2.80	395.8	b,c,g,h,i	very good	8.3-8.5
AHW -65						a,d,f,k,l,m	good	8.2-8.3
						e,j,n,o, p,q,r,s,t	Medium	7.8-8.2

Table 6. Performance of some F1 hybrid and F2 progenies of watermelon

Cross	Days to first female flower (DAS)	Days to first harvest (DAS)	No. of marketable fruits	Fruit weig ht (kg)	TSS (°Br ix)	Remarks
F1 hybrid						
AHW 19 x Sugar Baby	55.2	96.5	5.4	3.97	5.0	Flesh dark red, firm and poor taste
AHW 19 x Charleston	50.4	97.4	5.2	3.17	8.2	Flesh red, firm and white heart
AHW 65 x Sugar Baby	57.2	100.2	4.3	3.57	6.0	Flesh red, firm and poor taste
AHW 65 x Charleston	56.2	98.5	6.2	3.10	8.5	Flesh red, firm and white heart
F2 progenies						
AHW 19 x Sugar Baby	41.5	79.7	4.2	2.57	10.5 -13.5	Flesh dark red, red, to pink, saffron to yellowish white in colour. Flesh firm with variable in seed colour,size and number. Very good eating quality. No fruit cracking.

B 1.3 Performance of advance lines of *kachari* (*Cucumis callosus*)

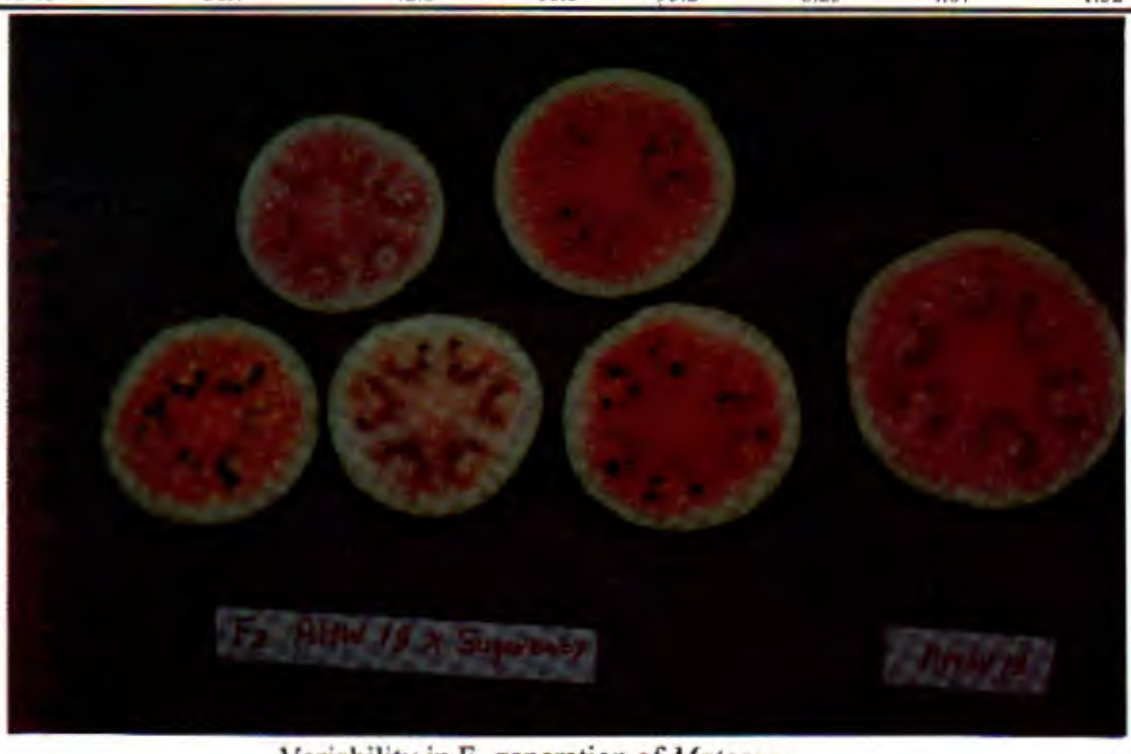
Kachari selections AHK 119 and AHK 200 were further evaluated in replicated trial during summer and rainy season of 1999. The detailed observations related to growth, flowering and fruit setting, maturity, yield and fruit quality characters were recorded (Table 7a). Besides, the characters like fruit fly infestation, incidence of diseases and reaction to drought under field conditions were also recorded. On an average both the selections bear 18-22 fruits/ plant which account to yield potential of about 95 and 100 q/ha, respectively, under hot arid environment in both the season. The seeds of selected plants (on the basis of earliness, number of fruits and yield/plant) were harvested for further evaluations.

Table 7 (a). Performance of *kachari* selections (Summer and Rainy, 1999)

Line	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (Kg)	Fruit Yeald (Kg/Plant)	Yield (q/h a)	Vine length (m)	No. of branches	Fruit fly infest ation (%)
AHK 119	35.7	75.6	22. 6	70.1	1.5 2	95. 1	2.2 0	6.9 2	< 5
AHK 200	33. 8	66.4	19. 8	95.6	1.8 6	100 .7	2.4 5	6.8 2	< 5

Table 7 (b). Evaluation of advance progenies of *salad kakdi* (*Cucumis* spp.)

Lines	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg/ plant)
AHC 2	42.5	54.8	10.2	225.5	28.50	3.14	2.14
AHC 13	36.7	42.8	16.8	95.2	8.25	4.07	1.32



Variability in F_2 generation of *Mateera*

B 1.4. Evaluation of advance progenies of *salad kakdi* (*Cucumis* spp.)

AHC 2: Five single plant progenies of *salad kakdi* AHC 2 were evaluated for earliness, fruit yield and marketable fruit quality traits during summer and rainy season of 1999. However, major emphasis was given on fruit characters like straight shape, softness of flesh and seed, crispiness and taste at marketable stage and rating was done as A,B and C grade, accordingly for further selctions. The character like earliness and fruit setting under high temperatures, fruit fly infestation and incidence of diseases were also taken into consideration. On an average all the progenies were at par with regards to growth and yield attributing traits. Fruits of these lines can be harvested in between 8-10 days from fruit set so that first harvesting was in between 50-55 days from sowing (Table 7b). Potential plants were identified on the basis of earliness and fruit quality characters and selfed seed of selected fruits were harvested for further evaluation.

AHC 13: Five single plant progenies of small fruited *salad kakdi* AHC-13 were evaluated for earliness fruit setting and fruit yield and quality attributes during summer and rainy season of 1999 (Table 7b). During the course of evaluation of these advanced single plant progenies, the major emphasis was on more number of fruits/plant and fruit quality at marketable stage were taken into consideration. All the progenies were at par for growth and yield attributing traits. The immature fruits (3-6 days from anthesis) can be used for *salad* purpose, therefore, proper fruits quality rating (A,B and C grade) was done on the basis of characters such as fruit size and shape, flesh and seed content, softness of seed, crispiness and taste and then overall fruit quality grade was alloted for the selection of plants. Desirable plants were selfed and seeds of selected plants were harvested for further evaluation.

B 1.5. Performance of advance lines of snapmelon (*Cucumis melo* var. *momordica*)

Snapmelon selections AHS 10 and AHS 82 were tested on large scale replicated trial during summer and rainy season of 1999. Observations with regards to growth, maturity, fruit yield and quality attributes were recorded and mean were computed to assess the yield potential (Table 8). Besides, the characters like fruit fly infestation, incidence of diseases and reaction to drought under field conditions were also recorded. On an average selection AHS 82 bears 5-6 fruits/plant with least fruit fly infestation (< 5 per-cent) and yield potential of 235 q/ha in both the season. Where as selection AHS 10 bears 4-5 fruits per plant with

Table 8. Performance of snapmelon selections (Summer and Rainy, 1999)

Line	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (Kg)	Fruit Yeald (Kg/Plant)	Yield (q/h a)	TSS (^{0}Brix)	Fruit fly infest ation %	Vine length (m)	No. of bran-ches
AHS 10	35. 7	64.3	4.8	0.78 0	3.87	202	5.2	10.0	2.51	4.1
AHS 82	36. 8	68.2	5.8	0.95 0	4.55	235	5.0	4.8	2.50	5.6

10% fruit fly infestation and average yield potential of 202 q/ha.

B 2. Improvement in chilli (*Capsicum annuum* L.) under hot arid environment

A total 132 chilli germplasm, collected during 1998 from chilli growing tracts of arid regions of Rajasthan, were evaluated during *kharif* season of 1999 at NRCAH, Bikaner. A wide spectrum of variability was observed for all the agromorphological characters under study. As knowledge gathered from growers in chilli growing areas and on evaluation of collected germplasm, in general, there are four types of land races of chillies, viz.:

Land races	Fruit characters
a) *Mathania* or *Desi* type	Fruit very long, curved, fleshy, thick, mild in pungency, less number of seeds and bright red in colour.
b) *Haripur- Raipur* type	Fruit medium-long, slender, thin, highly pungent with more number of seed
c) *Mahsana* type	Fruit long, thin, slender and straight, highly pungent with more number of seed
d) *Mandoria* type	Intermediate of a & b, fruits medium in length, slightly curved, pungent.

The local chilli land races viz.,*Mathania, Haripur-Raipur, Mahsana* and *Mandoria* type are being in cultivation in the arid region. Due to several production factors and occurrence of biotic and abiotic stresses, there is drastic reduction in yield potential of chilli. The original *Mathania* type chilli is out of its commercial cultivation. This is not only because of poor yields and incidence of diseases but also non availability of pure *Mathania* type seed material and adoption of popular cultivars and land races of adjoining states having more number of seeds in fruit. Therefore, all the collected germplasm were evaluated and grouped according to phenotypic fruit characters and the range of variation have been presented in (Table 9). The seeds of selected plants of promising germplasm were harvested for further evaluation.

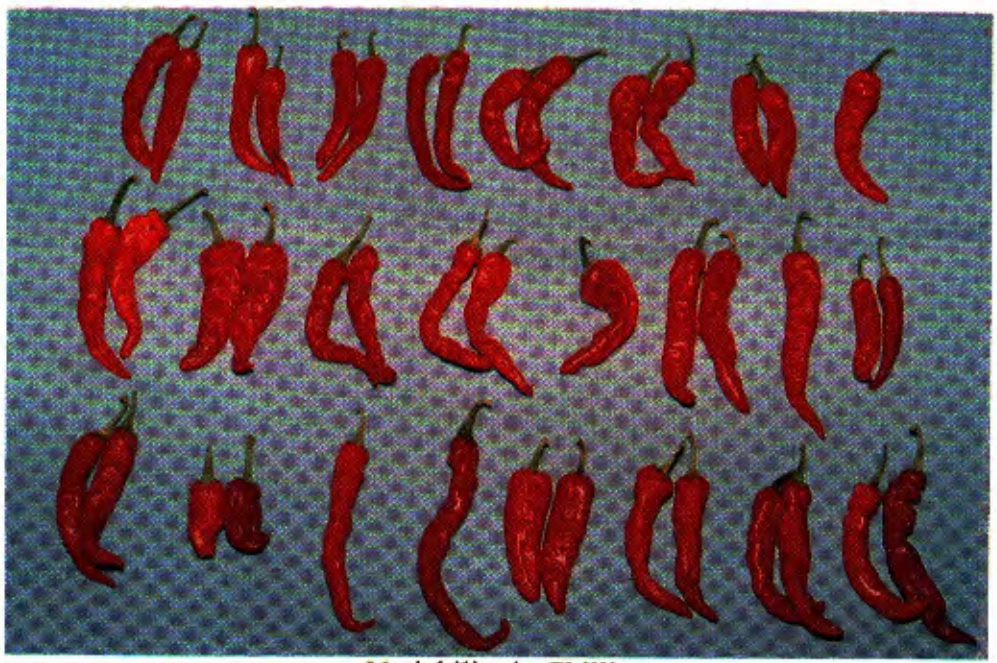
B. 3. Improvement in pomegranate by selection and hybridization

The pomegranate varieties from temperate regions have one desirable characteristics of blood red aril colour and this colour is lacking in our commercially accepted varieties. Therefore, selective simple and complex crosses were made involving desirable parents and seedlings of 15 F1 cross combinations have been planted at closer spacing in the field for evaluation during the year.

Table 9. Genetic diversity in evaluated chilli germplasm.

Characters	Range
Days to first flowering (DAT)	45.2-60.5
Days to 50% flowering (DAT)	52.5-68.4
Days to first harvest, green (DAT)	85.7-97.5
Days to 1st harvest, red ripe (DAT)	110.4-122.2
Number of fruits/plant	21.4-98.4
Plant height (cm)	46.5-78.4
Number of branches/plant	3.2-9.8
Fruit yield, green (g)	141.5-615.4
Fruit yield, red ripe (g)	135.4-556.8
Fruit yield, dry (g)	15.1-62.5
Fruit weight, green (g)	3.427-20.294
Fruit weight, red ripe (g)	4.225-22.689
Fruit weight, dry (g)	0.502-2.334
Fruit length (cm)	9.2-17.5
Fruit diameter (cm)	1.12-2.42
Number of seed/fruit	25.2-105.4
Seed weight/fruit (g)	0.195-0.943

Chilli plant in bearing



Variability in Chilli

VEGETATIVE PROPAGATION

Mission C: Rapid multiplication of propagules of fruit crops.

C1. Vegetative propagation of *Capparis decidua* and *Prosopis cineraria.*

An experiment was conducted in the nursery to evaluate seasonal variation in sprouting potential of cuttings of *Prosopis cineraria*. The cuttings were given dip treatment in a solution containing 10,000 ppm. IBA + 1000 ppm Thymine and then planted in polythene tubes filled with sand and soil mixture. The planting was done at monthly interval and observation on per cent sprouting was recorded. It was recorded that the ideal time for taking cuttings in *Prosopis cineraria* is during the month of February. It was further recorded that even with 10,000 ppm IBA + 1000 ppm Thymine the percentage sprouting was only 20%.

In another experiment, the effect of filling mixture, hormone concentration and type of cutting was investigated for the propagation of *Prosopis cineraria*. The results thus obtained are presented in Table 10. Perusal of table reveals that sprouting was observed in normal cuttings. The maximum sprouting was observed upto 40% when the cuttings were treated with 18,000 ppm IBA+1000 ppm Thymine and planted in mixture containing Sand: Soil (1:1) along with moss grass at the top. The etiolated cuttings and cuttings from forced sprouts did not show any sprouting.

Table 10. Effect of filling mixture, hormone concentration and type of cutting on sprouting percentage

Treatment	Sand+Soil			Pond Soil+FYM			Sand+Soil+Moss at bottom			Sand+ Soil+Moss at top		
	1	2	3	1	2	3	1	2	3	1	2	3
Control	-	-	-	-	-	-	-	-	-	-	-	-
5000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	-	-	-	10	-
7000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	10	-	-	10	-
10000 ppm IBA+ 1000 ppa Thymine	-	-	-	-	-	-	-	20	-	-	-	-
12000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	10	-	-	10	-
15000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	30	-	-	10	-
18000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	-	-	-	40	-
20000 ppm IBA+ 1000 ppm Thymine	-	-	-	-	-	-	-	10	-	-	-	-

1= Etiolated cuttings; 2= Normal cuttings, 3= Forced sprouts

GROWTH AND DEVELOPMENT

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

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 water-melon

An experiment was planted in field, using Randomized Block Design, to evaluate the effect of water stress on growth and development of *mateera* and water melon. In all 4 irrigation treatments were given viz. 2, 4, 6, and 8. Observations on plant morphometery, dry matter distribution and yield was recorded at periodic intervals viz. 45, 60, 75 and 90 days after sowing. The data is presented in Table 11-14. Perusal of data on growth parameters of both *mateera* cultivars viz. AHW 65 and AHW 19 reveal that plant morphometeric parameters viz. plant height, number of leaves, no. of branches, and internodal length do not get affected upto 4 irrigation levels throughout the life cycle of the plant. In AHW 65, the trend in fruit number and average fruit weight also demonstrated that at 90 days after sowing, the number of fruit were 1.2, 1.75, 1.4 at 8, 6 & 4 irrigations respectively. Similarly, the fruit weight at respective treatments was 1.1, 1.6 and 1.05 kg (Table 11). Similar trend was also observed in other cultivar AHW 19 (Table 12). Thus, our results demonstrate that plants of *mateera* (AHW 65 and AHW 19) are relatively drought resistant and show no reduction in plant parameters even upto 4 irrigations. The pattern of growth and development in water melon (MHW 102) is presented in Table 13. Perusal of data reveal that plant parameters such as plant height, no. of leaves per plant, no. of fruits per plant were adversely affected by withdrawing irrigation. The pattern of dry matter distribution in MHW-102 too reveals that under 8 irrigation maximum dry matter was accumulated in stem, leaves and root. However, by imposing water stress even to 6 irrigations reduced dry matter accumulation at 90 days in stem by 57.7%, 46.6% in leaves, 58.7% in roots. Similar results were observed in var. Sugar baby also (Table 14).

Table 11.Morphometeric and dry matter distribution of plants of cv. AHW 65 under different irrigation levels

Plant character	8 irrigation				6 irrigation				4 irrigation				2 irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
Plant height (cm)	25.8± 8.438	54.0± 5.477	152.0± 39.465	134.0± 50.299	9.0± 1.0	41.0± 25.593	115.0± 36.401	142.5± 33.040	13.333± 3.077	50.6± 18.955	142.0± 48.106	140.0± 63.640	15.2± 8.526	53.0± 20.187	113.0± 10.954	130.0± 64.962
No. of branches	3.4± 0.548	2.6± 0.894	4.2± 1.304	2.8± 1.483	2.2± 0.837	2.6± 1.673	3.2± 0.447	4.250± 0.500	3.6± 0.894	2.4± 1.673	2.4± 0.894	2.4± 0.894	3.4± 0.894	2.4± 0.894	3.0± 0.0	3.6± 1.817
No. of leaves	10.4± 2.510	36.2± 5.404	95.4± 42.170	42.8± 25.859	4.6± 2.302	27.4± 19.230	67.2± 25.732	65.25± 14.863	10.4± 1.817	28.0± 18.426	52.6± 17.271	38.4± 8.444	9.4± 3.782	25.2± 14.307	47.2± 12.755	47.6± 32.192
Inter node length	5.0± 1.414	3.4± 0.894	4.0± 1.225	4.0± 2.530	1.4± 0.580	2.6± 1.140	3.6± 0.894	4.5± 1.291	4.0± 1.414	3.0± 0.707	3.4± 0.894	3.8± 0.447	3.2± 1.304	3.0± 0.707	4.2± 1.304	3.6± 0.894
No. of fruits/plant	-	-	-	1.2± 0.447	-	-	-	1.75± 0.5	-	-	-	1.4± 0.548	-	-	-	-
Dry wt. stem (g)	0.569± 0.212	1.35± 0.265	8.668± 4.571	11.418± 7.081	0.268± 0.116	1.170± 0.991	4.906± 2.948	19.413± 9.439	0.426± 0.096	0.942± 0.712	4.131 2.53	6.525± 2.188	0.448± 0.209	0.824± 0.448	3.75± 1.560	9.2± 7.401
Dry wt. leaves (g)	0.984± 0.324	2.653± 0.713	23.933± 10.4	12.750± 10.078	0.312± 0.110	2.190± 1.021	10.056± 4.608	17.753± 5.696	1.294± 0.425	1.814± 0.982	8.34 3.16	15.856± 4.433	0.729± 0.356	1.398± 0.822	6.578± 3.205	11.272± 8.563
Dry wt. root (g)	0.390± 0.283	0.245± 0.181	1.110± 0.606	1.272± 0.762	0.186± 0.288	0.157± 0.109	0.640± 0.260	1.623± 0.892	0.566± 0.334	0.174± 0.094	0.49 0.05	1.388± 0.614	0.064± 0.032	0.228± 0.209	0.290± 0.289	1.310± 0.865
Fruit wt. (kg)	-	-	-	1.1± 0.28	-	-	-	1.625± 0.59	-	-	-	1.050± 0.251	-	-	-	-

Table 12.Morphometeric and dry matter distribution of plants of cv. AHW 19 under different irrigation levels

Plant character	8 irrigation				6 irrigation				4 irrigation				2 irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
Plant height (cm)	9.8± 1.9	49.6± 16.4	115.0± 55.9	145.0± 52.6	15.2± 7.2	53.65± 23.5	115.0± 50.2	171.0± 70.2	11.8± 6.4	57.2± 18.3	117.0± 42.3	194.0± 60.5	13.4± 9.4	65.0± 19.3	118.0± 31.14	140.0± 30.4
No. of branches	2.4± 1.14	3.8± 1.6	4.0± 1.8	3.2± 1.09	2.2± 1.3	3.8± 1.09	3.8± 1.3	4.6± 0.89	1.8± 0.83	4.4± 2.2	5.6± 1.6	3.4± 0.54	2.0± 1.0	3.2± 1.78	2.4± 0.8	3.2± 1.3
No. of leaves	8.8± 2.16	45.6± 17.9	92.2± 52.9	56.4± 33.5	9.8± 6.3	40.8± 19.6	66.0± 26.1	63.2± 28.4	8.6± 5.03	48.23± 21.2	113.6± 34.7	58.8± 17.3	7.8± 1.7	37.0± 17.0	57.2± 33.3	86.2± 40.6
Inter node length	1.4± 0.55	3.4± 0.5	4.8± 0.8	3.8± 1.7	3.0± 1.8	4.0± 1.0	4.40± 1.51	4.2± 0.8	2.2± 0.83	3.4± 1.14	5.2± 0.84	4.4± 0.89	2.4± 1.51	3.6± 1.14	4.2± 0.83	4.6± 0.89
No. of fruits/plant	-	-	-	1.4± 0.54	-	-	-	1.2± 0.44	-	-	-	1.0	-	-	-	-
Dry wt. stem (g)	0.214± 0.09	1.36± 0.47	8.025± 4.9	11.34± 6.9	2.22± 2.7	5.27± 1.4	5.86± 2.8	15.18± 11.6	0.52± 0.19	1.04± 0.58	13.9± 9.7	15.64± 5.56	0.316± 0.17	1.31± 0.81	5.09± 2.5	12.8± 6.9
Dry wt. leaves (g)	1.008± 0.48	2.40± 1.25	13.93± 10.0	15.43± 7.7	4.88± 4.6	6.86± 8.4	12.07± 5.0	16.25± 9.33	0.92± 0.9	2.53± 1.3	25.0± 5.9	17.11± 5.5	0.73± 0.22	2.10± 1.10	11.64± 6.2	12.4± 6.9
Dry wt. root (g)	0.34± 0.25	0.12± 0.08	0.52± 0.41	0.93± 0.41	0.37± 0.24	0.63± 0.32	0.402± 0.15	1.008± 0.77	0.20± 0.22	0.210± 0.188	1.110± 1.202	1.62± 0.58	0.092± 0.04	0.16± 0.07	0.82± 0.41	2.4± 2.6
Fruit wt. (kg)	-	-	-	1.9± 0.7	-	-	-	3.3± 1.7	-	-	-	2.75± 1.5	-	-	-	-

Table 13.Morphometeric and dry matter distribution of plants of cv. MHW 102 under different irrigation levels

Plant character	8 irrigation				6 irrigation				4 irrigation				2 irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
Plant height (cm)	62.0± 24.62	61.0± 21.909	101.± 31.898	228.0± 108.490	11.2± 3.114	35.6± 9.940	95.0± 42.131	168.0± 39.623	13.6± 2.702	25.8± 13.368	98.0± 13.038	200.0± 57.879	9.0± 2.345	32.6± 7.121	76.4± 38.566	110.0± 77.136
No. of branches	2.2± 0.447	4.6± 0.548	2.8± 0.837	5.2± 2.387	2.8± 1.095	2.8± 0.447	3.0± 0.707	3.8± 1.483	3.2± 0.837	8.6± 1.517	3.2± 1.304	3.6± 1.140	1.8± 0.447	2.6± 0.548	2.4± 0.894	3.2± 1.304
No. of leaves	9.2± 3.114	41.2± 8.075	48.6± 24.694	92.2± 37.218	6.0± 1.0	23.4± 4.827	60.6± 31.413	64.4± 27.401	6.8± 0.837	16.0± 10.173	48.8± 13.122	61.200± 16.037	5.0± 2.550	28.4± 9.099	45.2± 35.464	378.4± 123.734
Inter node length	3.2± 1.095	4.6± 0.548	5.4± 0.894	5.0± 1.225	2.8± 0.837	3.6± 0.894	4.6± 1.140	4.4± 0.548	3.4± 1.517	3.2± 0.837	5.4± 1.140	5.4± 1.673	1.6± 0.894	3.2± 0.827	4.4± 0.894	4.0± 1.225
No. of fruits/plant	-	-	-	1.4± 0.548	-	-	-	1.4± 0.548	-	-	-	1.0± 0.0	-	-	-	-
Dry wt. stem (g)	0.220± 0.170	-	-	26.888± 7.343	0.522± 0.138	0.830± 0.158	4.9± 2.948	11.362± 2.956	0.378± 0.096	0.626± 0.312	-	11.196± 3.036	0.246± 0.145	0.970± 0.448	4.406± 3.032	7.7± 5.879
Dry wt. leaves (g)	0.746± 0.256	-	-	39.456± 14.906	1.394± 0.416	1.960± 0.493	10.056± 4.608	21.046± 7.398	0.528± 0.190	0.920± 0.688	-	19.060± 3.561	0.432± 0.200	2.014± 0.708	10.25± 7.608	11.756± 7.983
Dry wt. root (g)	0.048± 0.038	-	-	2.074± 1.023	0.063± 0.022	0.080± 0.016	0.640± 0.260	0.856± 0.176	0.066± 0.029	0.252± 0.364	-	0.748± 0.387	0.058± 0.038	0.160± 0.066	0.573± 0.440	0.702± 0.198
Fruit wt. (kg)	-	-	-	5.9± 2.422	-	-	-	2.405 0.25	-	-	-	3.253 ±0.300	-	-	-	-

Table 14. Morphometeric and dry matter distribution of plants of cv. Sugar baby under different irrigation levels

Plant character	12 irrigation				10 irrigation				8 irrigation				6 irrigation			
	45	60	75	90	45	60	75	90	45	60	75	90	45	60	75	90
Plant height (cm)	44.6± 20.206	65.2± 33.952	154.5± 27.538	156.0± 73.689	24.2± 9.176	44.4± 12.219	130.0± 38.891	154.0± 26.810	9.0± 1.581	43.4± 12.361	67.6± 35.725	160.0± 20.000	24.0± 5.657	21.4± 8.081	98.0± 62.209	156.0± 73.689
No. of branches	3.6± 0.894	3.4± 1.517	5.0± 4.243	3.8± 0.837	2.8± 0.837	3.0± 1.225	2.0± 0.667	3.0± 1.225	2.6± 1.140	2.2± 1.304	3.4± 2.302	3.8± 0.447	3.0± 1.225	1.6± 0.894	3.8± 2.168	3.8± 0.837
No. of leaves	24.4± 11.194	42.6± 22.930	117.0± 128.003	55.0± 31.225	11.4± 2.966	35.4± 15.307	43.4± 12.681	91.6± 54.912	5.2± 0.837	28.8± 12.716	48.0± 36.871	74.0± 12.942	10.5± 1.517	12.4± 5.413	85.4± 59.735	85.0± 31.225
Inter node length	6.0± 0.701	36.0± 1.673	5.750± 0.957	4.0± 0-.707	4.0± 2.739	4.2± 1.304	3.187± 0.985	3.4± 1.140	1.2± 0.447	2.6± 0.548	3.0± 0.707	3.2± 1.095	5.4± 1.517	2.6± 0.894	3.8± 0.837	4.0± 0.707
No. of fruits/plant	-	-	-	2.0± 0.707	-	-	-	1.2± 0.447	-	-	-	1.0± 0.000	-	-	-	1.4± 0.548
Dry wt. stem (g)	1.362± 0.631	4.835± 7.968	1.083± 0.693	4.664± 3.884	0.424± 0.166	1.960± 0.582	-	7.0± 4.0	0.134± 0.038	-	4.722± 3.751	6.158± 2.414	-	0.360± 0.163	-	15.660± 7.009
Dry wt. leaves (g)	3.818± 1.625	13.985± 15.206	11.163± 7.658	11.134± 9.539	1.080± 0.291	2.546± 1.616	-	18.812± 14.709	0.502± 0.139	5.193± 2.000	11.378± 7.546	15.670± 4.455	-	0.702± 0.375	-	19.014± 13.2
Dry wt. root (g)	0.126± 0.055	0.365± 0.546	284.39± 459.742	0.364± 0.841	0.302± 0.335	0.114± 0.044	-	0.454± 0.350	0.024± 0.022	-	0.340± 0.160	0.474± 0.151	-	0.064± 0.015	-	1.0± 0.374
Fruit wt. (kg)	-	-	-	2.8± 0.975	-	-	-	4.750 ±0.189	-	-	-	5.12.5± 0.306	-	-	-	1.950± 1.037

Table 14. (Continue)

Plant character	4 irrigation				2 irrigation			
	45	60	75	90	45	60	75	90
Plant height (cm)	15.2± 3.834	39.6± 16.817	90.0± 35.355	144.0± 70.982	16.6± 13.221	29.6± 6.189	94.0± 38.308	75.0v 33.354
No. of branches	2.8± 0.837	2.6± 1.140	2.4± 0.894	4.4± 1.817	2.8± 1.095	3.0± 1.414	3.8± 1.095	1.8± 0.837
No. of leaves	0.4± 1.817	24.6± 15.821	47.0± 29.785	69.4± 17.3	9.4± 6.427	25.2± 10.281	61.2± 27.381	27.8± 14.167
Inter node length	4.4± 1.140	3.6± 0.548	3.6± 0.894	4.0± 1.0	4.8± 1.304	2.8± 0.837	3.2± 1.643	4.0± 1.414
No. of fruits/ plant	-	-	-	1.250± 0.500	-	-	-	-
Dry wt. stem (g)	-	0.782± 0.592	3.106± 1.489	14.332± 7.097	0.432± 0.235	0.883± 0.493	2.7± 1.693	2.7± 1.693
Dry wt leaves (g)	-	1.996± 1.997	7.640± 3.920	354.4± 753.374	1.282± 0.268	2.345± 1.302	9.812± 5.403	9.812± 5.403
Dry wt. root (G)	-	0.136± 0.093	0.272± 0.105	1.146± 0.658	0.352± 0.297	0.127± 0.040	0.300± 0.200	0.300± 0.200
Fruit wt. (kg)	-	-	-	1.688± 0.625	-	-	-	-

The above data demonstrate that the plants of watermelon MHW-102 are highly susceptible to water stress and do not tolerate any withdrawal of irrigation.

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

Analysis of photosynthetic parameters in *ber* was undertaken in a total of 10 varieties. The data thus obtained is presented in Table 15. The observations were recorded at 3 times viz. 10 AM, 1 PM and 3 PM and parameters studied included Relative Water Content, Stomatal Conductance, Transpiration, Internal CO_2 Concentration (C1NT), Photosynthesis (P_N), Carboxylation efficiency and Physiological water use efficiency. Perusal of table reveals that the RWC ranges between 62.32% to 95% in different varieties. The data on photosynthetic rate reveals that in cultivars such as Seb, Pewandi, Banarsi Kadaka, Kaithali, Sanaur-5 and Mundia, the rate remain nearly constant throughout the day. However, in cultivars like Narma, Kakrol Gola, Katha Phal, Dandan, the midday depression was observed. Similar pattern was also demonstrated by Carboxylation efficiency. Analysis of data on transpiration reveals that it ranges between 0.603 to 1.22 mg/m²/Sec. The pattern of transpiration demonstrated lower values during the midday in nearly all varieties except Pewandi, Banarsi Kadaka and Mundia.

Table 15. Comparison of photosynthetic rate and associated parameters in some ber cutlivars.

Variety	R.W.C.	Stomatal Conductance (cm/s)	Transpiration ($mg/m^2/sec.$)	Internal CO_2 (mg CO_2)	Photosynthesis ($mg/m^2/sec.$)	Physiological water use efficiency	Carboxylation efficiency
Seb							
10 AM	75.175± 6.590	2.691	0.739	8.901	1.468	1.98	0.164
1 PM	76.437± 8.399	1.493	0.675	8.637	1.195	1.77	0.138
3 PM	83.168± 2.373	2.394	0.891	9.504	1.143	1.28	0.120
Pewandi							
10 AM	78.405± 9.474	1.883	0.731	9.310	1.047	1.43	0.112
1 PM	70.131± 10.553	1.717	0.793	9.680	0.953	1.20	0.098
3 PM	77.004± 2.146	1.666	0.680	9.627	0.832	1.22	0.086
Banarsi Kadaka							
10 AM	85.831± 13.241	1.562	0.722	9.099	1.163	1.61	0.127
1 PM	75.915± 13.873	1.932	1.024	9.873	1.181	1.15	0.120
3 PM	80.179± 2.350	1.352	0.867	10.947	1.094	1.26	0.090
Kaithali							
10 AM	75.443± 4.794	1.827	0.758	8.725	1.154	1.585	0.132
1 PM	86.782± 12.667	1.669	0.765	8.540	0.877	1.146	0.102
3 PM	82.842± 1.944	1.583	0.835	10.920	0.788	0.940	0.072

Mundia							
10 AM	69.435± 2.922	2.422	0.829	9.292	1.407	1.695	0.152
1 PM	80.691± 7.319	3.693	1.220	9.367	1.797	1.470	0.192
3 PM	88.359± 5.061	2.125	0.815	10.120	1.068	1.310	0.105
Narma							
10 AM	85.720± 8.988	3.2	0.896	11.560	1.004	1.120	0.086
1 PM	89.356± 4.520	1.47	0.666	9.992	0.866	1.300	0.086
3 PM	85.709± 6.782	1.412	0.669	10.621	0.747	1.116	0.070
Kakrol Gola							
10 AM	95.054± 2.787	4.338	0.853	11.149	1.096	1.28	0.098
1 PM	90.627± 5.039	3.25	0.860	10.78	1.062	1.24	0.098
3 PM	83.631± 2.974	2.753	0.878	11.492	0.865	0.984	0.075
Katha Phal							
10 AM	79.824± 3.465	4.268	0.853	11.206	1.150	1.34	0.102
1 PM	86.472± 7.894	1.914	0.795	10.225	0.816	1.02	0.079
3 PM	83.527± 3.862	1.402	0.603	10.639	0.763	1.26	0.071

Dandan							
10 AM	76.046± 2.986	3.689	0.959	10.630	1.152	1.20	0.108
1 PM	78.036± 3.631	1.441	0.702	10.511	1.083	1.54	0.103
3 PM	90.333± 6.645	1.273	0.614	10.595	0.755	1.22	0.071
Sanaur-5							
10 AM	62.327± 4.919	3.539	0.8316	10.177	1.1567	1.390	0.113
1 PM	68.553± 9.195	1.926	0.846	10.089	0.999	1.18	0.099
3 PM	76.787± 4.123	1.513	0.630	10.718	0.726	1.152	0.067

WATER MANAGEMENT

Mission E: Water management in arid horticultural crops

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

During the period 1999-2000 confirmation of last year (1998-99) results was done. The same experiment was repeated using plants of pomegranate var. Jalore seedless with slight modifications. Only the three techniques viz. thermocouple psychrometer, liquid equilibration method and relative water content were used for measuring plant water status during the month of June and October 99. The plants were fully irrigated and from 3rd day onwards observations were recorded at an interval of 3 days. The results thus obtained are presented in Table 16. During June 99, the leaf water potential was in the range of-0.90 to -1.52 MPa when measured using thermocouple psychrometer, however, when the same was calculated using liquid equilibration method it ranges from -1.10 to -1.40 MPa. During June 99, in initial phase (3rd to 9th day), the change in plant water potential was very slow, thereafter, it demonstrated steep fall in the magnitude. The change in relative water content was slow in initial stages (3d to 9th day) subsequently, there was drastic reduction in RWC. It dropped from 80.2 to 63.0% during the whole experimental period.

During the month of October 99, the change was in plant water potential as measured by the psychrometer method ranged from -0.88 to -1.24 MPa . During this month the change was gradual in psychrometer method throughout the experimental period when the same was estimated through liquid equilibration method, minor fluctuations were recorded during experimental period. The RWC dropped from 80.0 to 68.0 from 3rd day to 30th day.

From above results it was confirmed that thermocouple psychrometric method is the most sensitive for estimating leaf water potential in field condition.

E.2 Effect of moisture conservation techniques and nutrients on the establishment of fruit plants in arid region.

This experiment was conducted in the year 1997-98 with three pit size i.e. no pit, 45x45x45 cm and 60x60x60 cm and with three filling mixtures i.e. (i) top soil+manure (ii) top soil +manure + pond silt and (iii) top soil + manure + pond silt+ fertilizers. The detailed data was presented regarding survival, plant height, plant spread, soil and plant water status and leaf mineral composition as affected by above treatments. In the year 1998, the recommendations of this experiment were presented and some queries were raised regarding the treatment combinations and it was decided that the experiment would be conducted again with slight modification having four filling mixtures instead of three.

Pit sizes :

0x0x0 cm (Not pit)

45x45x45 cm

60x60x60 cm

Filling mixture:

(i) Top soil

(ii) Top soil + manure

(iii) Top soil + manure + pond silt

Table 16: Plant water status as measured by different techniques at different soil water potential.

Techniques	June 99									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
Psychrometeric method (MPa)	-0.90	-0.95	-1.00	-1.07	-1.20	-1.26	-1.30	-1.32	-1.42	-1.52
Liquid equilibration (MPa)	-1.10	-1.10	-1.10	-1.15	-1.20	-1.20	-1.40	-1.40	-1.40	-1.40
Relative water content (%)	80.2	80.2	76.4	73.0	70.2	68.2	67.3	65.2	65.2	63.0
					October 99					
Psychrometeric method (MPa)	-0.88	-0.91	-0.95	-0.97	-1.00	-1.05	-1.12	-1.20	-1.22	-1.24
Liquid equilibration (MPa)	-1.10	-1.10	-1.10	-1.20	-1.20	-1.20	-1.20	-1.30	-1.40	-1.40
Relative water content (%)	80.0	80.0	78.4	76.0	73.0	71.3	70.8	69.2	69.1	68.0

(iv) Top soil + manure + pond silt + fertilizer

In the year 1999 (February) the plants of pomegranate var. Jalore seedless were planted with nine treatment combinations. The plant survival, plant height and plant spread was measured after 10 months. The data given in Table.17 depict that maximum survival (88.0%) of plant was recorded in T9 and minimum (62.57) in T1 treatment. Data also revealed that, in over all, the higher plant survival was recorded in those treatments where pit size was 60x60x60 cm (0.2 m^3) followed by 45x45x45 cm (0.10m^3) size pits. However, filling mixtures did not affect the plant survival.

Plant height was also measured every month and the plant height attained after 10 months has been given in Table 17. The data revealed that the maximum plant height (99cm) was measured in T9 and minimum (49 cm) in T1 treatment. Data also revealed that plant attained more height in (60x60x60cm) size pits follwed by (45x45x45cm) pit size and minimum height was measured in no pit treatment. Filling mixtures also affected the plant height and it was statistically at par in all filling mixtures except top soil filling material (T1) in respective pit sizes. In the month of June 99, the soil moisture content was statistically at par in 60cm^3 and 45cm^3 pit sizes and lowest moisture content was observed in no pit treatment. In the month of October 99, the moisture content pattern was same as in the month of June but the magnitude was higher. The relative water content of leaves was at par in 45cm^3 and 60 cm^3 pit sizes treatments and lowest was recorded in no pit treatment (Table 18).

Table 17. Effect of pit size and filling mixtures on the growth parameters of pomegrante

Treatment	Survival (%)	Plant height (cm)	Plant spread (m^2)
T_1 0.0 cm	62.5	49.0	0.28
45x45x45 cm (0.10 m^3) T_2 TS	72.5	70.0	0.46
T_3 TS+M	75.0	78.0	0.56
T_4 TS+M+P	74.0	78.0	0.63
T_5 TS+M+P+F	74.0	78.0	0.63
60x60x60 cm (.20 m^3) T_6 TS	85.0	75.0	0.53
T_7 TS+M	86.0	98.0	0.72
T_8 TS+M+PS	85.0	97.5	0.76
T_9 TS+M+PS+F	88.0	99.0	0.82
SEm ±	3.56	2.65	0.08
CD 5%	8.03	6.73	0.15

Table 18. Effect of pit size and filling mixture on the soil moister and plant water status

Treatments		Month			
		June		October	
		Soil moisture (%)	RWC (%)	Soil moisture (%)	RWC (%)
0 cm (No pit) (45 cm)^3	T_1	7.6	7.24	9.6	76.3
Top soil	T_2	11.5	84.6	13.2	89.4
Top soil + manure	T_3	12.5	84.7	14.2	88.4
Top soil +M+PS	T_4	13.2	86.2	13.5	89.2
TS+M+PS+F (60 cm)^3	T_5	14.1	88.2	14.1	90.5
TS	T_6	11.5	85.2	13.9	88.2
TS+M	T_7	12.6	92.5	14.5	89.2
TS+M+PS	T_8	13.5	90.5	14.3	92.1
TS+M+PS+F	T_9	12.6	90.3	14.5	90.2

INTEGRATED NUTRIENT MANAGEMENT

Mission F: Integrated nutrient management in horticultural crops.

F1. Response to substitution of manures and fertilizers with vermicompost in the growth and production of arid fruit crops.

F1.1. Growth and production of pomegranate *(Punica granatum)* fruit crop with organic and inorganic farming.

The recommended doses of NPK (375 g N, 150g P and 50g K) per plant per year were applied through 10 treatments along with control: i) cattle manure (CM) @ 18 kg/plant, ii) sheep manure (SM) @ 12 kg/plant, iii) vermicompost (VC) @ 7.5 kg/plant, iv) inorganic fertilizers (IF) (urea, single super phosphate and murate of potash), v) CM and SM in 50:50 ratio, vi) CM and VC in 50:50 ratio, vii) CM and IF in 50:50 ratio, viii) SM and VC in 50:50, ix) SM and IF in 50:50, x) VC and IF in 50:50 ratio, xi) control (NoPoKo) in the month of April, 99. The growth parameters like height, spread, no. of branches were recorded every month. The leaf samples from different treatments were collected in the month of September 99 and analysed for different nutrients (N, P, K, Ca, Mg, Zn, Mn, Cu and Fe). The soil moisture contents were also measured to monitor the moisture retention capacity in different treatments. The growth attributing data of different treatments revealed that plant height was in the range of 90 cm to 135 cm and maximum plant height was recorded in T10 treatment and minimum in control. The plant height was statistically at par in T1, T3, T5, T6, T8 and T10 and were significantly higher over T2 ,T4 ,T7 ,T9 and T11 treatments. The plant spread was recorded in the range of 0.45 to 1.05m^2. The maximum spread was recorded in T6 treatment and minimum was in control. Except treatments T4 and T11, plant spread was statistically at par in all other treatments. Number of branches were in the range of 2 to 5 and lowest number of branches were recorded in T4 and T11 treatments while in other treatments branches were more or less same in numbers (Table 19).

Leaf mineral composition: Data pertaining to detailed leaf mineral analysis are depicted in table 20 . The nitrogen content varied from 1.21 to 1.75% . The maximum N content was estimated in T3 followed by T6, T5, T8, T9 and minimum in control. Data revealed that vermicompost either alone or in combination with organic manures and inorganic fertilizer increased the N content over control although sheep and cattle manure also fairly increased the N content. The P content in leaves vary from 0.18 to 0.29% and maximum P content was estimated in T3 and T6 followed by T8 and T10 treatments. The K content ranged form 1.32 to 1.62%. The calcium and magnesium contents were fairly good in all treatmetns except control. Zinc content was in the range of 20 to 30 ppm. Copper, mangnese as iron were in the range of 5 to 8, 40 to 60 and 50 to 65 ppm respectively.

Physiological activity: The physiological parameters like photosynthetic activity, transpiration rate, water use efficiency, stomatal conductance and resistance were measured in different treatments. Data revealed that photo synthetic activity was recorded in the range 0.3692 to 0.5726 mg $Co_2/m^2/s$. The maximum activity was recorded in T8 (0.5720 mg $Co_2/m^2/s$) followed by T6 and T3 (0.5670 mg $Co_2/m^2/s$) and minimum activity was recorded in T4 and T11 treatments. The transpiration rate

was in the range of 1.21 to 1.562 mg $Co_2/m^2/s$. Accordingly water use efficieny was calculated from P_N and transpiration rate from 26.18 to 45.94%. The maximum WUE was recorded in T10 followed by T6 (42.82%), T8 (42.67%) and minimum in T11 & T3 treatments. Stomatal conductance varied from 1.820 to 2.150 cm/s. It appeared from the data that organically fertilized plants are having high stomatal conductance and the plants fertilized with inorganic fertilizer are having low stomatal conductance. Stomatal resitance is inversely related to stomatal conductance and having opposite pattern (Table 21).

Soil moisture status: The soil moisture contents were measured in different treatments on 3rd, 5th and 7th day after irrigation to pomegranate plants. It was noticed that on 3rd day after irrigation soil moisture contents were in the range of 12.4 to 19.5% and minimum moisture content was recorded in control and inorganically fertilized plants while where organic sources were used the moisture contents were fairly higher and similar. On 5th day after irrigation soil moisture content varied from 9.5 to 15.6% and on 7th day the range was 8.5 to 14.2%. Although the depletion in moisture was more in inorganically fertilized or inorganic fertilizer contributed treatments, while soil moisture depleted slowly in others. It is obvious that inclusion of organic sources of nutrients helps in checking the water losses through leaching and evaporation (Table 22).

Table 19. Effect of different sources of manure and fertilizers on plant growth.

Treatment	Plant height (cm)	Plant spread	No. of branches
T_1 SM	123	0.78	04
T_2 CM	117	0.85	04
T_3 VC	126	1.00	04
T_4 IF	95	0.48	02
T_5 CM:SM	122	0.85	05
T_6 CM:IF	124	1.05	05
T_7 CM:IF	118	0.75	03
T_8 SM:VC	132	0.98	04
T_9 SM:IF	115	0.81	03
T_{10} VC:IF	135	0.95	04
T_{11} COTROL	90	0.48	03
SEm ±	5.24	0.11	04
CD at 5%	14.68	0.29	02

Table 20. Leaf mineral composition in pomegranate leaves affective by different treatments.

Treatments			N	P	K	Ca	Mg	Zn	Cu	Mn	Fe
SM	T_1	100	1.54	0.24	1.45	2.65	0.25	30	6	52	58
CM	T_2	100	1.62	0.26	1.52	2.75	0.31	30	8	58	62
VC	T_3	100	1.75	0.29	1.62	2.71	0.30	28	6	60	65
IF	T_4	100	1.38	0.26	1.43	2.70	0.19	20	5	40	50
CM:SM	T_5	50:50	1.62	0.23	1.42	2.56	0.28	26	6	55	58
CM:VC	T_6	50:50	1.69	0.29	1.55	2.70	0.32	28	6	55	55
CM:IF	T_7	50:50	1.45	0.27	1.42	2.58	0.18	20	8	22	62
SM:VC	T_8	50:50	1.59	0.28	1.58	2.72	0.22	30	6	52	50
SM:IF	T_9	50:50	1.39	0.24	1.48	2.62	0.24	22	6	58	55
VC:IF	T_{10}	50:50	1.58	0.27	1.52	2.72	0.26	24	7	52	50
CONTROL	T_{11}	0:0	1.21	0.18	1.32	1.95	0.19	20	5	40	50

Table 19. Effect of sources of manures and fertilizers on physiological activity.

Treatments		P_N mg Co_2m^2/s	Transpiration rate $mg/m^2/s$	Water use efficiency (%)	Stomatal resistance (s/cm)	Stomatal conduction (cm/s)
SM	T_1	0.5346	1.314	40.68	0.504	1.982
CM	T_2	0.4934	1.264	39.03	0.513	1.950
VC	T_3	0.5670	1.364	41.60	0.467	2.142
IF	T_4	0.3650	1.315	27.76	0.571	1.752
CM:SM	T_5	0.5295	1.341	39.49	0.535	1.868
CM:VC	T_6	0.5720	1.336	42.82	0.465	2.150
CM:IF	T_7	0.4350	1.562	27.85	0.533	1.875
SM:VC	T_8	0.5726	1.342	42.67	0.470	2.128
SM:IF	T_9	0.4862	1.242	39.15	0.519	1.925
VC:IF	T_{10}	0.5150	1.121	45.94	0.465	2.150
CONTROL	T_{11}	0.3692	1.41	26.18	0.550	1.820

Table 22. Soil moisture pattern as influenced by different treatments.

Treatments		Contribution	3rd day	5th day	7th day
SM	T_1	100	18.2	15.6	14.2
CM	T_2	100	17.5	15.2	14.0
VC	T_3	100	16.8	13.5	13.2
IF	T_4	100	12.4	10.5	8.5
CM:SM	T_5	50:50	17.5	14.5	13.8
CM:VC	T_6	50:50	19.5	15.2	13.5
CM:IF	T_7	50:50	15.5	12.5	10.0
SM:VC	T_8	50:50	18.5	15.0	13.5
SM:IF	T_9	50:50	16.5	12.8	12.0
VC:IF	T_{10}	50:50	13.5	11.5	9.5
CONTROL	T_{11}	0:0	12.4	9.5	8.5

PLANT PROTECTION

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

I.1 Biological control of *ber* diseases

a) *In vitro* effect of *Trichoderma* spp isolates against *Torula herbarum* causes stem blight of *ber*

Twenty one isolates of *Trichoderma* spp were tested in vitro against *T.herbarum* causing stem blight of *ber*. All isolates suppressed the vegetative growth of pathogen except isolate NRCAH-DS 145 which inhibited the growth up to 42.2 % only (Table 23). Higher inhibition zones through antibiosis were formed by the isolates NRCAH-DS 181a followed by NRCAH-DS 142 and NRCAH-BS 221 (Plate 1). Isolate NRCAH-DS 148, NRAH-DS 149, NRCAH-DS 186 and NRCAH-BS 225 were mycoparasitic in nature. Other isolates were either competitive or hyper in nature. The *in vitro* revealed that the native fungal antagonists (*Trichoderma* spp) could be included as a component under integrated disease management formulation particularly stem blight of *ber*.

Table 23. *In vitro* effect of *Trichoderma* spp. isolates against *Torula herbarum*

Isolate	Per cent control over check	Inhibition zones (mm)
NRCAH - DS 89	61.1	8
NRCAH - DS 142	58.8	10
NRCAH - DS 145	42.2	4
NRCAH - DS 148	55.5	-
NRCAH - DS 149	89.0	-
NRCAH - WL 150	67.0	5
NRCAH - WL 151	71.1	7
NRCAH - DS 166	61.1	5
NRCAH - DS 175	58.0	5
NRCAH - DS 176	61.1	9
NRCAH - DS 177	61.0	5
NRCAH - DS 181	56.0	6
NRCAH - DS 181a	73.3	15
NRCAH - DS 186	89.0	-
NRCAH - DS 188	54.4	6
NRCAH - BS 221	59.0	9
NRCAH - BS 225	65.5	6
NRCAH - BS 240	72.2	-
NRCAH - BF 255	70.0	7
NRCAH - BF 258	60.0	5
NRCAH - BF 259	70.0	-

Values are means of 4 replicates.

b) *In vitro* effect of *Pseudomonas fluorescens* isolates against *Torula herbarum*.

Isolates of *Pseudomonas fluorescens* from this centre were tested against the same pathogen *in vitro*. Out of 45 isolates, few of them (NRCAH-TS 110, NRCAH-TS 111, NRCAH-WL 139, NRCAH-DS 188b, NRCAH-BS 208, NRCAH-BS 215, NRCAH-BS 233, NRCAH-PS 311, NRCAH-PR 330 and NRCAH-PR 334) could suppress the pathogen (90-100%). Isolates viz., NRCAH-WL 139, NRCAH-DS 188b, NRCAH-CF 196 and NRCAH-PS 317 grown rapidly and inhibited the pathogen. Higher colonization was recorded by isolate NRCAH-CF 196 but its biocontrol potential was very negligible. Isolate NRCAH-BS 207 could lyse pathogen mycelium and some of the isolates produced antifungal secondary metabolites. Isolate NRCAH-TS 111, NRCAH-DS 188b, NRCAH-PR 330 and NRCAH-PR 334 completely killed the pathogen mycelium (Table 24; Plate. 2). Being the pathogen as a common saprophyte

Trichoderma isolate against stem blight pathogen

P.fluorescens isolate against stem blight pathogen

Table 24. Antagonistic effect of *P. fluorescens* against *T. herbarum*

Isolates	Per cent control over check	Isolates	Per cent control over check
NRCAH- SS101	50.0	NRCAH- PS236*	56.0
NRCAH- BS212	42.0	NRCAH- DS175	35.5
NRCAH-SS 102	50.0	NRCAH- PS238	39.0
NRCAH- BS213	47.0	NRCAH-DS 176	33.0
NRCAH- SS103	44.0	NRCAH- PS239	50.0
NRCAH- BS 215	97.0(M)	NRCAH- DS188a	44.0
NRCAH-SS 103a	44.4	NRCAH- PS240	61.0
NRCAH- BS218	67.0	NRCAH- DS 188b	100
NRCAH-SS 106	53.3	NRCAH- CS289	47.0(M)
NRCAH- BS221*	85.0	NRCAH- DS190	39.0
NRCAH- TS 110	89.0(M)	NRCAH- PS 311	95.0
NRCAH- BS222	10.0	NRCAH- CF194	56.0
NRCAH- TS 111	100	NRCAH- PS317	64.0
NRCAH- BS224	35.0	NRCAH- CF195*	80.0
NRCAH- TS115	56.0(M)	NRCAH- PS324	39.0
NRCAH- BS226	64.0	NRCAH- CF196	56.0
NRCAH- TS116	61.1(M)	NRCAH- PR 330	100
NRCAH- BS228	447	NRCAH- BS200*	80.0
NRCAH- WL 139	93.0(M)	NRCAH- PR 334	100
NRCAH- BS 233	92.0	NRCAH- BS207	39.0(M)
NRCAH-DS 142	33.3	NRCAH- PR336	56.0
NRCAH- BS235	67.0(M)	NRCAH- BS 208	95.0
NRCAH- WL151	22.0(M)		

Values are means of four replicates

M - Indicates secondary metabolite producing isolates , * Slow growth isolates

use of both bacterial and fungal antagonists in addition to fungicides treatments can limit the occurrence of stem blight of ber.

I.2. Diseases of arid fruits and vegetables :

Integrated management of *ber*

Powdery mildew

Powdery mildew incidence was not occurred due to unfavorable environmental conditions during this year. However, wild species of *Ziziphus* were removed from orchard and 0.1% Karathane was sprayed at 15 days intervals from fruits setting to maturity stage as precautionary measures.

II. Diseases of cucurbitaceous vegetables

In general, diseases incidence was very less during summer season. Among the following arid vegetables screened against fungal and viral diseases, muskmelon (open) recorded maximum incidence of 14.1 % fungal (*Collectotrichum lagenarium*) and 10.5 % of viral diseases followed by muskmelon -238. *Kakdi* genotypes AHC (13-1) and AHC (13-3) showed negligible level of both diseases (Table 25).

Table 25. Diseases incidence in cucurbitaceous vegetables

Genotypes / Lines	Diseases incidence (%)	
	Colletotrichum lagenarium	CMV/CYMV/ WMMV
Mateera AHW- 65	5.7	7.0
Mateera AHW- 19	6.6	2.0
Kakdi AHC-13-1	2.2	1.0
Kakdi AHC-13-3	2.7	1.5
Muskmelon -238	10.3	7.8
Muskmelon (Open)	14.1	10.5

CMV - Cucumber mosaic virus, CYMV-Cucumber yellow mosaic virus WMMV - Water melon mosaic virus

III. New Records

a) Wilt in cactus pear

Wilt disease in *Opuntia* spp caused by *Fusarium oxysporum* was studied in detail. Fungus was isolated and purified. Our preliminary identification was confirmed from Indian Type Culture Collection Centre (ITCC), New Delhi and received the reference No. 3638.98. Soil drenching of 0.1 % Ridomil could effectively suppress the disease incidence.

b) Pad spot in Indian aloe

Pad spot caused by *Nigrospora oryza* has been recorded for the first time in Indian aloe. Identification of the causal organism was confirmed from Indian Type Culture Collection Centre(ITCC), New Delhi and received the reference No. 3638.98.

Substitution of organic manure and fertilizer with vermicompost in the growth and production of arid fruits

Microbial population in organic manures and fertilizer mixed with vermicompost.

Assessment of microbial population in organic manures and inorganic fertilizer supplimented with vermicompost was carried out. Application of inorganic fertilizer suppressed the fungal and actinomycetes colonization in rhizosphere and non rhizosphere of pomegranate plants. However, the bacterial population was not much influenced. Combination of cattle manure and vermicompost recorded higher population of fungal,bacterial and actinomycetes than other combinations. Cattle manure alone or in combination with vermicompost could enhance the Fluorescent Pseudomonads colonies. In any case, rhizosphere population was higher than non rhizosphere. Enhancement of beneficial bacterium like Fluorescent Pseudomonads and actinomycetes was also found in sheep manure and vermicompost treatments. Rest of the treatments did not encourage the microbial growth(Table 26). Further studies are under progress.

Table 26. Microbial population (Colony forming unit/g of soil)

Treatments	Fungi (10^{-4} cfu/ gm of soil)		Bacteria (10^{-5} cfu /g of soil)				Actinomycetes (10^{-3} cfu / g of soil)	
	Rhizosphere	Non-rhizosphere	Rhizosphere		Non rhizosphere		Rhizosphere	Non-rhizosphere
			OB*	Fps*	OB	Fps		
Cattle manure	17	7	64	9	7	1	22	12
Sheep manure	26	13	45	0	12	0	19	17
Vermicompost	6	13	28	2	12	0	14	4
Inorganic fertilizer	2	1	22	0	2	0	10	5
Cattle manure +Sheep manure	19	14	29	0	14	1	32	15
Cattle manure+ Vermicompost	30	14	95	5	13	2	38	5
Cattle manure + Inorganic fertilizer	4	4	21	0	4	0	12	6
Sheep manure + Vermicompost	8	7	30	1	8	1	13	8
Sheep manure + Inorganic fertilizer	14	5	29	0	5	0	23	13
Vermicompost + Inorganic fertilizer	6	10	35	0	10	0	12	3
Control	12	8	21	0	11	0	18	6

Values are means of four replications.

* OB Other Bacteria

* Fps - Fluorescent Pseudomonads

PLANT PRODUCTION

Mission K: Production of planting materials

K1. Establishment of Progeny Block

About two hectare area has been developed as "Progeny Block" by planting different fruit types. This Progeny Block will serve as mother block for obtaining bud-wood/scion shoot of desired plant material and also as field conservatory for demonstration purpose of the fruit types suitable under arid ecosystem. So far, 56 varieties/strains of different fruit trees accomodating 15 genera have been collected from different places in India and abroad (Table 27).

Table 27. Status of Progeny Block at NRCAH, Bikaner

Fruit type	Year 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, 1997	08	Godhra, Abohar, Aurangabad, Pant Nagar, Bharatpur
6. *Phalsa*	August, 1997	02	Faizabad, Godhra
7. *Karonda*	August, 1997	05	Faizabad, Godhra, Bharatpur, Udaipur, Pant Nagar
8. *Lasoda*	August, 1997	05	Bikaner, Bharatpur
9. Tamarind	July, 1997	02	Bikaner, Rahuri
10. *Khejri*	August, 1997	01	Bikaner
11. Carob	July, 1997	01	Israel
12. Marula nut	July, 1997	01	Israel
13. Chinese ber	March, 1998	01	Simla
14.*Boardi*	July, 1997	01	Saudi Arabia
15. *Khirni*	August, 1997	01	Godhra
16. Pomegranate	March, 1998	04	Jodhpur, Rahuri

Before planting in the field, proper acclimatisation and hardening of new introductions are very essential for better establishment of precious material. For the purpose, two growing structures have been developed. Fine nozzle sprinkler system has been installed for irrigation. These structures are also being utilized for multiplication of fruits, vegetables and ornamental plants. As new introduction during 1999, three rooted cuttings of pomegranate and two cladodes of cactus (fodder and fruiting type) were introduced from Argentina. Few seeds of date palm from Turkey and Egypt were sown in the polybags. The seeds of custard apple from Bangalore were also sown in the polybags.

2. Multiplication of plant material

The fruit trees of commercial significance like, *ber, aonla* and pomegranate have been multiplied through vegetative means for distribution of true-to-type planting material among farmers and also for experimental purpose (Table 28). Some ornamental plants were also multiplied by seeds/ cuttings/ suckers under growing structures for the purpose of campus beautification. Besides vegetative propagation, 3000 seedlings of desi *ber* were raised for hedge row plantation around experimental blocks. 100 *aonla* seedling rootstocks were also raised for gap filling in establishing *aonla* block. For experimental purpose, 3000 pomegranate hybrid seedlings and 3600 date palm seedlings were raised in polybags under growing structures. As a source of revenue generation, Rs. 9000/- have been generated by on-spot selling of above mentioned planting materials and *guarpatha* leaves for vegetable purpose to the farmers.

Table 28. Production of plant material (1999)

Fruit types	Variety	Propagation method	Plant produced (No.)	Purpose	
				Experimental	For sale
Ber	Gola	Patch budding	250	--	250
	Seb	Patch budding	100	--	100
	Umran	Patch budding	40	--	40
	Banarasi Kadaka	Patch budding	60	--	60
Aonla	NA 6	Patch budding	66	--	66
	NA 7	Patch	174	--	174

		budding			
	Chakaiya	Patch budding	45	--	45
	Seedling	Seeds	100	100	--
Pomegranate	Jalore Seedless	Cutting	215	120	95
	Hybrids	Seeds	2500	2500	--
Date palm	Halawy,	Seeds	1000	1000	--
	Khunejee	Seeds	1000	1000	--
	Barhi	Seeds	200	200	--
	Khalas,	Seeds	200	200	--
	Medjool,	Seeds	200	200	--
	Zahidi	Seeds	200	200	--
Indian Aloe	Local Selection	Sucker	560	500	60

3. Propagational studies

Similar to *ber*, when seeds of *aonla* were sown in the nursery during March for rootstock purpose, they did not attain the desired thickness for budding during July-August. Therefore, an investigation was carried out during 1998-99, to see the effect of polycontainers on germination, seedling vigour, root behaviour and budding success in *aonla* under hot arid ecosystem. The treatments were; T1= Polytube (25X10 cm) both end open, T2= Polytube (40X15 cm) both end open, T3= Polybag (40X15), T4= Polybag (40X15) having 20 holes of 0.5 cm at lower half, T5= Polybag (40X15) having 40 holes of 0.5 cm in whole the bag and T6= Polybag (40X15) having 5 cm hole in the centre at the bottom. The patch method of budding was performed during July-August, 1998-99. The experiment was laid out in CRD having 4 replications and pooled data were analysed statistically.

Data presented in table 29 indicated that there was significant effect of polythene size on the germination, seedling vigour and budding success in *aonla*. The polytube (40X 15 cm) had given good response over 25 X 10 cm size. The differences were also very apparent between polytubes and poly bags but there was least difference among different manipulations of bigger size (40X15 cm) polybag only. From the present study, it is apparent that use of perforated polybags (40X15 cm) are superior over polytubes either 25X10 cm or 40X15 cm size and > 88.89 % budding success in *aonla* can be obtained under hot arid ecosystem of Rajasthan.

Table 29. Effect of polycontainers on budding sucess in *aonla.*

Treatment	Germination (%)	Buddable stock (%)	Rooting behaviour	Budding success (%)
T_1	82.60	67.02	Straight	44.42
T_2	91.40	91.60	Straight	80.74
T_3	92.63	88.62	Coiled	86.21
T_4	92.25	92.28	Slightly Curved	89.62
T_5	91.75	90.84	Slightly Curved	90.61
T_6	91.62	91.49	Slightly curved	88.89
SEm (±)	1.002	3.000	-	2.847
CD(p=0.05)	2.106	6.304	-	5.981

4. 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 and *bael* started fruiting during this year. Therefore, the data on vegetative vigour only have been presented in table 30.

Table 30. Vegetative vigour of some cultivars of arid fruits.

Fruit type/ cultivar	Year of plantation	Vegetative vigour	
		Plant height (m)	Crown spread (m)
Bael			
Pant Aparna	August, 1997	2.00	2.25
Pant Sujata	August, 1997	3.60	2.85
Pant Swarna	August, 1997	2.8	1.5
Pant Shivani	August, 1997	2.60	1.70
Pant Urvashi	August, 1997	2.80	1.15
NB 5	August, 1997	2.50	1.50
NB 7	August, 1997	2.75	2.25
NB 9	August, 1997	2.00	1.75
Aonla			
Kanchan	July, 1997	2.75	2.20
Krishna	July, 1997	2.50	2.25
Chakaiya	July, 1997	2.50	2.40
NA 6	July, 1997	2.20	2.30
NA 7	July, 1997	2.50	1.60
NA 10	July, 1997	2.20	2.50
Ber			
Mundia	Sept., 1998	1.10	0.90
Umran	Sept., 1998	1.00	0.75
Seb	Sept., 1998	0.95	0.95
Gola	Sept., 1998	0.90	1.50
Citrus			
Sweet orange : Mosambi	August, 1997	2.72	2.45
Mandarin: Kinnow	August, 1997	1.70	1.10
Malta	August, 1997	1.85	1.45
Grapefruit:Marsh Seedless	August, 1997	1.50	1.55
Red Blush	August, 1997	1.30	1.25

Lemon:			
Pant I	August, 1997	1.90	2.05
Godhra	August, 1997	1.10	1.20
Abohar	August, 1997	1.80	1.15
Lime: Kagzi	August, 1997	1.75	1.05
Guava			
Allahabad Safeda	Sept., 1997	2.55	3.60
L 49	Sept., 1997	1.65	1.87
Karonda			
KS 1	July, 1997	0.78	1.20
KS 2	July, 1997	0.80	1.30
KS 3	July, 1997	0.63	1.24
KS 4	July, 1997	0.70	1.40
KS 5	July, 1998	0.45	0.40
Lasoda			
LS 1	July, 1997	2.50	2.20
LS 2	July, 1997	4.50	4.20
LS 3	July, 1997	1.20	0.70

LANDSCAPING

The centre is in the establishment phase, hence creation of aesthetic and ecofriendly environment inside the campus is very essential. Under the landscaping unit following activities have been undertaken during this year:

1. Land leveling

The area undertaken by the centre was very undulating. Therefore, as a first step of campus beautification, about 2 ha area in front of main office-cum-laboratory building has been levelled. Some paths and beds were made as per need of the site after removing the bushes and stones. Thereafter, pits were dug for plantation of perennials. The land leveling work was also initiated around residential area and electric substation area of the campus.

2. Establishment of Lawn

In front of main office building about one ha area has been demarcated by bricks for the development of lawn. The area was further divided into four compartments with a provision of circle at the centre. The cross path connecting the circle was further developed with walking steps. The area was ploughed, levelled and dressed properly. All the unwanted weeds, bushes and stones were removed from the site and mixed with 3500 cft. FYM followed by light irrigation. The runners of *Cynodon dactylon* grass were planted at a spacing of 5X5cm during monsoon season. The sprinkler system has been installed for irrigation purpose. The performance of the grass is very satisfactory and first cutting has been done. At present lawn is in excellent condition under hot arid ecosystem.

3. New plantation

Towards main gate, along the inner side of the boundary wall the plantation of Bougainvillea has been done. 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. At three sides of the lawn, the plantation of *Polyalthia longifolia* has been done followed by thatching of individual plant to protect them from winter frost and hot winds during summer. 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. Near the type V quarter another small piece of land was converted into grass lawn. The *Lawsonia alba* was planted at one side to develop as hedge row.

4. Annual plantation

Flower beds were developed around the lawn area and near the enterance of main building for plantation of seasonal annuals. Seedlings were raised in the nursery and planted in the beds from time to time. During rainy season, *Gomphrena* was grown while during winter season; marigold, iceplant, *Petunia*, holy hock, *Aster, Carnation,* larksper, *Acroclinum, Calendula, Chrysanthemum,* poppy etc. were grown in the beds.

Indoor beautification : 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; *Sansevieria, 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 repoting or by planting with new types.

FARM DEVELOPMENT

Land development and utilization:

To date, more than 55 hectares farm area has been developed. Out of which, the area in *ber* (8 ha.), pomegranate (4 ha.), *aonla* (2 ha), date palm (3 ha), vegetables (4 ha) and nursery and progeny block (2 ha) are being utilised as germplasm repositories and experimental plots while remaining area is under seed production to generate farm revenue. An area of about 20 ha was taken for rainfed *guar* cultivation in 1999. Because of failure of monsoon there was very poor crop.

Germplasm status:

A total 300 collections of *ber*, 150 of pomegranate, 47 of date palm, 106 of cactus pear and 19 of *aonla* are being maintained in the germplasm repositories. A row accommodating 23 plants of different varieties of date palm developed through tissue culture was planted in the field and maintained with 100 per cent survival. Required number of varieties of various arid fruit species i.e. *Ziziphus, Punica, Emblica, Aegle, Cordia, Carrissa, Grewia, Tamarindus, Citrus, Mangifera, Moringa, Psidium,* etc. are being maintained in the progeny block of the farm as mother plants for multiplication.

Seed production and revenue generation:

Seed production of eight varieties of cucurbit vegetables released by the NRCAH i.e. two each in *mateera* (AHW 19 & 65), snapmelon (AHS 10 & 82), *kachari* (AHK 119 & 200) and *salad kakdi* (AHC 2 & 13) and *tinda,* bottlegourd and clusterbean has been started and about 300 kg seed have been produced.

Irrigation system:

To operate close irrigation system, 400 m long PVC 4" water supply pipe line has been further extended along main road. Now, the functional close irrigation system in the farm area includes 25 lakh liter capacity water reservoir (diggi) connected with IGNP water supply channel and tube well and inter connection of elevated surface tank (5 lakh litre capacity) and a network to distribute water through (2000 m long) PVC main pipe line (35 ha), sprinkler set (2) and drip set (11 ha).

NETWORK PROJECT

Title : Network Project on drip irrigation systems in perennial horticultural corps.

Objectives:

1. To evaluate irrigation schedules under drip irrigation system for target fruit crops.
2. To evaluate the efficiency of drip irrigation system over bubbler irrigation system in target fruit crops.
3. To determine the crop regulation nutritional properties, wetting pattern weed management system with fruit crop under drip irrigation system.
4. To standardize the fertilizer schedule and efficiency of fertilizer at different crop stages.

Progress of Research:

Pomegranate: In pomegranate crop, the plant height, plant spread were measured at monthly interval. The fruit yield and TSS were also measured at crop maturity. The leaf tissue analysis and soil moisture movement pattern were also analysed. The details of each parameter is given below.

Plant height: Plant height of pomegranate plants was measured at monthly interval but in report only every six monthly is being presented. The data revealed that in the month of March, 99, the plant height was significantly higher in drip irrespective of the irrigation levels over bubbler irrigation system. In the month of August, 99, the plant height was maximum (120 cm) in 0.75 CPE through drip irrigation level and statistically at par with 0.90 CPE through drip and both were significantly higher over 0.5 CPE through drip and 1.00 CPE through bubbler. N fertilization also responded and height was significantly higher in 75 and 50% RD of N over control. In the month of February, 2000 maximum plant height (134 cm) was measured again in 0.75 CPE irrigation level and significantly higher over other irrigation levels. N fertilization increased the height significantly over control (Table 31).

Plant spread: Unlike plant height, plant spread was also measured at monthly intervals but in report the data for the month of March, 99, August, 99 and February, 2000 have been given (Table 32). The data revealed that in the month of March, 99 plant spread was statistically at per in all levels of irrigation through drip and they were significantly superior over 1.00 CPE through bubbler irrigation. Almost same trend was also observed in the month of August, 99. In the month of February, 2000 maximum plant spread (1.32 m^2) was recorded in 0.75 CPE irrigation level and minimum (0.68 m^2) in 1.00 CPE through bubbler. N fertigation also showed response on plant spread and in the month of February, 2000, maximum (1.35 m^2) spread was noticed in 75% RD of N and minimum (1.94 m^2) in control. The interaction between irrigation and fertigation were not noticed so far.

Fruit yield and TSS: Crop was nearly two years old although fruiting should not be allowed considering the crop age however, to see the effect of fertigation, fruiting (15-18) was allowed on each tree in *mrig bahar* and the yield and TSS were measured. The maximum fruit yield (6.50 q/ha) was recorded in 0.90 CPE through drip and statistically at par with 0.75 CPE and 0.50 CPE and they were significantly higher over

1.00 CPE through bubbler. So far effect of fertigation was not noticed in respect of fruit yield. TSS was recorded in the range of 13.00 to 14.00°Brix and more or less same in all treatments (Table 33).

Leaf Mineral Composition: In the month of July, 99, the leaf samples were collected according to standard leaf sampling technique to see the effect of fertigation on the status of nitrogen, phosphorus, potassium, zinc, iron and copper minerals. It was found that N content was in the range of 1.60-1.78 with mean value 1.76% in 0.90 CPE, 1.66% in 0.75 CPE, 1.72% in 0.50 CPE through drip and 1.70% in 1.00 CPE through bubbler system. The means of minerals at different irrigation levels did not differ statistically. Fertilization showed some response on N content and maximum N (1.87%) was found in 75% RD of N level followed by 50% RD of N and minimum N (1.45%) was estimated control, phosphorus and potassium were in the range of 0.20 to 0.26% and 1.30 to 1.52%, respectively. Likewise Zn, Fe and Cu were in the range of 35 to 50 ppm, 340 to 410 ppm and 6 to 8 ppm, respectively. Except N, concentration of other elements was more or less same irrespective of any fertigation treatments (Table 34).

Dynamics of moisture management: The soil moisture content was measured every month after the irrigation at different horizontal distances and vertical depth from the emitters. Fig. 1 shows that optimum soil moisture 12-15% was recorded at 20-45 cm horizontal distances and vertically at 30-45 cm depths. In bubbler irrigation, the maximum soil moisture (11.5%) remains upto 30 cm vertically. In drip irrigation system, top soil upto 10 cm remains dry due to sub-surface placement of drippers in PVC-pipes.

Quantity of water: Considering the daily pan evaporation, crop spacing (6x4 m), pan factor (0.7), crop factor (0.6) and crop wetting area (10%) and rainfall occurred during the period, the total amount of water given in different irrigation levels was worked out. Table 35 shows that in 0.90 CPE through drip, the total water applied was 2417 litres per year and it was 2014, 1343 and 2685 litres/year in 0.75 CPE, 0.50 CPE through drip and 1.00 CPE through bubbler, respectively. The minimum water was given in the month of January and maximum in the month of June.

Ber: The *ber* plants were pruned and framed in the month of May, 1999 and kept without fertigation upto last week of June, 99. From the month of July, irrigation treatments as per technical programme were deployed. The irrigation through drip was given on alternate day considering CPE, crop spacing (6x6 m), wetting area (15%), crop factor (0.6) and pan factor (0.7). The nitrogen fertilizer (urea) was given once in a week. The plant height and spread was recorded every month beginning from August, 99. The fruit yield and TSS were also recorded at harvest. The leaf samples were collected for tissue analysis and they are underway for analysis and data will be presented in next report.

Plant height: Data pertaining to plant height are presented in Table 36. Data revealed that the plant height was recorded in the range of 1.05 to 1.88 m in the month of August, 99. The maximum plant height (1.88m) was recorded in 0.9 CPE through drip and statistically at par with 0.75 CPE through drip and both these treatments were significantly higher over 0.50 CPE through drip and 1.00 CPE through bubbler. All fertigation

treatments were at statistically at par. In the month February, 2000 plant grew and attained maximum height (2.05 m) in 0.75 CPE through drip followed by 0.90 CPE and minimum in 1.00 CPE through bubbler. Irrigation treatments (0.90 CPE and 0.75 CPE) gave significant more height over 0.5 CPE through drip and 1.00 CPE through bubbler. N fertigation response was not seen in plant height.

Plant spread: The plant spread was recorded in the range of 3.85 to 4.65 m^2 in August, 99 (Table 37).The maximum spread was recorded in 0.90 and 0.75 CPE irrigation through drip treatments followed by 0.50 CPE and minimum spread (3.95 m^2) in 1.00 CPE through bubbler. N fertilization did not show any effect on plant spread.

Fruit yield & TSS: The fruit yield was recorded and their data have been presented in Table 38. The data revealed that the fruit yield was in the range of 27.50 to 40.0 q/ha and maximum average yield was recorded in 0.90 & 0.75 CPE followed by 0.50 CPE and minimum in 1.00 CPE bubbler irrigation treatments. N fertilization did not show any response on fruit yield. The TSS was also measured and found to the tune of 12-15oBrix and was statistically at par in all treatments.

Quantity of water: From the month of March, 99 to June, 99, watering was withheld for defoliation & pruning, from July,99 to February 2000 watering was given as per technical programme. The total water applied to each plant was 1314, 1095, 730 and 1460 litres in 0.90, 0.75, 0.50 CPE through drip and 1.00 CPE through bubbler irrigation treatments, respectively.

Table 31. Effect of fertigation on plant height (cm) of pomegranate

Treatments	Months		
	March,99	August, 99	February, 2000
A. Irrigation			
0.90 CPE through Drip	71	111	123
0.75 CPE through Drip	75	120	134
0.50 CPE through Drip	64	103	121
1.00 CPE through Bubbler	50	91	98
SEm±	3.86	3.74	3.64
CD at 5%	9.50	9.23	8.95
B. Fertilization			
75% RD of Nitrogen	70	117	132
50 %RD of Nitrogen	65	107	126
No Nitrogen (control)	60	92	87
SEm±	4.01	3.90	4.10
CD at 5%	9.87	9.60	10.09
AxB			
CD at 5%	NS	NS	NS

Table 31. Effect of fertigation on plant spread (m^2) of pomegranate.

Treatments	Months		
	March,99	August, 99	February, 2000
A. Irrigation			
0.90 CPE through Drip	0.52	1.00	1.16
0.75 CPE through Drip	0.59	1.21	1.32
0.50 CPE through Drip	0.52	0.95	1.16
1.00 CPE through Bubbler	0.40	0.53	0.68
SEm±	0.048	0.059	0.061
CD at 5%	0.104	0.127	0.130
B. Fertilization			
75% RD of Nitrogen	0.52	1.12	1.35
50 %RD of Nitrogen	0.51	1.15	1.14
NoNitrogen (control)	0.50	0.88	0.92
SEm±	0.051	0.052	0.059
CD at 5%	0.11	0.11	0.13
AxB			
CD at 5%	NS	NS	NS

Table 31. Effect of fertigation on fruit yield of pomegranate.

Treatments	Fruit yield (q/ha)	TSS °Brix
A. Irrigation		
0.90 CPE through Drip	6.50	13.50
0.75 CPE through Drip	6.12	13.40
0.50 CPE through Drip	5.60	13.30
1.00 CPE through Bubbler	4.00	14.00
SEm±	1.25	1.27
CD at 5%	NS	NS
B. Fertilization		
75% RD of Nitrogen	6.25	13.10
50 %RD of Nitrogen	6.00	14.00
NoNitrogen (control)	5.24	13.50
SEm±	1.20	1.25
CD at 5%	NS	NS
AxB		
CD at 5%	NS	NS

Table 34. Effect of fertigation through drip on leaf mineral composition of pomegranate

Treatments	N	P	K	Zn	Fe	Cu
	%			ppm		
A. Irrigation						
0.90 CPE through Drip	1.76	0.25	1.50	49.50	390	7
0.75 CPE through Drip	1.76	0.24	1.48	43.25	376	8
0.50 CPE through Drip	1.72	0.25	1.48	37.50	375	7
1.00 CPE through Bubbler	1.70	0.22	1.32	41.50	340	7
Sem±	-	-	-	-	-	-
CD at 5%	NS	NS	NS	NS	NS	NS
B. Fertilization						
75% RD of Nitrogen	1.87	0.24	1.50	45.50	400	7
50 %RD of Nitrogen	1.70	0.24	1.46	37.50	378	7
NoNitrogen (control)	1.45	0.23	1.47	36.00	370	8
Sem±	0.10	-	-	-	-	-
CD at 5%	0.22	NS	NS	NS	NS	NS
AxB						
CD at 5%	NS	NS	NS	NS	NS	NS

Table 35. Water Application (litres) to promegranate plants (1-2 years) / year

Months	Irrigation level			
	0.90 CPE	0.75CPE	0.50 CPE	1.00
January	59	49	33	65.00
February	108	90	60	120.00
March	153	128	35	170.00
April	288	240	160	132.00
May	324	270	180	360.00
June	351	293	195	390.00
July	243	203	135	270.00
August	216	180	120	240.00
September	243	203	135	270.00
October	234	195	130	260.00
November	122	101	68	135.00
December	77	64	43	85.00
Total	2417	2014	1343	2685

Table 36. Effect of fertigation on the plant height (m) of *ber*

Treatments	Plant height (m)	
	August, 1999	February, 2000
A. Irrigation		
0.90 CPE through Drip	1.88	1.95
0.75 CPE through Drip	1.78	2.05
0.50 CPE through Drip	1.38	1.65
1.00 CPE through Bubbler	1.05	1.25
Sem±	0.082	0.078
CD at 5%	0.18	0.17
B. Fertilization		
75% RD of Nitrogen	1.80	1.95
50 %RD of Nitrogen	1.65	1.75
No Nitrogen (control)	1.60	1.65
Sem±	0.10	0.11
CD at 5%	NS	NS
AxB		
CD at 5%	NS	NS

Table 37. Effect of fertigation on the plant spread of *ber*

Treatments	Plant spread (m^2)	
	August, 1999	February, 2000
A. Irrigation		
0.90 CPE through Drip	4.65	5.02
0.75 CPE through Drip	4.65	5.15
0.50 CPE through Drip	4.20	4.35
1.00 CPE through Bubbler	3.88	3.95
SEm±	0.24	0.29
CD at 5%	0.50	0.62
B. Fertilization		
75% RD of Nitrogen	4.50	5.05
50 %RD of Nitrogen	4.35	4.95
No Nitrogen (control)	3.85	4.75
Sem±	0.30	-
CD at 5%	0.65	NS
AxB		
CD at 5%	NS	NS

Table 38. Effect of fertigation on fruit yield & TSS of *ber*

Treatments	Fruit yield (q/ha)	TSS °Brix
A. Irrigation		
0.90 CPE through Drip	37.50	13.20
0.75 CPE through Drip	37.50	13.20
0.50 CPE through Drip	32.40	12.80
1.00 CPE through Bubbler	28.60	13.00
Sem±	-	-
CD at 5%	NS	NS
B. Fertilization		
75% RD of Nitrogen	32.46	12.50
50 %RD of Nitrogen	34.50	12.00
No Nitrogen (control)	34.20	13.50

STAFF POSITION

Table 39. Cadre Strength as on 31.03.2000

	STRENGTH	IN POSITION
SCIENTIFIC	23*	12
ADMINISTRATION	12	10
TECHNICAL	12	11
SUPPORTING	09	09
TOTAL	56	42

* Including two posts of PC Cell of AICRP (AZF)

Staff as on 31.03.2000

Scientific:

1. Dr. G.B.Raturi, Director
2. Dr. B.B.Vashishtha, Principal Scientist(Hort.)
3. Dr. B.D.Sharma, Sr. Scientist (Soil Science)
4. Dr. R.Bhargava, Sr. Scientist (Plant Physiology)
5. Dr. P.L.Saroj, Sr. Scientist (Hort.)
6. Sh. R.S. Singh, Scientist (Sr. Scale) on study leave.
7. Dr. D.K. Samadia, Scientist (Sr.Scale) Hort.
8. Sh. P. Nallathambi, Scientist (Plant Pathology) on study leave.
9. Smt. C. Uma maheshwari, Scientist (Plant Pathology)
10. Sh. Anil Kumar Shukla, Scientist (Hort.)
11. Sh. Sumer Singh Meena, Scientist (Hort.)
12. Sh. Arun Kumar Shukla, Scientist (Hort.)

Technical:

1. Sh. M.K.Jain, T-4 (Sr. Computer)
2. Sh. Prem Prakash Pareek, Hindi Translator
3. Sh. Udaivir Singh, T-II-3 (Field Technician)
4. Sh. Sanjay Patil, T-II-3 (Artist-cum-Photographer)
5. Sh. Chhuttan Lal Meena, T-II-3 (Field Technician)
6. Sh. Bhoj Raj Khatri, T-2 (Computer)
7. Sh. Vinod Kumar, T-1 (Field Technician)
8. Sh. Prithvi Raj Singh, T-1 (Field Technician)
9. Sh. G.K. Tripathi, T-1 (Lab. Technician)
10. Sh. Satpal, T-1 (Gypsy Driver)
11. Sh. Ashok Kumar Mali, T-1 (Tractor Driver)

Administration:

1. Sh. Ayaz Ahmed, AFAcO
2. Sh. V.K.Pandey, Assistant
3. Sh. Rajesh Daiya, UDC
4. Sh. Kuldeep Pandey, UDC
5. Sh. Akhil Thukral, Jr. Steno (English)
6. Sh. Rakesh Kumar Swami, LDC
7. Sh. S.C. Rathore, LDC
8. Sh. Navneet Kumar Sharma, LDC
9. Sh. Mukesh, LDC.
10. Sh. K. Sakthi Narayan, LDC

Supporting:

1. Sh. Shiv Dayal, SSG-II
2. Sh. Ghanshyam Khatri, SSG-II
3. Sh. Rawat Singh, SSG-I
4. Sh. Sua Lal Choudhary, SSG-I
5. Sh. Birdhi Chand Meena, SSG-I
6. Sh. Gulla Ram, SSG-I
7. Sh. Shiv Lal, SSG-I
8. Sh. Mohan Lal, SSG-I
9. Sh. Manoj Kumar Vyas, SSG-I

FINANCES

Budget allocation and expenditure incurred during 1999-2000 are given in table below.

Table 40. Budget allocation and expenditure incured during 1999-2000.

Head	Allocation		Expenditure	
	Plan	Non Plan	Plan	Non Plan
Pay and allowences	4.50	38.50	3.88	38.11
TA	2.00	1.00	1.90	0.95
Other charges including equipments	63.00	5.00	62.96	4.95
Works	70.50	0.50	70.50	0.49
Total	140.00	45.00	139.24	44.50

PUBLICATIONS

A. Research papers

Bhargava, R. Sharma, B.D., Vishal Nath, Pareek, O.P. and Vashishtha, B.B. (1999) Comparison of photosynthetic activity, stomatal resistance and chlorophyll content in some cultivars of *ber*. Paper presented in National Seminar on Plant Physiology at Interface on Agriculture and Industry. UAU, Udaipur, 30 December to 1 January.

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B. Popular/Technical Articles

डॉ. दिलीप कुमार समादिया एवं डॉ. ओम प्रकाश पारीक (1999) शुष्क क्षेत्र में फ्रूट ककड़ी की खेती, उन्नत कृषि, (जुलाई–अगस्त 38;4):20–24.

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शुक्ला, अरूण कुमार, शुक्ला, अनिल कुमार एवं सिंह, आलोक कुमार (2000). कुन्दरू की वैज्ञानिक खेती कैसे करें। उन्नत कृषि।

Saroj, P.L.(1999) अच्छी फलत के लिए नींबू वर्गीय फल वृक्षों की देखभाल। Farmers and Parliament, XXXVI(10): 29-32

Radio talk

शुक्ला डॉ.अनिल कुमार : इन दिनों फलों के बगीचों में कृषि कार्य, आकाशवाणी, बीकानेर, दिनांक 21.12.1999

शुक्ला डॉ. अरूण कुमार : अनार के बगीचे में सिंचाई, खाद एवं उर्वरक, आकाशवाणी, बीकानेर दिनांक 20 जनवरी, 2000

शुक्ला डॉ. अरूण कुमार : बेकार पड़ी भूमियों में फलों की खेती, जुलाई, 1999

Dr. D.K.Samadia delivered following radio talks:

1- मरूस्थलीय बागवानी में महिलाओं की भूमिका, आकाशवाणी, बीकानेर। दिनांक 14.3.2000

2- अधिक लाभ के लिये फूल गोभी की अगेती फसल उगाये, आकाशवाणी,बीकानेर, दिनांक 26.9.1999.

Meeting /Seminars/Symposium

Dr. O.P.Pareek, Director attended following:

1. Participated in the Regional Committee Meeting during 15.4.1999 to 17.4.1999 at CCS HAU, Hisar (Haryana)
2. Participated in the RAC Meeting of RAU at Jaipur during 5.5.1999 to 7.5.1999.
3. Directors meeting on 13-16 Dec., 1999 at ICAR, New Delhi.

Dr. B.D. Sharma, Sr. Scientist (Soil Science) attended followings:

1.International Conference on Managing Natural Resources for Sustainable Agricultural Production in 21 st Centuary', Feb. 14-18, 2000 at IARI, New Delhi.

2. National Seminar on Plant Physiology to Interface of Agri. Horticulture and Industry held at RAU, Udaipur during 30 Dec.,1999 to 1st Jan., 2000.

3. National Seminar on Advances of S.S.-99 during 26-30 Nov., 1999 at TNAU, Coimbatore.

4. Internate Usage in Agriculture organised by NAARM, Hyderabad during 29 March, 2000 to April 1, 2000.

Dr. P.L. Saroj, Sr. Scientist (Hort.) attended followings:

1. International Conference on Managing Natural Resources for Sustainable Agricultural Production in 21 st Centuary', Feb. 14-18, 2000 at IARI, New Delhi.

2. Participated in Intensive Hindi Training cum Workshop at NAARM, Hyderabad during 3-7 July, 2000.

3.Participated in NATP meeting to formulate the project on " Develop Sustainable Agri-Silvi- Horti. production Systems for marginal lands" at CHES, Godhra (Gujarat).

Dr. R. Bhargava, Sr. Scientist (Plant Physiology) attended followings:

1. National Seminar on Plant Physiology to Interface of Agri. Horticulture and Industry held at RAU, Udaipur during 30 Dec.,1999 to 1st Jan., 2000.

Dr. D.K.Samadia, Scientist (SS) Hort. attended followings:

1. First Consultation cum Orientation Workshop on Plant bio diversity (NATP),

NBPGR, New Delhi from August 25-26, 1999.

2. National Seminar on Plant Physiology to Interface of Agri. Horticulture and Industry held at RAU, Udaipur during 30 Dec.,1999 to 1st Jan., 2000.

3.International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21 Century, February, 14-18, 2000 at IARI, New Delhi.

4. First Zonal Workshop for Co-operators of arid region under NATP on Plant biodiverstiy. March, 1-2, 2000, NBPGR, New Delhi.

Training

Dr. D.K.Samadia attended following training:
1.Training course on "Use of Computer in Agricultural Research at IASRI, New Delhi, 19.4.99 to 1.5.99. 2.Training on "Exploration and collection of germplasm in arid region", October, 5-6, 1999 NBPGR, Jodhpur.

Mr. G.K. Tripathi, Lab. Tech. (T-1) attended computer training course MS-Office 97 at IASRI, New delhi during 31.5.1999 to 5.6.1999.

Dr. Vishal Nath, Scientist, SS (Hort.) attended following trainings :

1. Computer training course on MS-Office 97 (II) at IASRI, New delhi during 14-19 June, 1999.

2. Advance Courses of PHT of Fruits during 29.9.1999 to 26.10.1999 at CCS HAU, Hisar.

Promotions

1. Dr. B.D.Sharma, Scientist (Sr. Scale) promoted to the post of Senior Scientist (Soil Scientist) w.e.f. 04.10.1998.

2. Dr. R.Bhargava, Scientist (Sr. Scale) promoted to the post of Senior Scientist (Plant Physiology) w.e.f. 10.03.1999.

3. Dr. Vishal Nath, Scientist (Hort.) promoted to the post of Scientist (Sr. Scale) w.e.f. 21.07.1998.

4. Dr. D.K.Samadia, Scientist (Hort.) promoted to the post of Scientist (Sr. Scale) w.e.f. 14.09.1998.

5. Shri Bhoj Raj Khatri, T-1 (Computer) promoted to the post of T-2 (Computer) w.e.f. 29.3.1999.

6. Shri Ghanshyam Khatri, SSG-I promoted to the post of SSG-II w.e.f. 06.01.2000.

Resignation

1. Shri Shaji C.P., Jr. Steno (English) resign from council service on 24.11.1999.

Joining

1. Dr. G.B.Raturi, Head, CHES (IIHR), Godhra joined on 22.01.2000 as Director.

2. Shri Anil Kumar Shukla joined on 31.08.1999 as Scientist (Hort.).

3. Shri Sumer Singh Meena joined on 01.11.1999 as Scientist (Hort.).

4. Shri Arun Kumar Shukla joined on 20.11.1999 as Scientist (Hort.).

5. Shri. N.K.Sharma joined on 29.10.1999 as Jr. Clerk.

6. Shri Akhil Thukral joined on 10.11.1999 as a Jr. Steno (English).

7. Shri Mukesh joined on 11.11.1999 as a Jr. Clerk.

8. Shri K.Sakthi Narayan joined on 12.11.1999 as Jr. Clerk.

Transfer

1. Dr. Vishal Nath, Scientist, SS (Hort.) relieved on 10.12.1999 to join as Senior Sci-

entist (Hort.) at CHES (IIHR), Ranchi.

Retirement

1. Dr. O.P.Pareek, Director relieved on superannuation w.e.f. 31.07.1999, later re-employed as Director on 12.08.1999 and worked till 22.01.2000.

Special assignment

Dr. P.L.Saroj, Sr. Sci. (Hort.), Nominated as member for "Research Degree Committee" by the CCS University of Meerut (UP).

Visitors

1. Dr. R.K. Pathak, Tech. Coordinator, Diversified Agril. Support Project, Lucknow on dated 13.04.1999.
2. Dr. Harcharan Dass, Ex-Direc tor, NRC Citrus, Nagpur on dated 13.04.1999.
3. Dr. R.N. Pal, ADG (PC & H), ICAR, New Delhi on dated 30.07.1999.
4. Dr. Kirti Singh,Ex-Chairman, ASRB; Secretary, NAAS, New Delhi on dated 29.01.2000.

Field Visit

A group of 25 women farmers alongwith 3 officers visited the experimental farm of the NRCAH under scheme, "Training Women in Agriculture (TWA) from Regional Farmers Training Centre, Navasari, Gujarat. Besides, more than ten groups of farmers, farm woman alongwith extension officials, under various schemes of State Deptt. of Agriculture, KVK, IFFCO, visited the experimental farm, of the NRCAH during the year.

Dr.Kirti Singh, Ex-chairman ASRB, discussing the research programmes & achievements.

Dr. R.S. Paroda, DG, ICAR & Secretary DARE inaurgurating Office cum Lab Building of NRCAH

Dr. R.S. Paroda, D.G. ICAR & Secretary DARE presiding the inaurgural function.

Dr. R.S. Paroda , DG, ICAR & Secretary DARE during field visit.

Dr. G.B. Raturi, Director, Welcoming Dr.S.P. Gosh, DDG(H) during RAC Meeting.

Chairman & members of RAC discussing the research programmes with Scientists in Laboratory.

Chairman & members of RAC discussing the experiments with Scientists.

सारांश

देश के राजस्थान, हरियाणा, पंजाब, गुजरात, महाराष्ट्र, आन्ध्र प्रदेश तथा कर्नाटक राज्यों में फैला शुष्क क्षेत्र भारत के कुल क्षेत्रफल का लगभग 12 प्रतिशत है। कठिन परिस्थितियों के कारण यहां का जन–जीवन विकट होता है। ऐसी स्थिति में कृषि कार्य करना विशेषकर उद्यानिकी कृषि तो अत्यंत दुष्कर है। विपरीत कृषि जलवायु एवं भू–मौतिकी परिवेश के कारण इस क्षेत्र में उद्यानिकी उत्पादन नगणय है। यद्यपि उपलब्ध प्राकृतिक संसाधनों के उचित उपयोग, सुखा सहिष्णु किस्मों को विकसति कर वैज्ञानिक तकनीकियों के आंकलन आदि से इस क्षेत्र में उद्यानिकी उत्पादन बढ़ाने की प्रबल संभावनाएं दृष्ति होती है। शुष्क क्षेत्र में उद्यानिकी उत्पादन बढ़ने से यहां के जन–जीवन में उल्लेखनीय सुधार तो होगा ही साथ ही देश व इस क्षेत्र की आर्थिक स्थिति का स्तर भी बेहत्तर होगा। इन सब तथ्यों को दृष्टिगत रखते हुए भारतीय कृषि अनुसंधान परिषद् नई दिल्ली ने राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान केन्द्र के रूप में एक संस्था की रूपरेखा तैयार कर अप्रैल, 1993 से इसकी विधिवत स्थापना की।

मूल ध्येय

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

उद्देश्य

1. शुष्क परिस्थितियों में उद्यानिकी फसलों की जैवविविधता की पहचान कर उनका संग्रहण संरक्षण, मुल्यांकन तथा वर्गीकरण करना।
2. लक्षित फल–फसलों जैसे – बेर, अनार, आवंला, खजूर एवं खीरावर्गीय, फलीदार–फलदार (सोलैनीसियस 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. शुष्क जलवायु के अनुरूप उद्यानिकी फसलों की उत्पादकता बढ़ाने के लिये पोषक तत्त्वों, 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 जैसे संसाधनों के उपयोग हेतु उद्यानिकी फसल–चक्र पद्धतियों के पारिस्थितिजन्य परिमापकों का अध्ययन करना।
6. शुष्क क्षेत्रीय उद्यानीकी 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 1999-2000 के मध्य किए गये महत्वपूर्ण अनुसंधान कार्यों का संक्षिप्त विवरण

(i) इस अवधि में बेर में 15 व आवंला में 5 जीन प्रारूप संग्रहित किए गये। इसके साथ ही अनार की दो किस्में अर्जेंटीना से प्राप्त की गई। केन्द्र में अब कुल जननद्रव्य संग्रहण इस प्रकार है बेर 315, अनार 155, आवंला 19, नागफणी (केक्टस पीअर) 108, खजूर 48, काचरी 558, मतीरा 192, फूटकाकड़ी 90, मिर्च 132, खरबूजा 55।

(ii) तरबूज में मतीरे के समान सूखा सहिष्णु तत्वों का गुण विकसित करने के क्रम में इसकी प्रमुख किस्मों का संकरण मतीरे की कुछ किस्मों से कराया गया – जैसे ए.एच.डब्ल्यू. 19X सूगर बेबी, ए-एच- डब्ल्यू- 19X दुर्गापुरा मीठा, ए-एच- डब्ल्यू- 19x ए-एच- डब्ल्यू 65x सूगर बेबी, ए-एच- डब्ल्यू 65 x सूगर बेबी ए.एच.डब्ल्यू. 65X दुर्गापुरा मीठा सूगर बेबी X ए-एच- डब्ल्यू 19 आदि। ए-एच- डब्ल्यू 19X सूगर बेबी के संकरण में उत्साहजनक परिणाम सामने आए हैं।

(iii) खेजड़ी (प्रोसोपिस सिनेरिया) की कलमों में फरवरी माह में स्फुटन दर्ज किया गया।

(iv) मतीरे व तरबूज के विकास पर किए एक अध्ययन में पाया गया कि मतीरा पानी की कमी के प्रति सहिष्णु है एवं चार सिंचाई में भी अच्छी पैदावार दे सकता है जबकि तरबूज पानी की कमी के प्रति असहिष्णु है साथ ही इसकी उपज पर भी विपरित प्रभाव पड़ता है।

(v) बेर की 10 किस्मों पर किए गये प्रकाशसंश्लेषी परिमापकों के अध्यसयन में पाया गया कि नरमा, काकरोल गोला, कल्याण दनदन, आदि किस्मों में दोपहर के समय अवसादन होता है।

(vi) पौध रोपण हेतु गढ्ढों का आकार एवं नमी संरक्षण के उपायों के एक प्रयोग में देखा गया कि 60x60x60 सेमी आकार के गढ्ढे में पौधे की स्थापना अधिक सफल होती है।

(vii) तुलनात्मक अध्ययन में दर्ज किया गया कि अनार में कार्बनिक खाद अकार्बनिक उर्वरक से अधकि उपयोगी है। वर्मी कम्पोस्ट देने से पौधे में वृद्धि दर बढने के साथ ही आवश्यक नत्रजन मात्रा की भी पूर्ति हो जाती है।

(viii) केन्द्र ने अन्य सहयोगी कार्यकलापों में भी पूर्ण सहयोग प्रदान किया है। इसके वैज्ञानिकों ने विभिन्न किसान मेलों एवं अन्य विस्तार गतिविधियों में सक्रिय भाग लेकर किसानों को नई प्रौद्योगिकीयों से अवगत कराया। कृषि विश्व विद्यालय एवं अन्य कृषक संस्थाओं के माध्यमों से वैज्ञानिकों ने किसानों को विभिन्न प्रकार का प्रशिक्षण भी इस अवधि में प्रदान किया है।