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NATIONAL RESEARCH CENTRE FOR ARID HORTICULTURE
BIKANER-334006, INDIA

Annual Report

1998-99

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BIKANER-334006, INDIA

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Director
NRC for Arid Horticulture
10th Km Milestone, Sriganganagar Road,
Beechwal, Bikaner-334006 (Rajasthan), India
Phone : 0151-250147
Fax : 0151-250145
E.mail : nrcah@400x.nicgw.nic.in
Cable : UDYANSHODH

Complied and Edited by

Dr. O.P. Pareek
Dr. B.B. Vashistha
Dr. R. Bhargava

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Cover

Front : A front view of Lab. cum Office Building

Back : 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 1998-99 were:

1. During the period under report 7 cultivars of pomegranate were introduced from Iran. In *boradi* 15 genotypes were collected from Pipad and 3 from Bikaner. With this, the total collection reached to 300 in *ber*, 150 in pomegranate, 16 in *aonla*, 106 in Cactus pear, 47 in date palm, 193 in *mateera*, 558 in *kachari* and 90 in snapmelon.
2. A total of 8 varieties, 2 of *kachari* (AHK 119, AHK 200), 2 of *mateera* (AHW-19, AHW-65), 2 of snapmelon (AHS 10, AHS 82) and 2 of *salad kakadi* (AHC 2, AHC 13) were released during 1998.
3. As a result of extensive survey, a total of 132 collections of chillies were made from Mathania, Soila, Manai and Pal area.
4. Studies on water stress in *mateera* & watermelon demonstrate that *mateera* is drought tolerant and can give yield even under 4 irrigation whereas watermelon is drought susceptible and can not tolerate water stress.
5. Application of organic manure and inorganic fertilizers were compared in pomegranate. It was observed that application of vermicompost improved plant growth, photosynthetic activity and water conservation as compared to inorganic fertilizer.
6. Application of chemical treatments such as Virosil agro (5%), $CaNO_3$ (0.5 & 1%) and bavistin (0.1%) can improve the shelf life of *ber*.
7. The scientists of the centre took active part in *Kisan melas* and other extension activities and acted as resource personnel for various training programmes organised in Bikaner.

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.)

Out of 11 genotypes identified from Bharatpur, Shekhawati and Chomu region of Rajasthan during February, 1996 and budded *in situ* during July-August, 1997, 10 have started bearing. First year evaluation data reveal that NRCAH B11 is a heavy bearer while NRCAH B9 is a dwarf statured cultivar. NRCAH B2 is considered good for drying (Table 1). An early maturing type with subspherical fruit shape has been identified from Bikaner

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

With the collection of 15 genotypes from Pipad and three from Bikaner, the total collections in *boradi* reached upto 22. Genotypes collected earlier and budded *in situ* during 1997 have started bearing. NRCAH R1, a *boradi* type collected from Shekhawati region of Rajasthan has shown profuse bearing during first year. The genotype has red fruit with very good sweet acid blend after ripening while at raw stage, reddish brown fruits are acrid in taste. Ripe fruits were very much liked after dehydration.

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

Eight promising cultivars of *aonla* collected from GAU, Anand are being maintained in nursery. With this, the total genotypes in *aonla* are sixteen.

Aonla cultivars (NA 6, NA 7, Krishna, Kanchan, Chakaiya) have started flowering in the 3rd year of plantations. Under Bikaner condition, Krishna started early flowering (25.3.99) but the female flowers were very less. NA 7 started flowering in first week of April with 7-10 female flowers per branchlet. Branchlet emerging from middle portion of the

Table 1. Morphometric and fruit characteristics of *ber* genotypes budded during 1997.

Genotype	Plant height (m)	Plant spread (m)	Leaf size (cm)	Fruit shape	Fruit colour (Ripe)	Fruit size (cm)	Fruit weight (g)	TSS (°Brix)	Flesh thickness (cm)
NRCAH B1	1.75	7.4x4.9	6.2x5.1	Oval	Brownish green	3.9x3.0	19.5	20.0	1.9
NRCAH B2	1.62	4.5x5.1	5.8x4.2	Oval	Yellowish brown	4.1x2.8	21.7	15.0	1.8
NRCAH B3	1.53	4.2x4.3	5.7x4.2	Oblong oval	Greenish brown	4.2x2.9	22.6	23.0	1.9
NRCAH B4	1.50	1.3x4.3	5.0x4.5	Oblong oval	Greenish brown	4.1x2.9	16.6	15.5	2.0
NRCAH B5	1.50	3.2x2.8	4.9x3.7	Apple shaped	Yellowish	4.2x4.3	43.6	16.5	3.2
NRCAH B6	1.10	2.8x2.3	—	Oblong oval	Yellowish green	5.9x3.7	37.6	17.0	2.8
NRCAH B7	1.70	4.5x4.6	7.2x4.1	Ovate	Yellowish green	5.1x4.0	39.0	21.5	3.1
NRCAH B9	1.30	3.1x3.5	4.3x3.4	Oval	Yellowish	2.6x1.8	5.4	24.0	1.1
NRCAH B10	1.26	3.6x3.5	6.0x3.4	Sub-spherical	Yellowish green	3.8x2.8	18.2	21.0	1.9
NRCAH B11	1.48	3.9x4.4	5.2x3.8	Sub-spherical	Yellowish	3.9x4.2	26.8	26.0	3.1
NRCAH B12	1.65	5.4x5.5	5.6x3.4	Sub-spherical	Yellow	5.8x4.3	38.5	21.0	2.8

branch had more female flowers. In NA 6 and Chakaiya, the flowering was comparatively late i.e. in the middle of April.

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

Seven pomegranate cultivars introduced from Iran (Table 2) in collaboration with NBPGR, New Delhi, in 1998 are being maintained for multiplication and evaluation.

Table 2. Introduction of pomegranate germplasm from Iran

S. No.	Name of cultivar	Cuttings received	Cutting sprouted
1.	Pust Piyaji	18	3
2.	Zag Evedekan	18	3
3.	Aleke Parend	20	3
4.	Aga Mohamad Ali	20	2
5.	Mehosh Beh Bahan	20	2
6.	Pust Garmet	20	2
7.	Malesh Shirin	20	1

The pomegranate orchards around Jalore and Jodhpur districts have sprung up through seedling and there is lot of variation. It was decided to take advantage of these genetic variations in the cultivar Jalore Seedless. During December, 1998, an exploration was undertaken in orchards of Jalore Seedless cultivar and fifty two promising plants were selected and open pollinated fruit samples were collected. Considerable variations were recorded in fruit yield and quality characters (Table 3). The range of diversity was recorded for fruit weight (74.3-298.2 g), fruit diameter (4.91- 7.62 cm), fruit length (5.0-7.9 cm), aril length (6.0-11.0 mm), weight of 10 arils (1.10-3.54 g) and TSS (11.0-20.10 Brix). Besides, the characters like fruit shape, rind colour, aril colour and softness were also recorded. From seeds of the fruits of selected trees, the progeny of about 2500 seedling has been raised for evaluation.

National Repository

i) Ber: With the collection of 19 genotypes/lines from Jodhpur during 1998, the total entries in the *ber* National Repository reached upto 300. Genotypes budded earlier (1996-97) on *in situ* raised rootstocks started bearing in third year. Many cultivars/ genotypes collected from different locations have shown synonimity with respect to growth and fruiting characters. Vegetative growth, flowering, fruiting and fruit characters of genotypes have been recorded.

ii) Pomegranate: The work on collection of genetic diversity of

Table 3. Variability in fruit characters of Jalore Seedless

Variability pockets	Sample number	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Aril length (mm)	Weight of 10 aril (g)	TSS (^{0}Brix)
Bheswara	1-10	100.4-198.2	5.52-7.21	5.5-7.0	6.2-9.1	1.10-1.83	11.0-13.9
Ahor	11-21	97.1-190.2	5.51-6.91	5.7-7.1	6.0-8.1	1.29-2.20	11.1-16.2
Ahor	22-26	106.1-154.2	5.51-6.51	5.4-6.9	6.0-8.1	1.50-2.11	12.1-16.2
Ahor	27-30	128.4-142.1	6.11-6.51	5.9-6.4	6.1-10.1	1.71-2.91	15.1-17.2
Bilara	31-36	76.5-215.4	5.51-7.62	5.9-7.4	7.0-10.2	1.96-2.80	14.1-17.1
Bilara	37-39	74.3-144.2	4.91-6.91	5.0-6.5	8.0-10.1	1.87-2.67	15.1-16.2
Jodhpur	40-54	75.1-298.2	5.55-7.42	5.2-7.9	7.0-11.0	1.84-3.54	16.2-20.1
Range	1-54	74.3-298.2	4.91-7.62	5.0-7.9	6.0-11.0	1.10-3.54	11.0-20.1

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 evaluated. Of these, only ten varieties which fruited were evaluated for fruit quality and yield potential.

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

Realising the potential of cucurbit vegetables in the arid region, especially watermelon type *mateera (Citrullus lanatus), kachari (Cucumis callosus),* snapmelon *(Cucumis melo* var momordica*), salad kakdi* and muskmelon *(Cucumis sp.),* research initiatives have been undertaken from 1994. During 1997 and 1998, some exotic seed material of cucurbit vegetables were introduced from Iran by the NBPGR, New Delhi in collaboration with NRCAH and supplied to the Centre for evaluation (Table 4).

Table 4. Cucurbit species/varieties introduced from Iran

S. No.	Crop/Variety	EC. No.	Year	Source Country	Performance at NRCAH, Bikaner
A	**Cucurbits**		1997	Iran	No germination under all the condition
1	Watermelon	EC 407550			
2	Pumpkin	EC 407551			
3	Muskmelon	EC 407552			
4	Japanese pumpkin	EC 407553			
B	***Citrullus lanatus***		1998	Iran	Evaluation is in progress
5	Charleston local	EC 420977			
6	Mahbobi	EC 420978			
C	***Cucumis melo var. cantaloupensis***		1998	Iran	Evaluation is in progress
7	Samsuri	EC 420979			
D	***Cucumis melo***		1998	Iran	Evaluation is in progress
8	Darehgaz	EC 420980			
9	Karzaba	EC 420981			
10	Lang-E-Round	EC 420982			
11	Khaghany	EC 420983			
12	Zard-E-Isfhan	EC 420984			

GENETIC IMPROVEMENT

Mission B: Genetic Improvement in arid horticultural crops.

B.1 Improvement in cucurbit vegetables under hot arid environment

B.1.1 Performance of advanced progenies of *mateera (Citrullus lanatus)*

Twenty six advanced progenies of *mateera* were evaluated for earliness, yield and fruit quality attributes in replicated randomised block design (RBD) during the summer and rainy season of 1998. The mean data were utilised to assess the yield performance (Table 5). These were high yielding progenies, therefore, for better comparison the fruits of these progenies were rated as A,B and C grade on the basis of fruit quality characters viz., flesh firmness, colour, taste and TSS and then over all grades alloted. On the basis of rating, progenies of AHW 19 and AHW 65 were compared for yield attributing traits. The mean data reveal that among the AHW 19 the maximum fruit yield per plant was obtained from the progeny AHW 19-3-2-1a2 (18.17 kg) where as in AHW 65 the progeny AHW 65-4a (15.96 kg) recorded the highest yield.

B.1.2 Performance of *mateera* lines

Two selected *mateera* lines namely AHW 19 and AHW 65 were tested on large scale with six replications, both during summer and rainy season of 1998, under arid environment. The observations with regards to growth, yield and quality attributes were recorded to assess the yield performance of these lines. The data in Table 6 show that the maximum fruit yield (485.5 q/ha) was recorded in AHW 19 with average 4.2 fruit and 95.2 g seed yield/plant and in which harvesting can be started 78.2 days after sowing (DAS). Whereas the line AHW 65 produces 401.2 q fruits per hectare with average 5.2 fruits and 110.4 g seed yield/plant and exhibited earliness in harvesting (72.4 DAS).

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

Two most promising advanced lines of *kachari* namely AHK 119 and AHK 200 were tested in replicated trial during summer and rainy season in 1998. The detailed observations related to growth, earliness, fruit yield

Table 5. Performance of advance progenies of *mateera* (Summer and rainy season, 1998)

Progeny code	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (kg)	Fruit yield (kg/plant)	Ripe flesh thickness (cm)	Unripe flesh thickness (cm)	TSS (^{0}Brix)
AHW18-3-2-1f	47.6	82.5	3.2	4.05	12.96	14.51	2.02	7.4
AHW 19-3-2-1a2	42.7	76.2	4.6	3.95	18.17	15.24	1.71	8.3
AHW 19-3-2-1k	44.5	78.5	4.4	3.82	16.80	14.73	1.81	8.0
AHW 19-3-2-j	43.8	78.3	4.2	3.74	15.70	14.53	1.79	7.9
AHW 65-3a	43.2	74.5	4.9	3.05	14.79	14.81	1.71	8.0
AHW 65-4a	41.5	71.9	5.6	2.85	15.96	15.56	1.74	8.4
AHW 65-4b	41.4	72.5	5.4	2.90	15.66	15.17	1.79	8.1
AHW 82-1-2-1c	47.5	82.5	3.5	3.54	12.39	13.51	2.14	7.2
AHW 108-1-1a	49.2	84.5	3.2	3.15	10.08	15.11	2.0	8.5
AHW 108-1-1b	46.5	83.2	3.4	3.24	11.01	15.24	2.0	7.5
AHW 118-1-2-a	45.7	81.5	3.2	3.54	11.32	13.54	1.74	7.2
AHW 118-2-a	48.2	83.2	3.4	3.13	10.64	14.21	1.84	7.0
AHW 140-1-1a	49.2	85.1	3.6	3.32	11.95	14.25	1.93	7.1

Table 6. Performance of *mateera* lines (Summer and rainy season, 1998)

Line	Days to first female flower (DAS)	Fruit set/ plant	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (kg)	Fruit yield (kg/ plant)	Fruit yield (q/ha)	Seed yield/ plant (g)	TSS (^{0}Brix)	Vine length (m)	Branches/ plant
AHW 19	45.2	9.4	78.2	4.2	3.75	15.75	485.5	95.2	8.25	3.10	5.1
AHW 65	41.5	14.2	72.4	5.2	2.85	14.82	401.2	110.4	8.42	2.67	5.3

and quality characters were recorded and average computed. The observations on fruit fly infestation, diseases incidence under field conditions were also taken into account to assess the yield performance under arid environment. The data (Table 7) revealed that the yield potential of AHK 119 was 96.65 q/ha in which the vine produces 24.5 fruits (1.48 kg/plant) . Where as the line AHK 200 recorded the yield potential of 109.52 q/ha with 19.4 fruits (1.90 kg/plant). The first harvest was earliest in AHK 200 (68.2 DAS) in comparison to 75.4 days after sowing in AHK 119.

B.1.4 Performance of snapmelon (*Cucumis melo* var. *momordica*) lines

Two high yielding lines of snapmelon namely AHS 10 and AHS 82 were tested on large scale replicated trial during summer and rainy season of 1998 under proper agronomic practices. Observations with regards to growth, maturity, fruit yield and quality were recorded and mean were computed (Table 8) to assess the yield potential. The maximum fruit yield 241.5 q/ha was recorded by AHS 82 in which the vine bears 5.9 fruits (4.67 kg) where as the yield potential of the line AHS 10 was 222.5 q/ha with 5.6 fruits (4.37 kg) per plant.

B.1.5 Performance of advanced lines of long fruited type *Cucumis* sp.

Twenty two advanced lines of long fruited type *salad kakdi (Cucumis sp.)* were evaluated in summer and rainy season of 1998. Observations related to growth, maturity, fruit yield and quality attributes were recorded for the evaluation and yield potential of these lines. However, major emphasis was given on fruit characters like size, shape, flesh thickness, seed content, softness of seed, crispiness and taste at marketable stage and rating was done as A,B and C grade and then over all fruit quality grade was alloted to the line. The characters like fruit set under high temperature, drought hardiness, fruit fly infestation and incidence of diseases were also taken into consideration during the screening of the lines. Out of these, three high yielding lines bear A grade and 4 lines B grade fruits. Fruits of these lines can be harvested for use between 8-12 days from fruit set, so that first harvesting was in between 50.0-55.8 days from sowing. The line AHC 2-9 exhibited earliness (50.0 DAS) in harvesting of marketable fruits. The maximum fruit yield (2.974 kg) per plant was recorded in the line AHC 2-9 in which the number of fruits/ plant (11.4) was also highest (Table 9).

Table 7. Performance of *kachari* lines (Summer and rainy season, 1998)

Line	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit yield (kg/ plant)	Fruit yield (q/ha)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Flesh thick-ness (cm)	Vine length (m)	Branches/ plant
AHW 119	37.2	75.4	24.5	1.48	96.65	60.5	5.84	4.42	0.51	2.23	6.17
AHW 200	37.5	68.2	19.4	1.90	109.52	98.4	6.92	4.95	0.91	2.14	6.42

Table 8. Performance of snapmelon lines (Summer and rainy season, 1998)

Line	Days to first female flower (DAS)	Fruit set/ plant	Days to first har-vest (DAS)	Fruits/ plant	Fruit weight (kg)	Fruit length (cm)	Fruit diame-ter (cm)	Flesh thick-ness (cm)	Fruit cavity (cm)	TSS (°Brix)	Fruit yield (kg/ plant)	Fruit yield (q/ha)	Vine length (m)	Bran-c hes/pl ant
AHW 10	36.7	9.5	65.9	5.6	0.875	19.5	8.52	2.12	5.84	4.8	4.37	222.5	2.34	4.5
AHW 82	37.2	8.4	67.4	5.9	0.910	22.5	9.51	2.10	5.62	4.8	4.67	241.5	2.67	5.2

Table 9. Performance of advanced lines of long fruited *Cucumis* sp. (Summer and rainy season, 1998)

Line	Days to first female flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (kg)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Fruit cavity (cm)	Fruit yield (kg/ plant)	Vine length (m)	Branches/ plant	Overall rating
AHC 2-8	37.5	52.3	8.7	254.5	22.7	3.74	1.02	1.84	2.147	2.12	5.1	B
AHC 2-9	35.4	50.0	11.4	280.7	26.8	3.86	1.12	1.74	2.974	2.71	6.2	A
AHC 2-11	40.2	54.9	7.9	250.5	22.7	3.67	1.01	1.94	1.977	2.61	5.3	B
AHC 2-13	41.2	55.8	8.5	265.5	24.5	3.59	1.06	1.82	2.225	2.53	6.1	B
AHC 2-14	36.2	51.8	10.9	255.8	23.9	3.74	1.10	1.76	2.520	2.74	5.7	A
AHC 2-18	36.2	51.8	10.2	240.2	23.4	3.75	1.04	1.81	2.425	2.12	4.2	B
AHC 2-22	39.5	53.4	9.7	274.2	23.1	3.64	1.02	1.93	2.674	2.54	5.3	A

B.1.6 Performance of advanced lines of small fruited type *Cucumis sp.*

Eight advanced lines of small fruited type *salad kakdi (Cucumis sp.)* were evaluated during the summer and rainy season of 1998. Characters related to growth, flowering, maturity and yield were recorded. The immature fruits (3-6 days from fruit set) can be used for *salad* purpose, therefore, proper fruit quality rating (A,B and C grade) was done on the basis of characters such as size, shape, flesh and seed content, softness of seed, crispiness and taste and then overall fruit quality grade was alloted to the lines. The data (Table 10) revealed that the maximum fruit yield (1.74 kg/plant) was in AHC 13-1-1-1 in which the number of fruits were 20.4 per plant of 95.7 g weight/fruit.

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

An exploration was undertaken in November, 1998 in the chilli (Mathania type) growing areas of Western Rajasthan. To collect the maximum genetic variability, pockets of chilli cultivation i.e. Mathania, Tinwari, Soila, Manai and Pal were explored and 132 collections have been made. Considerable variability was recorded in the form of earliness, fruit characters, bearing and yield potential (Table 11). Besides this, detailed informations were collected and analysed to deduce the reason for drastic yield reduction over the years in Mathania type chilli. The major factors affecting the yield potential are incidence of mosaic, die-back, fruit rot, fruit borer, nematode, termite, frost, improper crop rotation and non availability of seeds of pure Mathania type.

The range of variations were recorded in plant height (45-95 cm), number of branches (3-12), number of fruits/plant (7-200) and fruit length (6.0-16.5 cm). As per discussion & knowledge gathered from arid horticulturist, village workers and farmers revealed that the yield potential of Mathania type chilli was very high even up to 60-160 q/ha ripe fruits with excellent quality and the longest fruit length (20 cm) during 1980's. Now, due to several factors there is drastic reduction in yield (16-48 q/ha) and this popular type is completely out of its commercial cultivation. The collected diversity will be evaluated and improved to re-recognise popular type Mathania chilli for the cultivation by the arid zone farmers under high temperature.

Table 10. Performance of advanced lines of small fruited *Cucumis* sp (Summer and rainy season- 1998)

Line	Days to first bisexual flower (DAS)	Days to first harvest (DAS)	Fruits/ plant	Fruit weight (kg)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Fruit cavity (cm)	Fruit yield (kg/ plant)	Vine length (m)	Branches/plant	Overall rating
AHC 13-1-1-1	35.4	42.5	20.4	95.7	8.24	4.17	1.12	2.15	1.740	2.25	6.82	A
AHC 13-1-1-3	34.2	43.5	18.5	78.2	8.03	4.02	1.05	2.19	1.475	2.17	5.74	A
AHC 13-1-1-4	35.1	43.2	17.6	72.4	7.97	4.11	1.02	2.32	1.412	2.05	5.13	A

Table 11. Diversity in Mathania type chilli

Variability Pockets	Collections	Plant height (cm)	Branches /plant	Fruits/ plant	Fruit length (cm)	Picking/ crop	Ripe red fruit yield (q/ha)	
							1980	1998
Mathania	15	45–75	5–9	10–90	6.0–12.5	3.0–4.0	80–100	20–25
Mathania	3	50–65	4–8	17–75	8.0–10.2	2.5–4.0	75–95	18–22
Tinwari	22	70–80	6–10	25–70	8.0–14.5	2.5–3.5	90–160	25–32
Soila	6	65–70	3–4	7–12	7.5–11.5	3.0–4.5	70–112	16–35
Soila	24	75–85	6–9	25–200	7.5–14.0	3.5–4.5	80–145	22–48
Manai	13	70–80	6–9	10–180	7.0–15.1	3.0–4.0	60–90	20–28
Manai	24	65–75	4–5	8–25	7.1–16.3	3.5–4.0	70–95	24–35
Pal	13	85–95	5–9	10–35	7.5–16.2	4.0–5.0	75–110	25–35
Pal	12	80–95	6–12	25–45	7.5–16.1	4.0–5.0	70–105	25–35
Range	**132**	**45–95**	**3–12**	**7–200**	**6.0–16.3**	**2.5–5.0**	**60–160**	**16–48**

B.3 Improvement in Pomegranate by selection and hybridization

The pomegranate varieties from Russia 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 Jalore Seedless, G-137, Mridula, Musket, Gulsha Rose Pink and Gulsha Red in 1998 and progenies of 15 F1 cross combinations are ready for planting and evaluation.

VEGETATIVE PROPAGATION

Mission C : Rapid multiplication of propagules of fruit crops.

C.1 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 *Capparis decidua and Prosopis cineraria*.

The cuttings were given dip treatment in a solution containing 1000 ppm IBA + 1000 ppm Thymine for 3 minute and then planted in polythene tubes filled with sand and soil mixture. The planting was done at monthly interval and observations on per cent sprouting were recorded. In *Capparis decidua*, the ideal time for taking and planting cuttings is in the month of September when nearly 50 per cent cuttings sprouted and gave rise to plantlets.

In order to study the optimum concentration of IBA, the cuttings were planted in month of September and treated with varying concentrations (1000, 2000, 5000, 7000 and 10000 ppm IBA along with 1000 ppm Thymine). The controls were only dipped in distilled water. The sprouting was recorded at monthly interval. The results demonstrate that the maximum sprouting took place in 7000 pm IBA (50%) whereas in control it was only 10% (Table 12). Thus, our results reveal that application of 7000 ppm IBA along with 1000 ppm Thymine gave the best results.

Table 12. Percentage of cuttings sprouted after 6 months of planting

S. No.	Treatment	Percentage Sprouting
1	Control	10%
2	1000 ppm IBA + 1000 ppm Thymine	20%
3	2000 ppm IBA + 1000 ppm Thymine	30%
4	5000 ppm IBA + 1000 ppm Thymine	20%
5	7000 ppm IBA + 1000 ppm Thymine	50%
6	10000 ppm IBA + 1000 ppm Thymine	30%

C. 2 *In situ* establishment of *ber* orchard

An experiment was conducted to study the *in situ* establishment of *ber* orchard. For this, well established multi branch seedling rootstocks were

headed back from ground level in order to induce new shoots of similar age. The *in situ* budding was done at fortnightly interval i.e. 15th July, 16th August and 15th September by using buds of cultivar Gola, Kaithali, Mundia and Umran. The data on percentage bud sprout were recorded at weekly interval (Table 13). The differences with respect to per cent success among cultivars and time of budding are significant, however the interaction between both the factors was not significant (Table 14). The percentage bud sprouts were increased with succeeding date of observations in all the cultivars. Among four cultivars, highest success was obtained in Umran budded on 15th September (81.4%) followed by

Table 13. *In situ* budding success (per cent bud sprout) in different *ber* cultivars at different time intervals

Cultivar		Time of budding		
		15th July	16th August	15th September
Gola	7 DAB	18.3 (7.7-27.6)	16.3 (10.0-20.8)	13.0 (5.2-18.9)
	14 DAB	43.4 (30.7-58.6)	34.4 (30.5-38.7)	35.8 (27.5-47.5)
	21 DAB	57.9 (46.1-70.5)	53.5 (46.9-67.2)	54.1 (42.0-70.2)
	28 DAB	67.2 (56.7-72.3)	58.7 (50.0-71.3)	57.3 (48.7-76.4)
	Mean	46.7 —	40.7 —	40.1 —
	CV(%)	45.6 —	47.5 —	62.6 —
Mundia	7 DAB	15.6 (12.3-29.0)	26.1 (20.5-34.4)	22.1 (20.0-28.3)
	14 DAB	30.2 (22.9-38.8)	51.1 (40.6-59.4)	43.7 (35.7-56.0)
	21 DAB	50.2 (40.8-60.3)	58.0 (43.7-76.6)	54.7 (43.7-65.7)
	28 DAB	61.2 (50.1-78.5)	64.6 (54.5-79.0)	58.0 (43.7-76.6)
	Mean	28.1 —	50.0 —	44.6 —
	CV(%)	51.8 —	33.7 —	36.3 —
Kaithali	7 DAB	17.0 (9.5-25.2)	34.1(20.0-55.6)	20.8(15.3-30.2)
	14 DAB	28.4(25.2-33.7)	52.6(28.0-74 .1)	47.6(36.7-62.5)
	21 DAB	53.1(50.0-56.5)	61.6(51.5-80.0)	64.8(51.7 -75.3)
	28 DAB	66.8(56.7-75.3)	70.3(55.3-82.1)	69.1(51.7-81.5)
	Mean	41.3 —	54.7 —	50.6 —
	CV(%)	54.9 —	28.3 —	43.3 —
Umran	7 DAB	12.4(5.2-20.3)	9.8(0.0-18.3)	48.0(20.7-80.0)
	14 DAB	23.5(20.3-28.6)	37.9(27.5-48.3)	59.5(34.5-80.0)
	21 DAB	55.9(52.5-60.6)	65.3(50.0-80.5)	79.4(58.6-95.2)
	28 DAB	61.8(53.0-68.5)	75.3(56.7-90.0)	81.4(62.1-95.2)
	Mean	38.4 —	41.1 —	67.1 —
	CV(%)	62.9 —	62.6 —	24.0 —

DAB=Days after budding, Figures in parenthesis are range of variation

Table 14. Interaction effect between cultivar and time of budding on percentage bud sprout at final observation

Cultivar	Time of budding			Mean
	15th July	16th August	15th September	
Gola	67.2 (±6.2)*	58.7 (±8.5)	57.3 (±11.1)	61.1
Mundia	61.2 (±10.6)	64.6 (±9.1)	58.0 (±12.1)	61.3
Kaithali	68.8 (±8.4)	70.3 (±11.4)	69.1 (±12.3)	69.4
Umran	61.8 (±3.9)	75.3 (±13.2)	81.4 (±12.7)	72.8
Mean	64.8 —	67.2 —	66.5 —	—
		SEm±	CD(p=0.05)	
	Cultivar (C)	22.4	8.3	
	Time of budding (T)	65.0	12.3	
	Interaction (CxT)	40.5	NS	

*Figures in parenthesis are standard deviation.

Kaithali budded on 16th August (70.3%), Gola budded on 15th July (67.2%) and minimum in Mundia budded on 16th August (64.4%). The observations indicated that even under hot arid ecosystem of Rajasthan *in situ ber* orchard can be established successfully by patch budding but success varied significantly with cultivar and time of budding.

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. 1, 4, 6, and 9. 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 are presented in Tables 15-17.

Perusal of data on growth parameters of both *mateera* cultivars viz. AHW 65 and AHW 19 reveals 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. It is only at 1 irrigation level that the plant morphometeric characters start to decline. The trend in fruit number and average fruit weight also demonstrated that at 85 days after sowing, the number of fruit were 3.88, 3.02, 3.02 and 1.83 at 9, 6, 4 and 1 irrigations respectively. Similarly, the fruit weight at respective treatments was 2.84, 1.31, 1.75 and 1.2 kg in AHW 19. (Table 16). Similar trend was also observed in other cultivar AHW 65. 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 11) is presented in Table 17. Perusal of data reveals that plant parameters such as plant height, numbers of leaves per plant, number of fruits per plant were adversely affected after 60 days onward by withdrawing irrigation. The pattern of dry matter distribution in MHW-11 too reveals that under 9 irrigation maximum dry matter was accumulated in stem,

Table 15. Morphometry and dry matter distribution of plants of cv. AHW 65 under different irrigation levels

Plant character	All Irrigation (Days)				6 Irrigation (Days)				4 Irrigation (Days)				1 Irrigation (Days)			
	45	60	75	85	45	60	75	85	45	60	75	85	45	60	75	85
Plant Height (cm)	42.0 ± 33.9	77.6 ± 37.9	74.8 ± 58.2	143.8± 71.5	42.0 ± 12.3	69.2 ± 28.0	145.4± 50.3	135.4± 13.4	48.1 ± 18.4	91.4 ± 27.1	113.0± 70.0	207.2± 131.0	52.0 ± 25.9	72.5 ± 22.7	116.8± 48.4	140.4± 26.4
No. of Branches	2.0 ± 1.7	2.6 ± 1.8	1.8 ± 1.1	1.8 ± 0.45	2.9 ± 0.8	3.0 ± 1.5	3.8 ± 0.8	4.8 ± 1.6	2.8 ± 0.8	2.8 ± 1.5	3.2 ± 0.45	4.0 ± 1.23	2.2 ± 1.3	2.8 ± 1.9	3.0 ± 1.2	4.8 ± 1.6
No. of leaves	20.6 ± 25.0	38.0 ± 27.1	32.4 ± 33.0	45.4 ± 48.8	20.2 ± 7.1	35.8 ± 17.1	36.4 ± 14.7	73.6 ± 29.4	32.0 ± 12.1	44.2 ± 31.9	37.2 ± 12.03	69.4 ± 49.8	27.0 ± 18.8	47.8 ± 38.7	63.8 ± 65.2	82.0 ± 36.6
Inter-node length	3.1 ± 1.5	4.7 ± 0.2	3.4 ± 0.5	4.9 ± 0.22	4.0 ± 1.9	3.8 ± 1.6	5.2 ± 1.8	4.9 ± 1.25	2.9 ± 1.03	3.8 ± 0.1	5.2 ± 1.3	5.3 ± 1.6	3.6 ± 0.9	3.5 ± 0.8	4.0 ± 1.2	4.6 ± 0.9
No. of fruits/ plant	—	—	2.2 ± 0.84	2.5 ± 0.5	—	—	2.4 ± 1.14	4.1 ± 1.14	—	—	2.8 ± 0.8	3.2 ± 0.8	—	—	1.4 ± 0.5	1.8 ± 0.84
Dry wt. stem (g)	0.76 ± 0.00	2.14 ± 1.6	9.0 ± 6.4	5.75 ± 3.02	0.69 ± 0.32	1.98 ± 1.25	12.31± 1.66	9.18 ± 4.11	0.78 ± 0.3	3.27 ± 1.4	9.05 ± 8.5	10.8 ± 8.5	0.93 ± 0.4	2.63 ± 2.6	8.1 ± 5.6	10.6 ± 5.12
Dry. wt. leaves (g)	3.23 ± 3.7	8.81 ± 0.9	9.6 ± 7.0	11.56± 6.48	2.20 ± 0.9	8.6 ± 0.6	11.67± 5.39	14.57± 5.5	2.06 ± 0.76	8.6 ± 1.39	8.10 ± 3.4	23.1 ± 26.2	2.44 ± 2.18	11.6 ± 7.5	16.3 ± 12.6	17.96± 7.1
Dry wt. root (g)	0.06 ± 0.05	0.19 ± 0.09	0.3 ± 0.4	0.37 ± 0.15	0.03 ± 0.07	0.19 ± 0.08	0.94 ± 0.2	0.64 ± 0.2	0.07 ± 0.01	0.21 ± 0.07	0.47 ± 0.19	0.58 ± 0.2	0.18 ± 0.13	0.18 ± 0.11	0.65 ± 0.2	0.62 ± 0.27
Fruit wt. (kg)	—	—	1.59 ± 0.95	1.89 ± 1.06	—	—	1.10 ± 0.56	1.5 ± 0.52	—	—	1.66 ± 1.2	2.0 ± 0.9	—	—	0.79 ± 0.5	0.95 ± 0.48

Table 16. Morphometry and dry matter distribution of plants of cv. AHW 19 under different irrigation levels

Plant character	All Irrigation (Days)				6 Irrigation (Days)				4 Irrigation (Days)				1 Irrigation (Days)			
	45	60	75	85	45	60	75	85	45	60	75	85	45	60	75	85
Plant Height (cm)	35.5 ± 13.1	71.22± 41.6	153.4± 31.6	180.0± 70.7	52.5 ± 20.8	74.4 ± 38.4	166.6± 27.5	164.6± 47.4	41.2 ± 15.1	93 ± 39.6	165 ± 66.2	165 ± 47.6	58.4 ± 19.3	90 ± 34.5	124.4± 66.8	153 ± 58.9
No. of Branches	1.8 ± 0.8	3 ± 1.5	3.6 ± 1.1	3.8 ± 2.05	2.8 ± 1.3	2.8 ± 1.3	2.6 ± 1.1	3.6 ± 0.89	2.2 ± 1.3	2.8 ± 1.7	4.6 ± 1.34	4.4 ± 1.14	2.8 ± 1.6	5.2 ± 1.6	5.2 ± 1.4	5.8 ± 1.79
No. of leaves	14.2 ± 6.7	44.4 ± 43.1	43.0 ± 14.1	73.2 ± 56.3	24.4 ± 12.7	41.2 ± 25.1	38.8 ± 14.7	49.6 ± 25.01	21.2 ± 13.3	64.6 ± 49.8	52.6 ± 21.8	78 ± 24.14	21.2 ± 13.3	64.6 ± 49.8	52.6 ± 21.8	78.0 ± 24.14
Inter node length	3.25 ± 0.8	3.8 ± 1.1	4.5 ± 1.0	6.0 ± 1.41	3.7 ± 0.9	3.9 ± 1.0	5.8 ± 1.4	4.4 ± 0.8	4.25 ± 0.6	3.8 ± 1.3	5.2 ± 1.8	5.0 ± 0.6	3.8 ± 0.8	42.0 ± 0.8	5.2 ± 1.3	4.4 ± 0.5
No. of fruits/ plant	—	—	3.2 ± 1.3	3.88 ± 0.64	—	—	3.6 ± 1.14	3.02 ± 0.71	—	—	2.4 ± 1.14	3.02 ± 0.82	—	—	1.0 ±	1.83 ± 0.75
Dry wt. stem (g)	0.42 ± 0.2	4.37 ± 4.2	15.94± 7.9	13.42± 11.7	0.86 ± 0.5	3.48 ± 2.3	12.15± 4.5	10.95± 3.58	0.56 ± 0.3	5.96 ± 5.3	9.05 ± 9.7	13.04± 5.3	0.94 ± 0.4	7.56 ± 4.7	10.16± 6.2	12.6 ± 6.1
Dry. wt. leaves (g)	2.04 ± 1.11	16.2 ± 8.6	14.4 ± 6.7	15.6 ± 13.5	3.05 ± 1.26	14.3 ± 5.1	13.8 ± 5.4	12.8 ± 4.1	1.9 ± 1.3	19.8 ± 0.6	8.10 ± 3.4	19.51± 7.94	3.12 ± 1.3	19.79± 9.2	20.13± 10.5	20.68± 6.8
Dry wt. root (g)	0.04 ± 0.01	0.34 ± 0.2	0.66 ± 0.25	0.83 ± 0.28	0.07 ± 0.03	0.3 ± 0.23	0.4 ± 0.12	0.52 ± 0.19	0.08 ± 0.03	0.33 ± 0.27	0.83 ± 0.44	—	—	—	0.92 ± 0.57	0.1 ± 0.02
Fruit wt. (kg)	—	—	1.7 ± 1.1	2.85 ± 1.25	—	—	1.34 ± 0.69	1.31 ± 0.53	—	—	2.4 ± 2.0	1.75 ± 0.79	—	—	1.08 ± 1.01	1.21 ± 0.78

Table 17. Morphometry and dry matter distribution of plants of cv. MHW 11 under different irrigation levels

Plant character	All Irrigation (Days)				6 Irrigation (Days)				4 Irrigation (Days)				1 Irrigation (Days)			
	45	60	75	85	45	60	75	85	45	60	75	85	45	60	75	85
Plant Height (cm)	43.6 ± 12.3	117.4± 24.5	173.0± 82.2	233.4± 112.06	41.2 ± 21.8	88.4 ± 33.9	113.8± 46.3	125.6± 33.7	75.4 ± 22.1	90.2 ± 29.2	119.0± 25.11	88.8 ± 19.2	47.8 ± 2.7	74.5 ± 22.5	159.0± 52.5	85.4 ± 19.2
No. of Branches	1.8 ± 0.8	2.6 ± 0.5	4.4 ± 0.9	3.4 ± 0.89	1.8 ± 0.8	2.8 ± 1.4	2.6 ± 0.9	3.8 ± 1.9	2.4 ± 0.5	3.0 ± 1.0	4.0 ± 1.58	3.0 ± 1.0	3.6 ± 0.5	3.4 ± 0.5	2.2 ± 0.8	3.0 ± 1.0
No. of leaves	16.6 ± 7.7	41.8 ± 17.8	81.4 ± 42.0	49.4 ± 26.7	14.4 ± 6.1	33.4 ± 14.4	29.2 ± 14.6	33.0 ± 19.2	25.8 ± 9.1	32.6 ± 14.8	37.8 ± 17.6	30.2 ± 15.7	31.6 ± 6.7	27.6 ± 9.1	43.4 ± 29.4	30.2 ± 15.7
Inter node length	3.3 ± 0.7	4.7 ± 2.6	5.1 ± 1.8	4.9 ± 1.14	3.0 ± 0.7	4.6 ± 1.14	3.8 ± 0.8	4.7 ± 0.98	4.6 ± 0.6	4.4 ± 1.1	5.8 ± 1.1	5.6 ± 1.5	3.5 ± 1.1	4.6 ± 0.9	5.3 ± 1.3	5.8 ± 2.0
No. of fruits/ plant	—	—	3.4 ± 1.1	2.75 ± 0.5	—	—	3.2 ± 1.3	2.2 ± 0.5	—	—	3.4 ± 1.14	2.5 ± 0.55	—	—	3.4 ± 1.14	2.5 ± 0.55
Dry wt. stem (g)	0.8 ± 0.3	8.9 ± 4.6	27.14± 15.8	11.7 ± 5.8	0.57 ± 0.3	3.73 ± 1.4	9.46 ± 2.9	9.69 ± 5.06	1.44 ± 0.7	9.17 ± 2.4	15.8 ± 6.5	5.92 ± 2.27	1.16 ± 0.2	4.58 ± 1.6	11.32± 6.4	4.2 ± 2.1
Dry. wt. leaves (g)	2.84 ± 1.26	14.9 ± 4.6	23.86± 16.1	19.1 ± 10.7	2.26 ± 1.6	9.7 ± 3.0	10.67± 5.04	8.3 ± 4.47	4.38 ± 2.2	9.6 ± 3.1	15.9 ± 6.6	7.65 ± 2.65	2.63 ± 0.6	7.3 ± 1.8	18.4 ± 11.3	5.1 ± 2.1
Dry. wt. root (g)	0.1 ± 0.04	0.34 ± 0.17	1.26 ± 1.1	1.02 ± 0.56	0.06 ± 0.03	0.23 ± 0.08	0.61 ± 0.24	0.58 ± 0.12	0.09 ± 0.03	0.23 ± 0.11	0.5 ± 0.2	0.58 ± 0.15	0.1 ± 0.03	0.28 ± 0.11	0.46 ± 0.15	0.6 ± 0.3
Fruit wt. (kg)	—	—	1.4 ± 0.5	2.25 ± 1.75	—	—	1.24 ± 0.8	1.16 ± 0.61	—	—	0.96 ± 0.7	1.53 ± 1.4	—	—	1.02 ± 0.6	1.47 ± 1.05

leaves and root. However, by imposing water stress even to 6 irrigations reduced dry matter accumulation at 85 days in stem by 17.25%, 56.5% in leaves, 43.13% in roots.

The above data demonstrate that the plants of watermelon MHW-11 are highly susceptible to water stress and do not tolerate any withdrawal of irrigation.

D.1.2 To determine the critical stage for water stress

A field experiment was laid out in RBD using two cultivars of *mateera* (AHW 19 and AHW 65) to determine the critical stage when the growth, development and yield is most affected by imposing water stress. The water stress was given at 3 stages viz. at 30 days after planting, 45 days after planting and 60 days after planting by with holding irrigation. In control plots all irrigations were given. The observations were recorded at 45, 60, 75 and 85 days after sowing. The results are presented in Tables 18-19.

Perusal of data reveals that in cv. AHW 19 withdrawing the irrigation at 45 days after sowing adversely affected the vegetative growth of the plants (Table 18). The plant height reduced to 133.8 cm as compared 141.8 cm in control; number of leaves reduced to 58.8 per plant as compared to 70.0 in control. Similarly, the dry matter distribution pattern demonstrate that lowest dry matter accumulation was in plants given stress at 45 days (11.09g in stem, 10.84g in leaves, 0.36g in root).

Comparison of number of fruits and average weight of fruit reveals that withholding of irrigation at any stage has no effect on number of fruits/plant. However, the average weight of fruit drastically reduced when water stress was imposed at 45 days after sowing. Similar results were found in other cultivar too. This illustrates that water stress imposed at 30-45 days after sowing has more deterimental affect on the growth, development and yield of *mateera* crop.

Table 18. Morphometry and dry matter distribution of plants of cv. AHW 19 under imposition of water stress at different days.

Plant character	All Irrigation (Days)				No irrigation at 30 days				No irrigation at 45 days				No irrigation at 60 days			
	45	60	75	85	45	60	75	85	45	60	75	85	45	60	75	85
Plant Height (cm)	35.0 ± 14.5	39.6 ± 23.7	149.6± 21.6	141.8± 62.06	18.6 ± 18.9	48.0 ± 29.2	120.6± 34.5	156.4± 46.5	37.8 ± 21.15	64.4 ± 73.1	174 ± 94.8	133.8± 98.9	67.6 ± 23.6	73.6 ± 80.9	157.2± 51.04	151.4± 51.4
No. of Branches	3.4 ± 1.5	1.6 ± 1.3	5.0 ± 0.7	3.6 ± 1.3	2.8 ± 1.1	2.6 ± 0.8	4.1 ± 0.55	4.21 ± 1.1	4.0 ± 2.2	2.4 ± 0.7	3 ± 0.7	3.2 ± 2.05	4.2 ± 0.45	2.2 ± 1.6	4.0 ± 0.71	4.4 ± 1.5
No. of leaves	21.2 ± 10.2	18.4 ± 26.0	44.4 ± 21.06	70.0 ± 18.5	36.8 ± 13.4	30.0 ± 22.0	62.0 ± 32.5	84.4 ± 24.2	25.0 ± 11.5	44.4 ± 70.3	44.2 ± 34	58.8 ± 51.9	40.2 ± 13.5	50.4 ± 60.0	78.2 ± 33.2	71 ± 40.0
Inter node length	3.25 ± 0.8	3.33 ± 0.5	5.6 ± 0.8	4.5 ± 1.12	3.5 ± 0.5	4.2 ± 1.26	3.7 ± 1.0	4.8 ± 0.8	3.10 ± 1.5	3.13 ± 1.0	5.1 ± 0.71	4.8 ± 1.15	3.7 ± 0.45	3.0 ± 0	4.25 ± 1.15	4.1± 0.65
No. of fruits/ plant	—	—	2.8 ± 1.3	3.0 ± 0.82	—	—	3.2 ± 1.3	3.17 ± 0.7	—	—	3.6 ± 1.8	4.67 ± 1.2	—	—	2.8 ± 0.8	5.8 ± 0.73
Dry wt. stem (g)	0.49 ± 0.3	1.23 ± 1.2	18.35± 8.11	18.63± 5.12	0.69 ± 0.39	0.32 ± 0.11	9.98 ± 6.98	12.78± 6.07	0.71 ± 0.5	4.17 ± 7.5	12.5 ± 6.2	11.09± 15.1	1.24 ± 0.6	3.25 ± 3.7	16.21± 9.8	11.9 ± 5.90
Dry. wt. leaves (g)	1.78 ± 0.86	3.41 ± 4.9	16.8 ± 6.9	15.23± 8.05	2.60 ± 1.03	2.44 ± 1.25	12.33± 4.69	14.68± 4.4	2.56 ± 2.5	2.94 ± 2.27	13.61± 4.6	10.84± 11.8	3.75 ± 1.43	8.83 ± 11.6	15.03± 10.1	13.25± 8.2
Dry wt. root (g)	0.04 ± 0.02	0.14 ± 0.1	0.65 ± 0.23	0.68 ± 0.23	0.05 ± 0.02	0.12 ± 0.02	0.66 ± 0.43	0.66 ± 0.3	0.06 ± 0.03	0.020± 0.1	0.6 ± 0.1	0.36 ± 0.28	0.06 ± 0.3	0.21 ± 0.21	0.7 ± 0.3	0.69 ± 0.3
Fruit wt. (kg)	—	—	1.76 ± 0.9	1.54 ± 0.75	—	—	0.79 ± 0.74	0.03 ± 1.67	—	—	4.82 ± 9.5	1.9± 1.06	—	—	1.95 ± 0.79	2.06 ± 1.07

Table 19. Morphometry and dry matter distribution in plants of cv. AHW 65 under imposition of water stress at different days

Plant character	All Irrigation (Days)				No irrigation at 30 days				No irrigation at 45 days				No irrigation at 60 days			
	45	60	75	85	45	60	75	85	45	60	75	85	45	60	75	85
Plant Height (cm)	20.0 ± 2.78	61.6 ± 23.7	201 ± 92	215 ± 3.03	54.20± 3.03	85.6 ± 44.1	223.8± 63.8	159.1± 62.14	40.8 ± 19.5	39.01 29.9	157 ± 25.4	174.8± 40.8	46.20± 21.49	60.401 36.2	144 ± 34.17	13.1 ± 59.1
No. of Branches	1.2 ± 0.44	2.0 ± 1.2	2.8 ± 0.8	4.8 ± 2.9	3.2 ± 0.84	2.6 ± 1.5	3.2 ± 1.3	2.8 ± 2.05	3.4 ± 1.1	1.8 ± 1.7	3.8 ± 1.3	3.2 ± 0.8	3.0 ± 1.23	2.6 ± 1.6	3.2 ± 0.4	3.0 ± 0.71
No. of leaves	8.75 ± 2.21	28.6 ± 17.1	45.2 ± 15.1	63.6 ± 24.3	36.8 ± 11.8	39.4 ± 27.5	98.75± 37.9	42.2 ± 15.6	27.8 ± 13.8	22.4	62.2 ± 28.2	86.6 ± 37.4	27.40± 14.15	38.6 ± 3.0	78.6 ± 34.13	61.8 ± 24.5
Inter node length	2.5 ± —	3.8 ± 0.8	4.2 ± 1.2	4.3 ± 0.5	3.60 ± 0.82	3.88 ± 0.63	4.6 ± 1.1	4.2 ± 1.3	4.1 ± 0.8	4.5 ± 1.3	4.9 ± 1.7	3.8 ± 0.57	3.10 ± 0.65	3.3 ± 0.8	4.2 ± 0.8	5.0 ± 1.06
No. of fruits/ plant	—	—	3.0 ± 0.7	2.67 ± 0.58	—	—	3.2 ± 0.8	4.4 ± 1.14	—	—	3.6 ± 1.14	4.5 ± 1.29	—	—	3.2 ± 1.3	5.0 ± 0.71
Dry wt. stem (g)	0.16 ± 0.08	1.21 ± 0.77	14.97± 9.6	15.48± 9.17	0.85 ± 0.19	2.72 ± 1.9	27.8 ± 14.4	5.09 ± 2.72	0.81 ± 0.5	1.08 ± 1.8	14.97± 1.3	9.76 ± 4.94	0.60 ± 20.5	3.23 ± 2.9	16.01± 7.01	11.16± 5.34
Dry. wt. leaves (g)	0.96 ± 0.29	4.57 ± 2.44	12.08± 4.4	10.65± 5.78	2.81 ± 0.75	7.01 ± 4.3	24.61± 15.6	9.15 ± 4.08	1.91 ± 1.05	3.54 ± 3.7	15.19± 5.33	14.33± 8.8	2.16 ± 1.2	9.09 ± 8.4	19.51± 10.4	8.53 ± 4.5
Dry wt. root (g)	0.03 ± 0.01	0.15 ± 0.4	0.8 ± 0.4	0.60 ± 0.42	0.13 ± 0.08	0.22 ± 0.1	1.16 ± 0.5	0.46 ± 0.26	0.05 ± 0.02	0.08 ± 0.04	0.80 ± 0.17	0.41 ± 0.26	0.05 ± 0.04	0.27 ± 0.13	0.79 ± 0.25	0.59 ± 0.35
Fruit wt. (kg)	—	—	2.1 ± 1.2	1.63 ± 1.2	—	—	1.55 ± 0.68	1.56 ± 0.59	—	—	1.98 ± 1.1	2.27 ± 1.15	—	—	2.19 ± 1.64	1.71 ± 0.08

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.

An experiment was conducted to compare the different techniques of measuring plant water status on pomegranate (*Punica granatum*) fruit crop. In this study, 4 techniques viz. Thermocouple Psychrometer method, Pressure Chamber method, Liquid Equilibration method and Relative Water Content were tried to measure the plant water status. In two months i.e. June and October, 1998, the plants were fully irrigated and from 3rd day onward, with the interval of three days, the observations were recorded on plant water potential in leaves. In July 98, plant water potential was in the range of -0.90 to -1.30 MPa from 3rd to 30th day of irrigation with psychrometric method. By using pressure chamber method the values range from -1.0 to -1.55 MPa, similarly in liquid equilibration method they do so -1.20 to -1.40. The relative water content of these plants were as high as 76.4% on third day which drop to 65.2% by 30th day (Table 20).

Table 20. Plant water status as measured by different techniques at different soil water potential

Technique	June 1998									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
Psychrometer method (MPa)	-0.90	-0.94	-0.98	-1.00	-1.00	-1.00	-1.08	-1.12	-1.12	-1.30
Pressure chamber (MPa)	-1.00	-1.10	-1.10	-1.15	-1.26	-1.40	-1.40	-1.40	-1.55	-1.55
Liquid Equilibration (MPa)	-1.20	-1.20	-1.20	-1.20	-1.20	-1.20	-1.40	-1.40	-1.40	-1.40
Relative water content (%)	76.4	76.2	76.2	74.5	71.0	69.2	68.8	68.8	66.2	65.2

The trends observed in October were nearly same as described above. The application of psychrometric method revealed that the values range from -0.91 to -1.35 MPa; through pressure chamber it was -1.00 to -1.60 MPa. Observations on liquid equilibration method were identical to those observed in July 1998. The relative water content showed its highest value on 3rd day of irrigation (76.6%) which drop to 64.6% by 30th day (Table 21).

A comparison of 4 methods, of study demonstrate that liquid equilibration method is least sensitive. This is on account of the fact that sucrose solution of definite molarity were used which automatically negates the minor variations. In our study, pressure chamber method was also not seemed to be a precise method since the water potential of arid crops is very high. By using air it is difficult of produce pressure to more than 1.60 MPa in the chamber. Since relative water content is highly dependent on fluctuations in environmental factors and it can not be relied on for measuring plant water status. Our observations show that psychrometric method is more sensitive, easy to measure, independent to environmental factors and can be measured on intact leaves.

Table 21. Plant water status as measured by different techniques at different soil water potential

Technique	October 1998									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
Psychrometer method (MPa)	-0.91	-0.93	-0.96	-0.98	-1.00	-1.02	-1.07	-1.18	-1.30	-1.35
Pressure chamber (MPa)	-1.00	-1.10	-1.15	-1.15	-1.20	-1.42	-1.42	-1.42	-1.56	-1.60
Liquid Equilibration (MPa)	-1.20	-1.20	-1.20	-1.20	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40
Relative water content (%)	76.8	76.2	76.2	74.2	71.5	69.4	68.8	68.2	65.4	64.6

INTEGRATED NUTRIENT MANAGEMENT

Mission F : Integrated nutrient management in horticultural crops

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

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

A field experiment was laid out on sandy soils to evaluate the effect of organic manures, compost and inorganic fertilizers on growth and production of pomegranate fruit crop. Accordingly, the recommended doses of NPK (250 g N, 125g P and 50 g K) per plant per year were applied through 11 treatments i.e. i) through cattle manure (CM) @ 12 kg/plant, ii) through sheep manure (SM) @ 9.0 kg/plant, iii) through vermi-compost (VC) @ 5 kg/plant, iv) through inorganic fertilizers(IF) (urea, single super phosphate and murate of potash), v) through CM and SM in 50:50 ratio, vi) through CM and VC in 50:50 ratio, vii) through CM and IF in 50:50, viii) through SM and VC in 50:50, ix) through SM and IF in 50:50, x) through VC and IF in 50:50 ratio, xi) Control (without nutrients) in randomised block design with four replications. The planting was done in the month of September 1998 and at that time half doses of NPK nutrients were applied through different treatments as basal. The soil moisture contents were also measured to monitor the moisture retention capacity.

The growth attributing data in different treatments (Table 22) revealed that after six months of planting the plant height was in the range of 48.8 to 67.50 cm and maximum height was measured in treatments T_{10} (combination of vermi-compost and inorganic fertilizers) followed by T_3 (through vermi-compost), T_8 (combination of sheep manure and vermi-compost), T_6 (combination of cattle manure and vermi-compost). The minimum height was observed in T_{11} (control) and slightly higher in T_4 treatment (IF).

Table 22. Growth parameters of pomegranate plants as influenced by organic manures, vermi-compost and fertilizers

Treatments		Contribution(%)	Height (cm)	No. of leaves/ plant	No. of branches/plant	Plant spread (m^2)
Sheep manure (SM)	T_1	100	57.6	401	1.7	0.40
Cattle manure (SM)	T_2	100	58.5	406	1.8	0.40
Vermi-compost (VC)	T_3	100	65.5	470	3.0	0.41
Inorganic fertilizer (IF)	T_4	100	51.6	385	1.5	0.21
Cattle manure + Sheep manure	T_5	50:50	59.0	415	2.0	0.35
Cattle manure + Vermi-compost	T_6	50:50	62.5	430	3.0	0.42
Cattle manure + Inorganic fertilizer	T_7	50:50	59.4	425	2.0	0.40
Sheep manure + Vermi-compost	T_8	50:50	64.5	472	3.0	0.41
Sheep manure + Inorganic fertilizer	T_9	50:50	59.3	415	2.0	0.38
Vermi-compost + Inorganic fertilizer	T_{10}	50:50	67.5	485	3.0	0.45
Control	T_{11}	0	48.8	315	1.6	0.21

The number of leaves per plant were counted in different treatments and they were in the range of 315 to 485. The variation in number of leaves in different treatments were in accordance with the plant height. The number of branches per plant (primary) were counted and they were in the range of 1.6 to 3.0/plant. Data revealed that no specific pattern was observed with regards to treatments. The plant spread was in the range of 0.21 to 0.45 m^2 and the maximum spread was noticed in the treatment T_{10} (VC + IF) followed by T_6 (CM + VC), T_3 and T_8 while the minimum spread was in T_4 (IF only) and T_{11} (Control).

The physiological parameters (photosynthetic activity, transpiration rate, water use efficiency, stomatal conductance, stomatal resistance and chlorophyll content)were measured in different treatments (Table 23).Data revealed that the photosynthetic activity was estimated in the range of 18.86 to 33.78 mg CO_2 fixed /m^2/s and maximum activity was measured in T_6 treatment followed by T_7, T_5 and T_3 and the minimum activity was

observed in control (T_{11}) treatment. The transpiration rate was measured in the range of 0.4012 to 0.5740 $mg/m^2/s$ in different treatments. From the photosynthetic activity and transpiration rate, the physiological water use efficiency was estimated and data revealed that WUE was in the range of 45.25 – 62.30%. The maximum WUE was estimated in T_6 followed by T_2, T_{10} and minimum was in treatment T_{11} (control). Ratio of chlorophyll a and b were drawn from the absolute data of a and b and it was in the range of 2.67 to 3.10 and highest value was observed in T_6 and T_7 treatments and lowest (2.67) was in control (Table 23).

Soil moisture status

In different treatments, soil moisture content was measured on 3rd, 5th and 7th day after irrigation of pomegranate plants. It was noticed that on 3rd day after irrigation organic manures and vermi-compost fertilized plants were having moisture content from 16 to 18% while in control and inorganic fertilized plants it was in the range of 11 to 13 per cent. On 5th day of irrigation, trends were same and after one week organic and vermi-compost fertilized plants were having the moisture content in the range of 11 to 13% while it was only 7 to 8% in control and inorganically fertilized plants. It is obvious that organically fertilized plants received bulk amount of organic matter which helps in checking the water losses through leaching and evaporation (Table 24).

The above data show that application of vermi-compost alongwith inorganic fertilizers and cattle manure helps in maintaining the soil water status for a longer period. Due to this the leaves maintain turgid state permitting a higher rate of metabolic activities. This accounts for better growth and photosynthetic activity in T_{10}, T_3 and T_6 treatments.

Table 23. Physiological parameters of pomegranate as affected by organic manures, compost and fertilizer

Treatments		Contribution (%)	Photosynthetic activity ($mg\ CO_2/m^2/s$)	Transpiration rate ($mg/m_2/s$)	Water use efficiency (%)	Stomatal resistance (s/cm)	Stomatal conductance (cm/s)	Chlorophyll a/b
Sheep manure (SM)	T_1	100	25.40	0.4696	54.09	1.556	0.6427	2.75
Cattle manure (CM)	T_2	100	33.23	0.5363	61.96	1.537	0.6507	2.75
Vermu-compost (VC)	T_3	100	30.56	0.5355	57.05	1.685	0.5933	2.75
Inorganic fertilizers (IF)	T_4	100	20.13	0.4012	56.17	2.469	0.4050	3.05
Cattle manure+Sheep manure	T_5	50:50	31.08	0.5740	54.41	1.570	0.6368	3.05
Cattle manure+Vermu-compost	T_6	50:50	33.78	0.5422	62.30	1.530	0.6533	3.10
Cattle manure+Inorganic fertilizers	T_7	50:50	31.09	0.5268	59.02	1.769	0.5653	3.10
Sheep manure+Vermi-compost	T_8	50:50	26.50	0.4863	54.49	1.586	0.6306	3.00
Sheep manure+Inorganic fertilizers	T_9	50:50	24.76	0.4284	57.80	1.910	0.5236	2.76
Vermi-compost+Inorganic fertilizers	T_{10}	50:50	29.09	0.4835	60.16	1.611	0.6206	3.05
Control	T_{11}	—	18.86	0.4168	45.25	2.558	0.3909	2.67

Table 24. Soil moisture pattern as influenced by different treatments

Treatments		Contribution(%)	3rd day	5th day	7th day
Sheep manure (SM)	T_1	100	17.4	13.0	12.0
Cattle manure (SM)	T_2	100	16.5	12.8	11.0
Vermi-compost (VC)	T_3	100	15.8	12.3	12.5
Inorganic fertilizer (IF)	T_4	100	11.6	8.0	8.0
Cattle manure + Sheep manure	T_5	50:50	18.2	13.8	11.0
Cattle manure + Vermi-compost	T_6	50:50	16.5	12.0	13.0
Cattle manure + Inorganic fertilizer	T_7	50:50	16.0	16.0	11.0
Sheep manure + Vermi-compost	T_8	50:50	17.3	10.0	12.3
Sheep manure + Inorganic fertilizer	T_9	50:50	16.0	10.0	9.5
Vermi-compost + Inorganic fertilizer	T_{10}	50:50	15.8	11.5	11.0
Control	T_{11}	—	12.0	8.0	7.0

POST HARVEST TECHNOLOGY

Mission H : Post harvest handling and processing studies in arid zone horticultural crops.

H. 1 Studies on storage of *ber*

An experiment was conducted to study the effect of physical and chemical treatments on improving the shelf life of *ber*. Ripened fruits of *ber* cultivar Gola were treated with four physical [cool water (10^0C) for 15 and 30 minutes and hot water (50^0C) for 5 and 10 minutes] and seven chemical [calcium chloride 0.5 and 1.0 per cent, virosil (H_2O_2) 2.5 and 5.0 per cent, calcium nitrate 0.5 and 1.0 per cent and bavistin 0.1 per cent] treatments alongwith an untreated control under completely randomised block design with three replications. Treated fruits were packed into perforated polythene bags (40x23 cm size with 8-10 holes/bags) and kept under ambient (28 ± 2^0C) as well as under cool (7 ± 1^0C) temperature conditions. Physiological loss in weight, pathological loss and colour change were monitered at three days interval using standard methods. Data were statistically analysed.

Physiological loss in weight

Per cent physiological loss in weight (PLW) was increased with the increase of storage period. It was noticed more under room temperature than under cool temperature conditions. Bavistin, calcium nitrate and virosil were effective in reducing the PLW at ambient temperature (Table 25). The PLW in control treatment was observed to be 8.1 per cent after 9 days of storage at ambient temperature. Minimum value (5.8%) was recorded in fruits treated with bavistin (0.1%) where as treatment with cold water 30 minutes and hot water 5 minutes recorded the maximum PLW. Physiological loss after treatment with calcium nitrate (0.5 and 1.0%), virosil (5.0%) and hot water (10 minutes) were comparable. Similarly, the treatments with calcium chloride 0.5 and 1.0 per cent and virosil 2.5 per cent were nearly identical after 9 days of storage.

At cool temperature, PLW was very low even after 15 days of storage. Calcium nitrate (0.5%) noticed the minimum weight loss (Table 26). Statistical analysis of the data does not show any significant difference among the treatments (p=0.07).

Table 25. Physiological loss in weight (%) during storage of treated *ber* (cv. Gola) fruits at ambient temperature

Treatment		Days after storage		
		3	6	9
Cool water (10°C)	15 minutes	1.7	4.4	6.9
Cool water (10°C)	30 minutes	2.7	6.3	9.8
Hot water (50°C)	5 minutes	2.9	6.4	9.3
Hot water (50°C)	10 minutes	2.1	4.0	6.7
Calcium chloride	0.5%	2.1	4.9	7.6
Calcium chloride	1.0%	2.0	4.6	7.3
Virosil (H_2O_2)	2.5%	2.1	5.0	7.7
Virosil (H_2O_2)	5.0%	1.8	4.1	6.6
Calcium nitrate	0.5%	1.1	3.8	6.7
Calcium nitrate	1.0%	1.6	4.0	6.3
Bavistin	0.1%	1.4	3.8	5.8
Control	No treatment	2.1	5.4	8.1
F Value		2.68	3.75	3.63
P Value		0.02	0.003	0.003

Table 26. Physiological loss in weight (%) during storage of treated *ber* (cv. Gola) fruits at cool temperature.

Treatment		Days after storage				
		3	6	9	12	15
Cool water (10^0C)	15 minutes	0.0	0.8	1.6	2.4	3.5
Cool water (10^0C)	30 minutes	0.5	1.8	2.8	3.3	4.4
Hot water (50^0C)	5 minutes	0.3	1.0	1.7	4.0	3.2
Hot water (50^0C)	10 minutes	0.2	1.4	2.1	3.0	3.9
Calcium chloride	0.5%	0.6	1.6	2.4	3.1	4.1
Calcium chloride	1.0%	0.4	1.1	1.8	2.3	3.1
Virosil (H_2O_2)	2.5%	0.5	1.9	2.9	3.7	4.7
Virosil (H_2O_2)	5.0%	0.2	1.7	2.7	3.2	3.9
Calcium nitrate	0.5%	0.1	1.0	1.7	2.0	2.4
Calcium nitrate	1.0%	0.1	1.0	1.7	2.8	3.8
Bavistin	0.1%	0.5	1.2	2.0	2.6	3.4
Control	No treatment	0.2	1.3	2.0	2.8	3.7
F Value		1.53	2.15	2.06	0.65	2.01
P Value		0.18	0.05	0.06	—	0.07

Pathological loss

After 9 days at ambient temperature storage, the pathological loss was to the tune of 67 per cent in control. Treatment with bavistin (a potent fungicide) reduced the pathological loss upto 10.6 per cent (Fig. 1 & Table 27). Among the other treatments tried, virosil 2.5 and 5.0 per cent and hot water for 10 minutes also reduced the pathological loss to less than 30 per cent after 9 days of storage under cool temperature storage, no pathological loss was noticed even upto 15 days of storage.

Colour change

Calcium nitrate (0.5%) recorded the minimum colour change (13%) followed by bavistin (0.1%) and virosil (2.5%) after 9 days of storage under ambient temperature (Fig. 1 Table 27). Calcium chloride 1.0 per cent and 0.5 per cent and hot water treatment for 5 minutes recorded the maximum colour change ranged from 73.0-86.7 per cent. However, under cool temperature no colour change was noticed even upto 15 days of storage.

Changes in fruits after withdrawal from cool temperature

There is a time lag between the withdrawl of fruits from the cool store to its consumption. In order to find out the time period upto which the fruits remain acceptable, this study was undertaken. The observations recorded at first day of shifting revealed no pathological loss in any of the treatment except control. Even the colour change was not recorded in treatments like calcium nitrate 0.5 per cent, virosil 2.5 per cent and cool water for 15 minutes. In all the other treatments, the colour change was less than 20 per cent (Table 27). At third day of shifting, the pathological loss was minimum 9.7% in bavistin (0.1%). The treatments with calcium nitrate 0.5% and 1.0% and virosil 2.5 and 5.0 per cent and hot water treatment for 10 minutes were also effective in controling the pathological loss whereas other treatments were not able to maintain the colour upto acceptable limit (Table 27). Therefore, from this study, it can be argued that *ber* fruits should be disposed off within 48 hours after withdrawl from cool storage. Therefore, it can be concluded that the Post harvest treatment of *ber* fruits with bavistin (0.1%), virosil (2.5 and 5.0 per cent) and calcium nitrate (1.0 per cent) have potential to improve the shelf life of *ber* fruits at ambient temperature storage. *Ber* fruits can be stored at cool tempelature upto 15 days provided the time lag between withdrawal of fruits from cool store and its supply to consumer should not exceed 48 hours.

Table 27. Effect of treatments on pathological loss and colour change in fruits shifted at ambient

Treatment		Days of shifting to ambient temperature			
		1st		3rd	
		Pathological loss (%)	Colour change (%)	Pathological loss (%)	Colour change (%)
Cool water (10°C)	15 minutes	0.0	00.0	30.2	60.0
Cool water (10°C)	30 minutes	0.0	10.0	32.5	63.0
Hot water (50°C)	5 minutes	0.0	13.0	35.0	86.7
Hot water (50°C)	10 minutes	0.0	12.5	13.0	66.6
Calcium chloride	0.5%	0.0	14.0	25.0	86.7
Calcium chloride	1.0%	0.0	20.0	25.0	100.0
Virosil (H_2O_2)	2.5%	0.0	00.0	14.0	54.0
Virosil (H_2O_2)	5.0%	0.0	14.5	12.0	75.0
Calcium nitrate	0.5%	0.0	00.0	15.0	36.7
Calcium nitrate	1.0%	0.0	18.0	18.2	80.0
Bavistin	0.1%	0.0	15.0	9.7	77.0
Control	No treatment	5.5	10.0	40.0	61.0

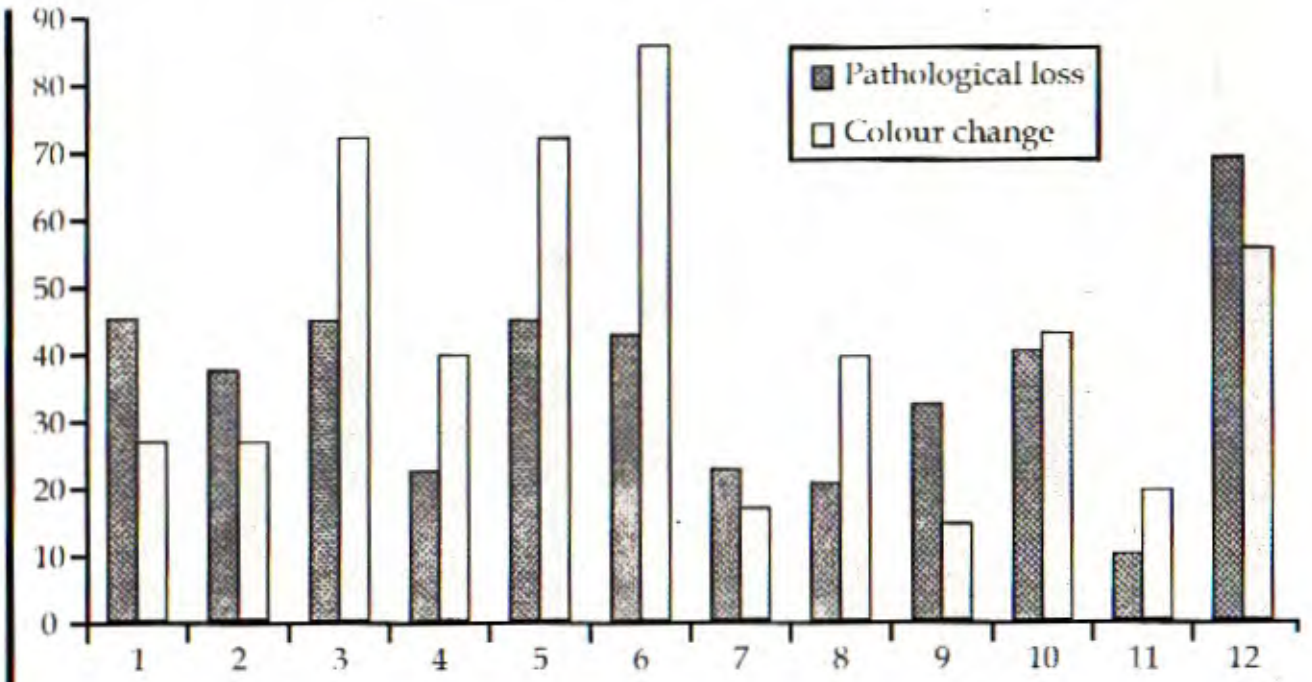


Fig. 1. Per cent pathological loss and colour change after 9 day of storage of *ber* fruits at ambient temperature

1. Cool water (15 min)
2. Cool water (30 min)
3. Hot water (5 min)
4. Hot water (10 min)
5. Calcium chloride (0.5%)
6. Calcium chloride (1%)
7. Virosil (2.5 %)
8. Virosil (5.0 %)
9. Calcium nitrate (0.5 %)
10. Calcium nitrate (1 %)
11. Bavistin (0.1 %)
12. Control

Biochemical changes

The biochemical changes both under ambient temperature and cool storage were monitored at regular interval. The following treatments were given to fruits before storage (i) $CaNO_3$ (1%), virosil agro (2.5%) virosil agro (5%) and bavistin (0.1%). The data thus generated are presented in Tables 28-32.

Perusal of data on reducing sugars reveals that in control, metabolite accumulates under cool storage (17.0-47.0 mg/g fruit) whereas under ambient temperature the levels of reducing sugars declined from 29.0 to 17.0 mg/g fruit. The treatment with virosil agro (5%) and bavistin (0.1%) reduced pathological and physiological losses. The perusal of data on reducing sugar reveals that treatment with above chemicals maintains the original level of reducing sugar at ambient temperature (Table 31). Similar results were also observed with respect to total sugars (Table 32). Perusal of pattern of changes in starch content reveals that both under ambient and cool temperature storage the starch content accumulates at initial stage. However, treatment with virosil agro (5%) and bavistin (0.1%) demonstrates marginal variation at room temperature (Table 28-32).

Perusal of data on amino acids reveals that upto 6 days the amino acid pool increases but after that it decreased at ambient temperature. Under cool temperature there was reduction in the level of amino acids as compared to that at 3 days of storage. No consistent trend was observed after treatment with chemical agents (Table 30).

Table 28. Changes in Protein (%) level in fruits of *ber* stored under cool and ambient temperature

Treatments	Ambient Temperature (days)			Cool Temperature (days)				
	3	6	9	3	6	9	12	15
Control	1.25	1.25	2.06	0.69	2.2	2.3	1.45	1.68
$CaNO_3$	1.25	1.17	1.95	2.22	1.59	2.21	1.87	1.95
Virosil agro 2.5%	2.42	1.10	1.46	1.08	2.0	1.74	2.04	1.38
Virosil agro 5%	1.55	1.27	1.13	2.29	1.70	2.09	1.47	1.18
Bavistin 0.1%	1.43	1.08	2.0	1.58	1.57	—	1.72	1.43

Table 29. Changes in starch content (mg/g fruit) in fruits of *ber* stored under cool and ambient temperature

Treatments	Ambient Temperature (days)			Cool Temperature (days)					
	3	6	9	3	6	9	12	15	18
Control	4.95	6.75	8.1	6.3	11.25	17.1	16.75	17.10	16.65
$CaNO_3$	6.75	7.65	7.20	8.55	10.35	13.7	6.0	17.5	13.5
Virosil agro 2.5%	6.75	5.17	13.5	7.87	10.80	9.45	7.20	19.12	9.0
Virosil agro 5%	8.10	5.85	7.65	6.75	13.50	18.45	7.87	21.60	12.37
Bavistin 0.1%	6.75	13.5	10.3	6.30	12.37	16.87	5.62	13.5	14.4

Table 30. Changes in amino acid content (mg/g fr. weight) in *ber* fruits stored at ambient and cool temperature

Treatments	Ambient Temperature (days)			Cool Temperature (days)					
	3	6	9	3	6	9	12	15	18
Control	5.5	34.2	14.7	38.5	11.7	7.0	15.1	9.4	4.8
$CaNO_3$	18.8	20.9	22.1	36.4	20.1	9.2	14.5	8.1	8.3
Virosil agro 2.5%	8.3	20.3	17.5	30.4	6.1	14.8	5.7	15.8	16.6
Virosil agro 5%	18.6	9.2	7.8	6.8	—	26.4	13.4	7.4	10.7
Bavistin 0.1%	11.2	12.9	14.7	17.3	5.8	8.5	8.1	16.2	5.3

Table 31. Changes in reducing sugar content (mg/g fr. wt.) in *ber* fruits stored at ambient & cool temperate

Treatments	Ambient Temperature (days)			Cool Temperature (days)					
	3	6	9	3	6	9	12	15	18
Control	29.0	17.0	21.0	21.0	17.0	13.0	47.0	20.0	13.0
$CaNO_3$	32.0	21.0	13.0	25.5	16.0	30.0	52.0	15.0	12.0
Virosil agro 2.5%	39.0	39.0	24.0	23.0	10.0	23.5	41.0	22.0	10.5
Virosil agro 5%	26.0	31.0	25.5	27.5	12.5	10.0	43.5	14.5	9.0
Bavistin 0.1%	27.0	25.5	23.5	40.0	13.75	11.5	42.5	30.0	13.0

Table 32. Changes in total sugars (mg/g fr. wt.) in *ber* fruits stored at ambient and cool temperature

Treatments	Ambient Temperature (days)			Cool Temperature (days)					
	3	6	9	3	6	9	12	15	18
Control	31.0	19.0	23.0	32.5	18.0	14.0	49.0	24.0	14.0
$CaNO_3$	36.0	24.0	14.0	35.0	16.0	32.0	38.0	15.5	12.0
Virosil agro 2.5%	50.0	41.5	26.0	54.0	10.5	26.0	45.0	22.5	11.0
Virosil agro 5%	29.0	37.5	25.0	60.0	15.0	11.5	27.0	15.0	12.0
Bavistin 0.1%	33.5	26.0	24.0	70.0	15.0	11.0	44.0	33.5	12.0

H. 2 Development of processing techniques for *Prosopis cineraria*

Immature tender pods of *khejri* (*Prosopis cineraria* L. Druce) are used for vegetable as fresh as well as after dehydration. To develop quality dehydrated pods, an experiment was conducted to standardize the blanching time and medium. Five treatments viz. 5 minutes blanching, 10 minutes blanching, 5 minutes blanching in 2% salt solution and 10 minutes blanching in 2% salt solution alongwith an untreated control were tried. Tender, green, less acrid pods of *khejri* were blanched and sun dried. Colour of dried pods, water absorption quality and colour of rehydrated pods were analysed by a panel of judges (house wives and consumers) on 10 point hedonic scale after one year of storage at room temperature. Observations and average scores have been presented in (Table 33). It is clear from table that blanching of *khejri* (*sangri*) in 2% salt solution for 5 minutes give greenish sangri which uniformly absorbs water and become yellowish green after rehydration. The treatment also scored maximum points.

Table 33. Dehydration of *Prosopis* pods for vegetable

Treatment	Colour of dried pods	Colour of pods after rehydration	Ability to absorb water	Score	Rating
5 minutes blanching in water	Light brown	Mustard yellow	Good	7.1	NLND
10 minutes blanching in water	Brownish	Yellowish	Less	6.3	LS
5 minutes blanching in 2% salt solution	Greenish	Greenish yellow	Very good	8.0	LVM
10 minutes blanching in 2% salt solution	Brownish	Mustard yellow	Very good	6.5	LS
No blanching	Black	Blackish brown	Very less	2.3	DM

NLND-Neither like nor dislike; LS-Like slightly; LVM-Like very much; DM-Dislike moderately.

PLANT PROTECTION

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

I.1 Biological control

Twenty eight isolates of *Trichoderma* spp and 52 isolates of *Pseudomonas fluorescens* were isolated from soil, plant samples (vegetables, *ber*, date palm and pomegranate) and purified. Variability in sporulation / colonization and secondary metabolites production among isolates of *Trichoderma* spp and *Pseudomonas fluorescens* were recorded. Regarding the distribution of soil fungi *Penicillium* spp dominated than other fungi. The other fungi recorded were *Aspergillus flavus, Aspergillus niger, Rhizopus, Fusarium*. The confirmation of *Pseudomonas fluorescens* isolates and screening of isolates in laboratory conditions are under progress.

I.2 Disease in fruits and vegetables

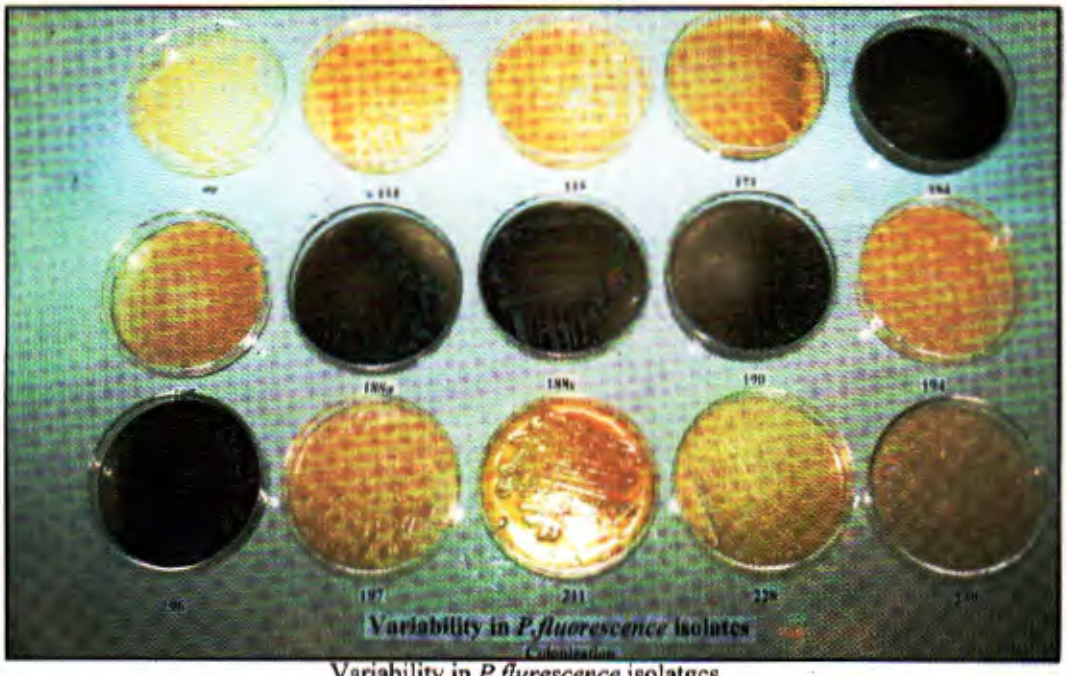
Ber: Integrated management of Powdery mildew disease

Integrated management practices include cultural and chemical methods were followed to control powdery mildew. All the wild species of *Ziziphus* and weeds from the orchard and near by areas were destroyed. *Ber* genotypes were sprayed with 0.1% karathane on new foliage after a month of pruning. Sprays were given at fortnight interval till the trees attain flowering stage. The rootstocks (*Ziziphus maurtiana* var. *rotundifolia*) were also monitored and karathane was sprayed in time. Hence, due to these integrated management practices and in addition to unfavourable environmental conditions powdery mildew incidence in *ber* did not occur.

Screening of *ber* germplasm against fruit rot

Fruit rot was recorded as a major disease in *ber*. The pathogen Alternaria *alternata* has been isolated and pathogenicity of the fungus was also confirmed under laboratory conditions. A survey in *ber* growing areas in Jodhpur and Jalore districts revealed that 70-80% of the trees at fruiting stage were infected by this disease Out of 242 genotypes evaluated, 51 genotypes were resistant followed by 88 moderately susceptible, 44 susceptible and only 10 as highly susceptible. Nearly 49 genotypes were not evaluated either due to lack of sufficient number of fruits or no fruiting. Genotypes like

Variability in *Trichoderma* spp.



Variability in *P.flurescence* isolatgcs

Tikadi, Rohataki Gola, Alwar Desi, Manukhi, Gorifa, Tasbetaso, Safeda, Jalandhari, Bahadhurghari were found to be resistant. Where as genotypes Akhrota, Kismis and NRCAH-7 were highly susceptible, recorded more than 50% incidence. In the absence of *ber* fruits the fungus infects pomegranate leaves and subsequently in cluster bean grown as inter crop in *ber* orchard during different periods of the year. During pruning stage pathogen could survive as saprophyte on dead organic wastes. Hence the availability of the pathogen propagules was ensured for subsequent infection. Spray of 0.2% mancozeb at peak stage of the fruit setting and subsequent sprays at 20 days interval till the fruits attain maturity could minimize the disease intensity .

New Records

1. Stem blight

It was observed as a major disease in *ber* after pruning. During the summer season the fungus penetrated through cut ends of the branches and later on black lesion appeared from the entry point. In advanced infection, the lesions progressed towards the basal portion of the plant and the whole plant could not sprout. Dormant structures as thick and brown mycelium with mass of spores were observed beneath the infected bark. In severe cases disintegration of bark tissues was common. As a result, withering of entire tree was common in some genotypes. Out of 238 genotypes evaluated, 120 plants in 81 genotypes were affected with this pathogen.

Pathogen has been isolated and purified from the diseased stem. Rapid growth and proliferation of the mycelium was observed at 15 to 20°C in laboratory conditions within 3 days. The pathogenicity was confirmed by artificial inoculation of the test fungus in healthy branches. Identical symptoms were recorded in inoculated branches and death of whole plant was rapid than naturally infected plant. The pathogen was preliminarily identified in our centre and further it was confirmed as *Torula herbarium* by the Indian Type Culture Collection Centre, IARI, New Delhi. As per the evidences from available literatures it is the first report in *ber*. Studies are under progress to find out the alternate hosts of this pathogen.

Management

Application of copper fungicide in the form of paste at cut ends of the branches and soil drenching (1%) could effectively control the disease (90.8%) within a month of treatment.

2. Leaf blight

Apart from the *Alternaria* leaf blight another new blight was

Stem blight in *ber* caused by *Torula herbarium*

recorded in *ber* genotypes. The causal organism have to be identified. However, the sterile nature of *Dueteromycotina* fungus was reported by the Indian Type Culture Collection Centre. General symptoms were appearance of red spots at initial infection, enlargement from the margin of the leaves. Advanced infection affected leaf portion showed reddish brown lesion, upward curling and defoliation. Leaves in the middle of the branches were susceptible than in young and matured leaves. The actual reason for such preferential infection have to be established. The fungus could not sporulate in moist chamber at laboratory conditions. Out of 242 genotypes, 159 were found resistant . Though leaf blight incidence was at low level, most of the genotypes were affected. Foliar application of 0.2% mancozeb suppressed the intensity of the disease.

Other Diseases

Minor diseases like *Cercospora* leaf spot, *Isariopsis* leaf spot and brown rust were noticed in wild as well as in cultivars of *Ziziphus* species.

Pomegranate

Eighty three genotypes of pomegranate were evaluated for fungal leaf spot diseases under natural disease incidence during the

month of August to December. The per cent disease intensity was worked out as per the standard procedures. Among 53 genotypes evaluated, 3 were resistant followed by 11 moderately susceptible, 32 susceptible and 7 highly susceptible (Table 34). However to ascertain the actual level of disease resistance in the germplasm collections, the pathogen inoculum has to be ensured by standard inoculation techniques.

Mateera

Nine lines of *mateera* (AHW) were evaluated for fungal and viral diseases incidence. Viral diseases such as water melon mosaic (WMV), cucumber yellow mosaic (CYMV) and cucumber mosaic (CMV) were common in most of the lines. Line 18-d recorded the maximum incidence of 45.9% followed by 45% in line 19k, 36.7% in line 118-a. Line 19-a2 recorded very less incidence (16.8%) for the diseases. In all these susceptible lines, fruits were very small with motling. Incidence of *Alternaria* leaf spot and anthracnose were also recorded in these lines. Line 118-a recorded 50% of *Alternaria* leaf spot followed by 19k (19.7%). However, 19-a2, 19-f, and 108-b were recorded very less incidence of leaf spot and all these were free from anthracnose disease except in case of 108-b (10.8%). Line 19-K was highly susceptible for fruit rot disease (36.4 %) at the time of maturity . All other lines recorded only 20-32% incidence. *Mateera* varieties AHW-19 and AHW-65 recorded 34.9% and 48.6% viral diseases, 35% and 23% of *Alternaria* leaf spot, 15% and 13% anthracnose 27.8% and 25.7% of fruit rot incidence in both of the varieties (Table 35)

Snapmelon

Only one line of snap melon (AHS 82) was evaluated during the period. It recorded 53% of viral diseases, 13.5% anthracnose and 19.6% fruit rot incidence. It was completely free from the *Alternaria* leaf spot.

Kachari

Kachari line-200 was relatively free from fungal diseases and less incidence of viral and fruit rot diseases during the season.

Cucumis sp

Twenty line of *Cucumis* sp (AHC 2) were evaluated for diseases resistance. Line 13-3 recorded the highest viral infection (62.5%) followed by 15-4 (47.6%), 14-2 (46.7%)and 11-3 (43%)and 6-2 (40 %) Lines 22-1, 13-2, 11-2, 8-1 and 13-2 recorded 10-15% incidence only. Line 14-2 was highly infected by *Alternaria* leaf spot (86.7%) followed by 8-1 (62.0%) and 22-2 (61.1%). All other lines were relatively free from these diseases. Interestingly all the *Cucumis* sp lines were free from anthracnose infection except in case of 22-2 and 18-4 lines (44 and 16.7%) respectively.

Table 34. Fungal leaf spot incidence in pomegranate germplasm collections

Genotypes	Disease incidence (%)	Disease Reaction
Jalor seedless	10.3	MS
Ganesh	32.7	HS
G-137	19.1	MS
G-137	34.4	S
Basin seedles	27.3	S
Bedana Suri	11.7	MS
Kazahi Anar	44.7	S
Kabul II HR	32.3	S
Khog	51.4	HS
Yarcaude HRS	3.6	R
A.K. Anar	21.6	S
P-26	38.4	S
Mridula	37	S
Bosecha link	58.8	HS
Gul-Shah	57.4	HS
Gul-Shah-Red	18.4	MS
Gul-Shah-Rose pink	22.6	S
Sirin Anar	42.8	S
Achikdana	21.6	S
G.K.V.K.	55.9	HS
Musket	28.5	S
Jalor Red	23	S
Jodhpur Collection	12.9	MS
P-23	35.1	S
Alandi	0.0	R
Patana-3	28.1	S
Jyothi	0	R
Surkh Anar	23.8	S
Dorseta Malus	23.8	S
Jodhpur (Red)	31.2	S
Dholka	42.8	S
Coimbator white	26.9	S
Grenedo-de-elcho	17.8	MS
Tobest	20.3	S
Sarat Anar	24.4	S
P 13	18	MS
Damini Poona	17.4	MS
Alah	13.2	MS
Speen Sacarin	23.2	S
Utakal	24.1	S
Siaha sirin	28.7	S
Bedana thinsrin	26	S
Kabul kohinoor	21.2	S
Kandhari	14.7	MS
Sur Sukar	25	S
gah	32.7	S
Kalisirin	24.5	MS
Juietis Ec-104347 (USSR)	8.6	MS
Speen danedar	28	S
Malta	25.2	S
Dhollah	78	HS
Punica granatum	14.2	MS
Bela road	31.2	S
Kuryi-2-Ec 24684	61.8	HS

Table 35. Diseases incidence in cucurbitaceous vegetables

Genotypes/Lines	Disease incidence (Percentage)			
	CMV/WMMV/CYMV	*Alternaria*	*Anthracnose*	Fruit rot
Water melon				
Matcera AHW 19	34.9	35	15.5	27.8
Matcera AHW 65	48.6	23	13	25.7
AHW 18-d	45.9	10.8	0	21.4
AHW 19-a_2	16.8	6.5	0	20.3
AHW 19-f	23.3	3.8	0	28.9
AHW 19-k	45.1	19.7	0	36.4
AHK 19-j	36.1	8.2	0	21.7
AHK 65-3_c	28.3	5.6	26.4	29.1
AHK 65-4_a	34	17.4	21.8	20.0
AHK 108-b	23.9	4.3	10.8	29.3
AHK 118-a	36.7	50	10	32.0
Snap melon (AHS)	53	0	13.5	19.6
***Kachari*-ASK-200**	9.8	0	0	11.7
***Cucumis* spp**				
6-1	30.6	0	0	
6-2	40	0	0	
6-3	40.6	0	0	
8-1	13.4	62	0	
9-1	21.5	0	0	
11-1	2.6	0	0	
11-2	6	0	0	
11-3	43.6	0	0	
13-1	38.8	25.5	11.1	
13-2	12.5	16.5	0	
13-3	62.5	25	0	
14-1	17.6	0	0	
14-2	46.7	86.7	0	
14-4	47	14.2	0	
15-3	19	14.3	0	
15-4	47.6	22.2	0	
18-4	17.6	29.4	16.7	
22-1	10	0	0	
22-2	21.5	61.1	44.4	
22-3	11	22.2	5.5	

Values are means of all the plants in all the rows of each lines. Figures are per cent disease incidence over healthy plants.

WMMV : Water Melon Mosaic Virus CMV : Cucumber Mosaic virus

CYMV : Cucumber Yellow Mosaic Virus

PLANT PRODUCTION

Mission K: Production of planting materials

K.1 Establishment of Progeny Block

About two hectare area has been developed as Progeny Block by planting different fruit types. This Progeny Block will surve as mother block for obtaining bud-wood of desired plant materials and also as field conservatory for demonstration purpose. So far, 60 varieties/strains of different fruit trees of 15 genera have been collected from different places in India and abroad (Table-36). The plants maintained under Progeny Block are also under evaluation to see their suitability under hot arid environment.

K. 2 Multiplication of planting materials

The fruit trees of commercial significance like *ber, aonla* and pomegranate have been multiplied through vegetative means for distribution of true-to-type of planting materials among farmers. Provision of growing structures have also been made for quick multiplication of planting materials. These structures were also helpful for conservation of new introductions of fruit, vegetable and ornamental plants.

Table 36: Status of Progeny Block at NRCAH, Bikaner

Fruit type	Variety/Strains	Place of collection
1. *Ber*	Seb, Gola, Umran, Mundia	Jodhpur
	Umran Selection	Godhra
2. *Aonla*	Chakaiya, Krishna, Kanchan, NA-7, NA-6, NA-10	Faizabad
3. *Bael*	Pant Urvashu, Pant Shivani, Pant Swarna, Pant Sujata, Pant Aparna	Pant Nagar
	NB-5, NB-7, NB-9	Faizabad
4. Guava	Hisar Surkha, Banarasi Surkha	Hisar
	Allahabad Safeda, Red Fleshed	Kaimganj
	L-49	Aurangabad, Faizabad, Pant Nagar
5. Citrus	Lemon-Godhra Selection	Godhra
	Lemon-Abohar Selection, Mosambi, Kinnow, Malta-Jaffa	Abohar
	Mosambi-Aurangabad Selection	Aurangabad
	Lemon-Pant-1	Pant Nagar
	Lime-Bharatpur Selection	Bharatpur
6. *Phalsa*	Local	Faizabad, Godhra
7. *Kronda*	Local	Faizabad, Godhra, Bharatpur, Udaipur
	Pant Manohar, Pant Sundarsana	Pant Nagar
8. *Lasoda*	NRCAH 1,2,3; Local	Bikaner
	Local	Bharatpur
9. Tamarind	Local	Bikaner
	Pratisthan	Rahuri
10. *Khejri*	NRCAH-*Khejri*-1	Bikaner
11. Carob	—	Israel
12. Marula nut	—	Israel
13. Chinese *ber*	—	Shimla
14. *Boradi*	—	Saudi Arabia
15. Mango	Kesar	Godhra
16. *Khirni*	Godhra Selection	Godhra
17. Pomegranate	Jalore Seedless	Jodhpur
	G-137, Ganesh, Mridula	Rahuri

NEW VARIETIES RELEASED

The arid region is endowed with rich genetic diversity in *Citrullus* and *Cucumis* species having drought hardy characteristics. Through extensive surveys, under the project entitled, "Collection, characterization, conservation, evaluation and improvement of cucurbitaceous crops under arid environment", large collections of semicultivated and locally adapted land races of *mateera* (a type of watermelon, *Citrullus lanatus*), *kachari* (*Cucumis callosus*), snapmelon or *phoot* (*Cucumis melo* var. *momordica*) and *salad kakdi* (*Cucumis* spp.) were made at NRCAH, Bikaner. After evaluation, selected genotypes were purified and two varieties each of these cucurbit vegetables have been released at Institute level on the occasion of field day on 23rd May, 1998, which have excellent yield potential under hot arid conditions and these are:

Mateera

AHW 19: It is a medium-early maturing (75-80 days after sowing) variety developed through selection from the local land races found in arid region. Vine produces 3-3.5 fruits. The flesh is dark pink, solid (firm) with good eating quality and taste having 8 to 8.4% TSS. The variety is heavy yielder (460-500 q/ha) and tolerates high temperature.

AHW 65: It is a very early maturing (72 days after sowing) variety developed by selection from local germplasm and is suitable for dessert and vegetable purpose. Harvesting of tender fruits (100 g weight) is recommended for use as vegetable. Yields 3-4 mature fruits per vine and 375-400 q/ha. The flesh is delicious, pink, solid (firm) having 8-8.5 per cent TSS.

Kachari

AHK 119: The fruits are suitable for dehydration. The fruits are small, egg shaped having 50-60 g weight. Harvesting begins 68-70 days after sowing and continue up to 110-120 days. On an average, 22 fruits are borne per vine giving a yield of 95-100 q/ha.

AHK 200: The fruits are suitable for garnishing the vegetables and *salads*. The fruits are 100-120 g in weight. Fruits become ready for harvest in 65-67 days after sowing and harvesting continues upto 90-100 days. On an average, 20 fruits can be harvested from a vine giving a yield of 115-120 q/ha.

Snapmelon

AHS 10: Fruits can be harvested 68 days after sowing. The fruit are oblong, medium in size and (900g weight). The flesh is whitish pink, sweet in taste having 4.5-5.0 per cent TSS. The vines bear 4-4.5 fruits each giving an yield of 225-230 q/ha under arid conditions.

AHS 82: Fruit harvest starts 67-70 days after sowing and continues upto 110-115 days. Each vine bears 4.5-5.0 fruits giving an yield of 245-250 q/ha. The fruits are 925 g in weight. The light pink flesh is very sweet and tasty having 4.3-4.9 per cent TSS.

Salad kakdi (*Cucumis* spp.)

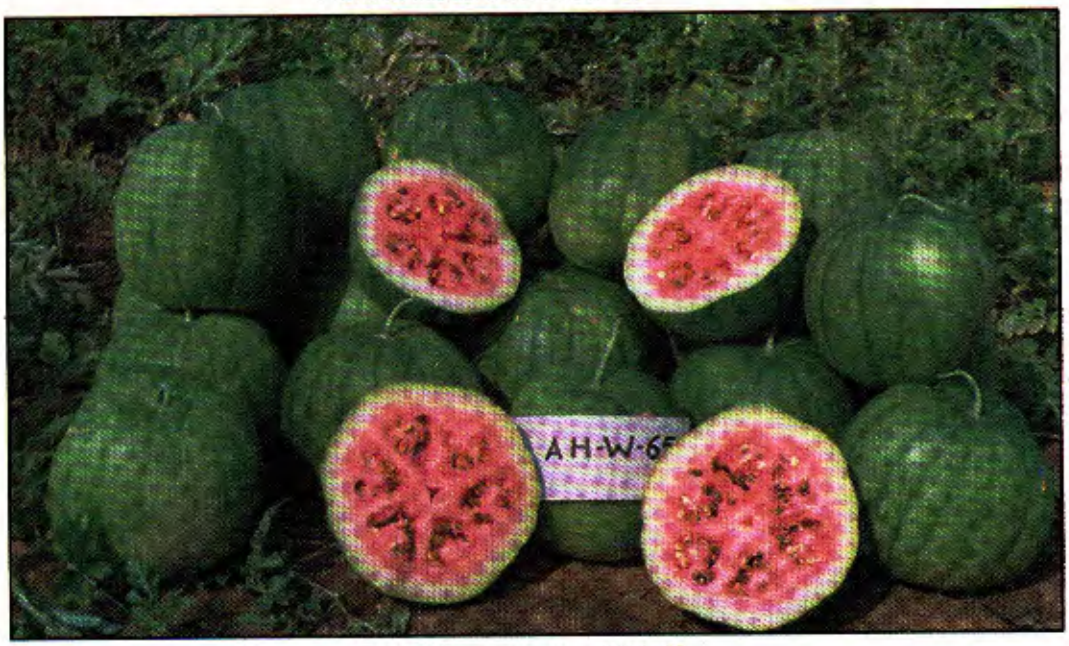
AHC 2: It is a very early maturing variety bearing uniform, long fruits. The fruits are medium long with light green skin without furrows. Harvesting of tender fruits can be done 8-12 days after fertilization for *salad* or for garnishing vegetables. Mature fruits become ready for harvest in 53-55 days after sowing and harvesting continue upto 90-100 days. Fruits weighing 275-300g are suitable for slicing when their length is 30-35 cm and diameter is 3-3.5 cm. The flesh is crisp textured, solid and 1.4-1.5 cm thick. About 12-15 tender fruits can be harvested giving an yield of 4 kg per vine and 175-202 q/ha under arid situations.

AHC 13: It is a very early and highly productive variety with profuse hermophrodite flowering. For slicing, the fruits can be harvested at very early stage (3-6 days after fertilization). First harvest can be obtained 50 days after sowing and harvesting continues upto 90-100 days. Continuous picking results in higher yield. About 20-25 fruits are borne per vine. The tender fruits weighing 75-100 g are harvested when the length is 5.5-7.0 cm and diameters is 4.4-5.0 cm. The flesh is crispy and tasty which is about 1.0 cm in thickness. On an average 2.15 kg tender fruits can be harvested per vine giving an yield of 85-125 q/ha. The variety also has high heat tolerance.

Table 37. Important characteristics of cucurbit varieties developed at NRCAH, Bikaner

Crop	Variety	Days to first harvest (DAS)	Fruit weight (kg)	Fruits/ plant	Yield (q/ha)	Remarks
Matera (*Citrullus lanatus*)	AHW 19	73.5	3.750	3.4	475	TSS around 8.0 per cent
	AHW 65	71.0	2.800	4.0	400	TSS around 8.0 per cent. Tender fruits can be used as cooked vegetable.
Kachari (*Cucumis callosus*)	AHK 119	69.0	0.060	22.2	99	Dehydration purpose
	AHK 200	61.0	0.110	19.5	115	Garnishing the vegetable and fruit salad.
Snapmelon (*Cucumis melo* var. *momordica*)	AHS 10	68.0	0.850	4.5	225	Ripe dessert fruit for salad.
	AHS 82	69.5	0.900	5.0	250	Ripe dessert fruit for salad.
Salad Kakdi (*Cucumis* spp.)	AHC 2	54.0	0.275	12.5	175	Tender fruits for salad.
	AHC 13	48.5	0.075	25.0	100	Tender fruits for salad.

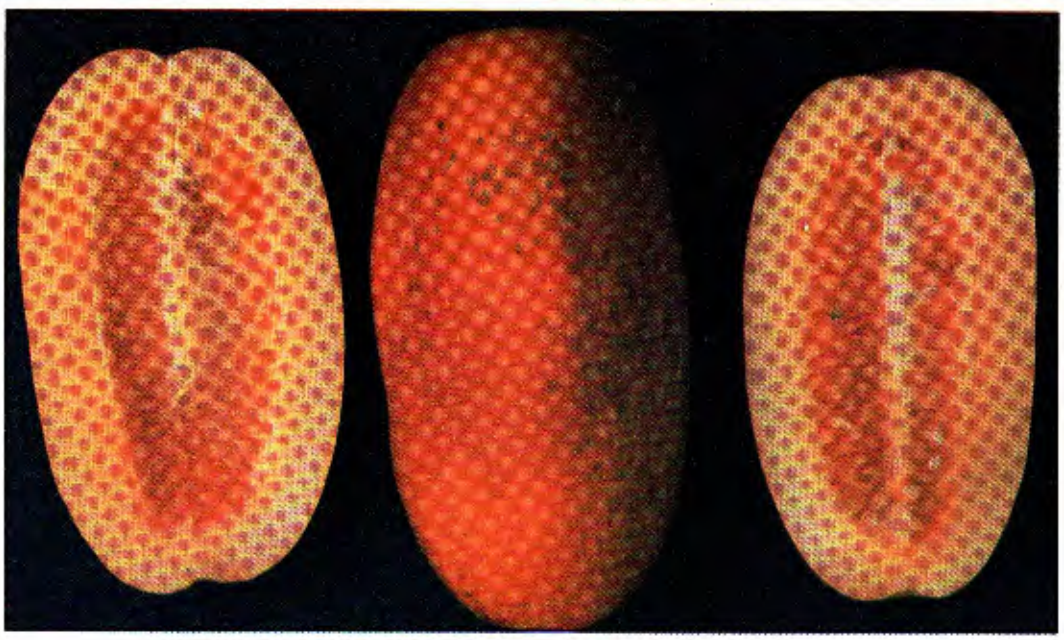
Fruits of *mateera* cv. AHW–19



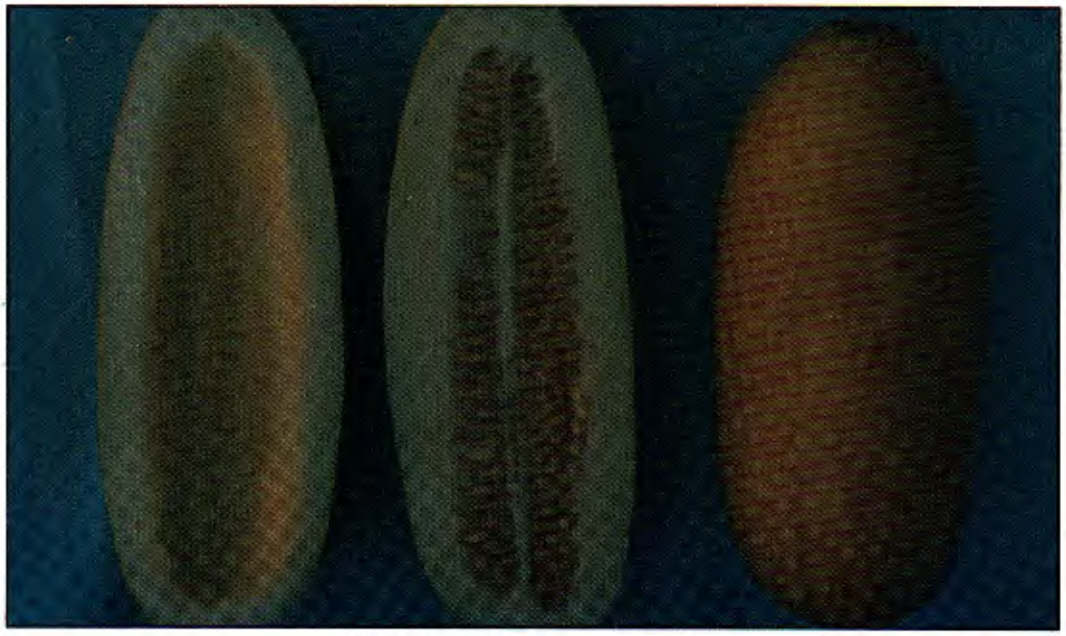
Fruits of *mateera* cv. AHW–65

Fruiting vines of *kachari* cv. AHK–119

Fruiting vines of *kachari* cv AHK–200



Fruits of sanpmelon cv. AHS–10



Fruits of snapmelon cv. AHS–82

Fruits of *Cucumis* spp. cv. AHC–2

A fruiting vine of *Cucumis* sp. AHC–13

FARM DEVELOPMENT

Land development

To date, more than 50 hectare farm area has been developed. Out of which the area in *ber* (8 ha), pomegranate (4 ha), *aonla* (2 ha), date palm (3 ha), vegetable (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. Massive land levelling and development works are in progress to develop experimental plots in accordance to the master plan of the farm.

Germplasm status

A total 300 collections of *ber*, 150 of pomegranate, 47 of date palm, 106 of cactus pear and 18 of *aonla* are being maintained in the germplasm repositories. Required number of varieties of various arid fruit species i.e. *Ziziphus, Punica, Emblica, Aegle, Cordia, Carrissa, Grewia, Tamarindus, Citrus, Mangifera, Moringa,* etc. are being maintained in the progeny block of the farm as mother plants for multiplication.

Shelterbelt and landscape plantation

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

Irrigation system

To operate close irrigation system, 300m long PVC 4" pipe line has been further extended to cactus pear block. Now, the functional close irrigation system in the farm area includes 25 lakh litre capacity water reservoir (diggi) connected with IGNP channel and Tubewell and inter connection of elevated surface tank (5 lakh litre capacity) and a network to distribute water through (1600 m long) PVC main pipe line(25 ha), sprinkler sets (2) and drip sets (7 ha).

Revenue generation

About rupees one lakh were generated as farm revenue through sale of seeds of cucurbit vegetables (*mateera, kachari, kakdi,* snapmelon and *tinda*) and *guar* and fresh fruits (*ber*) and vegetable and also some planting material during the year.

Seed production

Seed production of eight varieties of cucurbit vegetables released by the NRCAH i.e. two each in *mateera* (AHW 19 & AHW 65), snapmelon (AHS 10 & AHS 82), *kachari* (AHK 119 & AHK 200) and *kakdi* (AHC 2 & AHC 13) has been started on large scale in 1999.

FARM COMPLEX BUILDING INAUGURATED

Padam Bhushan Dr. R. S. Paroda, Director General,ICAR and Secretary, Department of Agricultural Research and Education, Government of India, New Delhi inagurated the farm complex building of NRCAH, Bikaner on 15 May, 1998 admist the august assemblage of dignitaries like Prof. K. Pradhan, Vice-Chancellor, RAU, Bikaner; Dr. A.S.Faroda, Director, CAZRI, Jodhpur; Dr. P.R.Kumar, Director, NRCRM, Bharatpur; Dr. M.S.Manohar, Director of Research, RAU, Bikaner; Dr. O.P. Pareek, Director, NRCAH, Bikaner and Dr. B.B.Vashishtha, P.S. (Hort.), NRCAH, Bikaner. Scientists from various ICAR Institutes, RAU, NGO's and state department officials also partipated in the function. Dr. Paroda hoped that the establishment of this centre will help to increase fruit and vegetable production in dryland areas of the country particularly in the arid regions. Dr. Paroda complimented the centre staff for doing excellent work in developing arid horticulture technology and germplasm conservation.

Dr. R.S. Paroda, DG (ICAR) & Secretary, DARE,Govt. of India, New Delhi inaugurating the farm complex building.

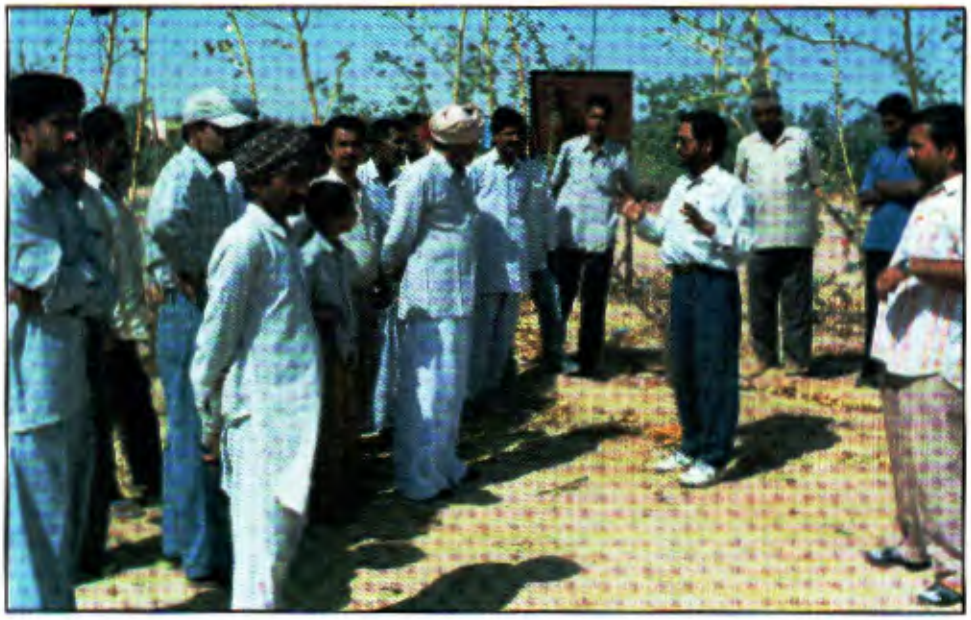
Dr. R.S. Paroda, DG (ICAR) & Secretary, DARE,Govt. of India, New Delhi seeing the activities of NRCAH.

FIRST FIELD DAY AT NRCAH

The first field day was organised on 23rd May, 1998 to disseminate the latest horticultural technology and new varieties developed by NRCAH in fruit and vegetable crops of arid region. A large number of extension workers, field officers and more than 250 farmers from the different districts of the arid zone assembled on this occassion and went around differrent experimental blocks, demonstration plots of cucurbit varieties and keenly observed the results. Concern breeder, Dr. D.K.Samadia, briefed about the important traits of newly developed varieties to the farmers in the demonstration plot itself. Besides farmers, a large number of agricultural scientists from Rajasthan Agricultural University, Bikaner and other ICAR and State Institutions participated in the function and a *Kisan Gosthi* was organised for interactions. On this occassion, the chief guest, Prof. K. Pradhan, Vice-Chancellor, RAU, Bikaner released the eight varieties of cucurbit vegetables developed by the centre and addressed the growers. Dr. O.P.Pareek, Director, NRCAH; Dr. M.S.Manohar, Director of Research, RAU, Bikaner and Dr. B.B. Vashishtha, Principal Scientist (Hort.), NRCAH, Bikaner highlighted the importance of horticultural technologies developed for arid region and also problems and their alternatives for better production in arid zone fruits and vegetable.

Dr. K. Pradhan, Vice-Chancellor,RAU, Bikaner releasing new varieties of cucurbits during field day.

QRT members discussing the experiments with scientists



Farmers-Scientist interaction during field Day

FINANCES

Budget allocation and expenditure incurred during 1998-99 are given in table below.

Table 38. Budget allocation and expenditure incurred during 1998-99

Head	Allocation		Expenditure	
	Plan	Non Plan	Plan	Non Plan
Pay and allowences	2.00	39.50	2.00	37.74
TA	1.00	1.00	1.00	0.76
Other charges including equipments	35.00	6.00	34.10	4.30
Works	87.00	—	87.90	—
Total	125.00	46 .50	125.00	42.80

PUBLICATIONS

A.Research papers

Nallathambi, P., Samadia, D.K. and C. Umamaheswari (1998). Thumba (*Citrullus colocynthis (L.) Schard:* A potential source of organic pesticide in Thar desert. Internal. Cong. Alletopathy Eco. Agri. Forest, Aug. 18-21, UAS, Dharward.

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Saroj, P.L., Arora, Y.K., Dadhwal, K.S., Sharma, N.K. and Shrimali, S.S. (1999). Intercropping of *toria* in mango orchard. Agroforestry Newsletter, 10 (2&3):10.

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शर्मा ब्रजेश दत्त, सिंह रमा शंकर, विशाल नाथ एवं पारीक ओम प्रकाश। गड्डे के आकार एवं भरावन मिश्रणों का अनार के पौध संस्थापना पर प्रभाव। स्मारिका– इक्कीसवीं सदी के लिए भारत में उद्यानिकी का विकास पर आयोजित राष्ट्रीय संगोष्ठी जनता कॉलेज, इटावा, 13&15 फरवरी, 1999

B.Popular/Technical Articles

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C. Book Chapters

Pareek, O.P. and Vishal Nath (1998). Arid and Minor fruits. In: Text Book of Horticulture, ICAR, New Delhi. In press.

D.Extension/Technical Bulletins

पारीक, ओ.पी.; विशाल नाथ एवं सिंह, आर.एस. (1998) शुष्क क्षेत्र में आंवला की बागवानी। राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान केन्द्र, बीकानेर। प्रसार प्रकाशन–3:1-10

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बीकानेर। प्रसार प्रकाशन। द्वितीय संस्करण।

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Samra, J.S., Mishra, A.S., Saroj P.L., Dhyani B.L. and Dubey R.K. (1999). Participatory Extension Stratigy, Institute Village Linkage programme. Pub.: CSWCRTI, Dehradun.

Best Paper Award

Samadia D.K. and Pareek O.P. were awarded the best poster presentation in 4th Agricultural Science Congress at Jaipur for their contribution , "*Kachari*: Arid region cucurbit vegetable for processing industry".

Nallathambi, P., Umamaheswari, C. and Vishal Nath were awarded for the best poster presentation in 4th Agricultural Science Congress Organised by RAU at Jaipur for their presentation Fungal colonization in processed fruits in ber.

Extension/Lectures

Dr. D.K.Samadia delivered following lectures:

1 खरीफ की प्रमुख सब्जियों की जानकारी।

2 किसान सखा प्रशिक्षण, कृषि विज्ञान केन्द्र, बीछवाल, बीकानेर दिनांकः 10.08.98

Dr. Pareek O.P. and Dr. Bhargava R. gave training to Asstant Professors of RAU in Academic Staff College on aspects of Research Project Management.

Radio talk

अ डा. समादिया डी.के. ने निम्नलिखित वार्ताएं दीः

1 जड़ वाली सब्जियों (मूली, गाजर व शलजम) की अगेती खेती, आकाशवाणी, बीकानेर दिनांकः 7.9.98

2 प्याज की स्वस्थ पौध (नर्सरी) कैसे तैयार करें आकाशवाणी, बीकानेर, दिनांकः 11.11.98

ब डा. विशाल नाथ ने निम्नलिखित वार्ताएं दीः

1 शुष्क क्षेत्र में आंवले का बाग कैसे लगायें– अगस्त, 1998.

2 उपयोग–फल एवं सब्जियों का प्रसंस्करण करके– नवम्बर, 1998

Meeting

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

1. National Consultancy on Horticultural Research, Development and Export meeting on 7-8 August, 1998 at IIHR, Bangalore.
2. National Agricultural Technology Project Launching Workshop on 6th October, 1998 at PHD House, New Delhi.
3. Directors meeting on 7-8 October, 1998 at ICAR, New Delhi.
4. Participated in 41st meeting of the Board of Management of Rajasthan Agriculture University, held at Jaipur on 4-5 March, 1999

Dr. B.B.Vashishtha, P.S. attended following meetings:

Participated in All India Citrus Show as a Judge.

Promotions

1. Sh. M.K.Jain, T-II-3 promoted as T-4 (Sr. Computer).
2. Sh. Rajesh Daiya, Jr. Clerk promoted as Sr. Clerk.
3. Sh. Kuldeep Pandey, Jr. Clerk promoted as Sr. Clerk.

Foreign Visits

Dr. O.P.Pareek, Director, visited University of Southampton on 16-17 July, 1998 to participate in the ICUC meeting in connection with initiation of authors for writing a series of books on *Ziziphus mauritiana*.

Dr. B.B.Vashishtha, P.S. visited Zimbabve during July 13-16, 1998 to attend International Workshop on *Ziziphus mauritiana*.

Resignation

Sh. Dinesh Kumar, T-II-3 (Lab.Tech.) resigned from NRCAH

Joining

1.Sh. Swaroop Chand Rathore joined as Jr. Clerk w.e.f. 13.4.1998.

2.Sh. Chhuttan Lal Meena joined as T-II-3 (FT) w.e.f. 13.7.1998.

3.Sh. G.K.Tripathi joined as T-1 (Lab. Tech.) w.e.f. 26.6.1998.

Visitors

1. Dr. R.M.Pandey, Ex-Director, IIHR, Bangalore on dated 21.4.98
2. Dr. R.C.Batra, QRT Member of NRCAH on dated 21.4.99
3. Dr. S. Chaudhari, Ex-Director of Research, Kalyani on dated 21.4.99.
4. Dr. R.K.Pathak, Technical Coordinator, Diversified Agricultural Support Project, Lucknow on dated 13.4.99
5. Dr. Harcharan Das, Ex-Director, NRC for Citrus, Nagpur on dated 13.4.99.
6. Dr.(Ms.) Mariya Judith
7. Dr. Peter Felker, Texas University, USA.

Name & Designation	Seminar/Symposium
Dr. O.P. Pareek, Director	1. Research Workers Group Meeting AICRP on AZF/CCS HAU, Hisar 14-16 Oct., 1998. 2. National Seminar on New Horizons in Production and Post Harvest Management of Tropical and sub- tropical fruits, IARI, New Delhi, 8-9 Dec., 1998. 3. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999
Dr. B.B. Vashishtha, P.S.	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998. 2. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999
Dr. B.D. Sharma, Sr. Sci.	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998.
Dr. R. Bhargava, Sr. Scientist	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998. 2. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999
Dr. Vishal Nath, Scientist (SS)	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998. 2. National Seminar on Multipurpose tree species for Agroforestry, Jhansi, July 4-6, 1998. 3. National Seminar on Management of Natural Resources in Rajasthan, RAU, Bikaner, Oct. 5-7, 1998. 4. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999
Dr. D.K. Samadia, Scientist (SS)	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998. 2. National Seminar on Management of Natural Resources in Rajasthan, RAU, Bikaner, Oct. 5-7, 1998. 3. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999
Mr. P. Nallathambi, Sci.	1. Research Workers Group Meeting AICRP on AZF, CCS HAU, Hisar 14-16 Oct., 1998. 2. 4th Agricultural Science Congress, Jaipur, 21-24 Feb., 1999

वार्षिक प्रतिवेदन सारांश

शुष्क क्षेत्र भारत के कुल क्षेत्रफल के लगभग 12 प्रतिशत भूभाग में फैला है। यह क्षेत्र राजस्थान, हरियाणा, पंजाब, गुजरात, महाराष्ट्र, आन्ध्रप्रदेश तथा कर्नाटक राज्यों में है। विपरीत कृषि जलवायु एवं भू-भौतिकी परिवेश के कारण इस क्षेत्र में उद्यानिकी उत्पादन नगण्य है। उपलब्ध प्राकृतिक संसाधनों के उचित उपयोग एवं पादपों की सूखा सहिष्णु किस्मों के समुचित विकास से इस क्षेत्र में उद्यानिकी उत्पादन की विपुल संभावनाएं हैं। इस क्षेत्र में उद्यानिकी उत्पादन बढ़ने से यहां के निवासियों की आर्थिक एवं सामाजिक परिस्थितियों में अपेक्षित सुधार लाया जा सकेगा। इन सब तथ्यों को दृष्टिगत रखते हुए भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने अप्रैल, 1993 में राष्ट्रीय शुष्क क्षेत्रीय उद्यानिकी अनुसंधान केन्द्र की विधिवत स्थापना की।

मुख्य ध्येय

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

उद्देश्य

1. शुष्क परिस्थितियों मे उद्यानिकी फसलों की जैवविविधता की पहचान एवं उनका संग्रह, संरक्षण, मुल्यांकन तथा वर्गीकरण करना।
2. लक्षित फसलों जैसे- बेर, अनार, आंवला, खजूर एवं खीरावर्गीय, फलीदार एवं सोलैनेसियस सब्जियों को उपलब्ध जैव विविधता के प्रयोग द्वारा उच्च गुणवत्ता, उत्पादकता तथा जलवायु के अनुरुप 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 अनुरुप उद्यानिकी फसलों की उत्पादकता बढ़ाने के लिए पोषक तत्वों, जल एवं मृदा का समुचित उपयोग करने की कृषि तकनीकों का विकास करके 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 उद्यानिकी फसलों के उत्पादों की सर्वउपलब्धता हेतु कटाई उपरान्त तकनीकियों का विकास करना।
7. शुष्क परिस्थितियों में उद्यानिकी फसलों हेतु समाकलित कीट एवं व्याधि प्रबन्ध की तकनीकियों का विकास करना।

वर्ष 1989-99 के मध्य किये गये महत्वपूर्ण अनुसंधा कार्यों का संक्षिप्त विवरण।

(i) इस अवधि में अनार की 7 किस्मों (ईरान से) एवं बेर के 18 जीन प्रारूपों (राजस्थान, से) के संग्रह के साथ ही केन्द्र पर कुल जननद्रव्य संग्रहण बेर में 300, अनार में 150, आंवला में 16, केक्टस पीअर (नागफणी) में 106, खजूर में 47, मतीरा मे 193, काचरी में 559 एवं फूट ककड़ी (स्नेपमेलन) में 90 हो गया है।

(ii) वर्ष 1998 के दौरान केन्द्र ने विभिन्न उद्यानिकी

फसलों की 8 किस्में विकसित की हैं। इनमें काचरी की एएच.के.-119 एवं एएच.के.-200, मतीरे की एएच.डब्ल्यू-19 एवं एएच. डब्ल्यू-65, फूट काकडी की एएच.एस.-10 एवं एएच.एस.-82 तथा सलाद ककड़ी की एएच.सी. 2 व एएच.सी.-14 हैं।

(iii) इस वर्ष जोधपुर के मथानियां, सोईला, मनाई एवं पाल क्षेत्रों से मिर्ची के 132 जननद्रव्यों का संग्रह किया गया।

(iv) मतीरा तथा तरबूज पर जल-अतृप्तता के अध्ययन से यह पाया गया कि मतीरा चार सिंचाईयों में भी अच्छी उपज देता है जबकि तरबूज में जल अतृप्तता की अवस्था आने पर उपज में कमी हो जाती है।

(v) अनार में कार्बनिक खाद एवं अकार्बनिक उर्वरक के तुलनात्मक अध्ययन में यह पाया गया कि वर्मीकम्पोस्ट के प्रयोग से पौधों में बढ़वार एवं अन्य क्रियाएं अकार्बनिक उर्वरक की तुलना में अच्छी रहीं।

(vi) वीरोसिल एग्रो (5%), $CaNa_3$ (0.5 एवं 1%) एवं बेविस्टिन (0.1%) रासायनिकों से उपचारित करने पर बेर की भंडारण क्षमता बढ़ाई जा सकती है।

(vii) केन्द्र के वैज्ञानिकों ने विभिन्न किसान मेलों एवं अन्य विस्तार गतिविधियों में सक्रिय भाग लेकर किसानों को नयी प्रौद्योगिकियों की जानकारी उपलब्ध करवाकर लाभान्वित किया। इसके अतिरिक्त बीकानेर स्थित राजस्थान कृषि विश्वविद्यालय एवं अन्य संस्थाओं के विभिन्न प्रशिक्षण कार्यक्रमों में केन्द्र के वैज्ञानिकों द्वारा प्रशिक्षण कार्य में की अग्रणी भूमिका निभाई गयी।


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