Annual Report 2006-2007

National Research Centre on Pomegranate
(Indian Council of Agricultural Research)

National Highway- 9, Bypass Road, Shelgi
Solapur – 413 006 (Maharashtra), India

Telephone : 0217-2374262 (Director), 0217-2374330 Fax : 0217-2374533
E-mail : nrcpomegranate@indiatimes.com ■ director@nrcpomegranate.org
Website : http://www.nrcpomegranate.org

Preface

National Research Centre on Pomegranate, Solapur (Maharashtra) was established on June 16, 2005 under the control of the Indian Council of Agricultural Research, New Delhi, as a step to strengthen research and development in pomegranate. Many universities and institutes all over the world have research projects on pomegranate as a part of their research programme, but this is the only institution working solely on pomegranate. Visualizing the increasing demand both for domestic consumption and export, it was felt necessary to address important constraints in production and post harvest management. This necessitated the establishment of the centre. The NRCP has pivotal role in catalyzing the process of harnessing the immense production potential of the country.

Pomegranate is a high value crop. Its entire tree is of great economic significance. Apart from its demand for fresh fruits and juice, the processed products like wine and candy are also gaining importance in world trade. All parts of pomegranate tree have high therapeutic value and are used to cure diseases like cancers, diabetes, gastrointestinal disorders, heart problems, etc. It also has great use in leather and dying industry. Demand in the international market has widened the scope for earning higher income from this crop. Net profits upto 5 lakhs/ha/annum have been obtained by some growers. Therefore, it is a highly remunerative crop for replacing subsistence farming and bringing prosperity from poor soils of arid and semi-arid regions. It provides nutritional security, has high potentials to develop waste lands widely available in the region and is an ideal crop for diversification. Moreover, it can make higher contribution to GDP from a small area.

To achieve these targets, coordinated and sustained efforts are required by all concerned with pomegranate research and development (R&D). We have to orient our research programmes to develop sustainable technologies by making best use of the opportunities to meet the increasing demands and challenges. Potential areas for pomegranate cultivation will have to be identified and non-traditional areas will be explored for its cultivation. Though pomegranate can tolerate water stress, it responds well to irrigation and fertigation. Developing Hi-tech micro-irrigation systems for water management will, therefore, be a priority. Desirable traits need to be introduced in existing commercial varieties and transgenic lines need to be developed through biotechnology. Rapid multiplication of planting materials can be achieved through traditional and non traditional methods of propagation.

The centre, two years in existence, presents its first Annual Report for the year 2006-07. The report covers research achievements pertaining to crop improvement, crop production and crop protection as well as other activities of the centre.

I express my gratitude to Dr. Mangala Rai, Secretary DARE and Director General, Dr. H.P. Singh, Deputy Director General (Horticulture) and Dr. S.N. Pandey, Assistant Director General (Horticulture), ICAR, New Delhi for their keen interest, full support and encouragement to strengthen the newly established centre. My thanks are due to Dr. P. Kumar, Principal Scientist, Dr K.K. Sharma, Senior Scientist, Dr Ram Chandra, Principal Scientist, Dr. W.L. Barwad, Senior Scientist, Dr.(Mrs.) Jyotsana Sharma, Senior Scientist, Dr R.A. Marathe, Senior Scientist and D.T. Meshram, Scientist for their efforts in bringing out this document. I also place on record the support that I received from administrative and technical staff of this centre.

V.T. Jadhav
Director

October, 2007

Contents

Executive Summary

Crop Improvement

An exploration programme was conducted in Nainital, Almora, Ranikhet, Bageshwar and Chamoli districts of Uttaranchal to collect native germplasm of pomegranate in collaboration with NBPGR Regional Station, Bhowali. Frequency distribution of wild pomegranate in these areas was noted. Abundant population of wild pomegranate was noticed in Someswar and Garur valley during the survey. Based on growth, morphological parameters and fruit taste, 13 accessions were collected. Variability in plant height, leaf and fruit size, stem, rind and aril colour, number of thorns and their size, TSS and acidity etc. was noticed. A total number of 119 germplasm of pomegranate was collected from various institutes and SAUs, out of which only one hundred six germplasm could survive. A National Field Gene Bank of Pomegranate with 67 accessions has been established in February, 2007.

For creation of variability in pomegranate, seeds of Ganesh and Bhagwa were irradiated with 0-30 kR gamma rays. Seed germination started from 8 days after sowing (DAS) and continued up to 28 DAS. Seed germination was not influenced at 0-6 kR irradiation in both the cultivars. Subsequently, the germination reduced at 9-30 kR treatments. However, survival of seedlings was significantly higher at 0-15 kR in Ganesh (92.0-95.4%) and at 0-24 kR in Bhagwa (92.9-98.9%).Seeds of Ganesh were more sensitive to gamma irradiation than Bhagwa.

Crop Production

Survey programme was under taken in Maharashtra, Andhra Pradesh and Karnataka. Information on existing cultural practices, nutritional status of pomegranate orchards and post harvest losses was collected. In general, the crop is grown in sub marginal and dry areas in black, red and gravel type of soils. Land holding under pomegranate ranged from 1- 200 acres, but majority of the farmers had more than 5 acres of orchards. Medium density planting was common. Bhagwa and Ganesh were the commercial varieties, but Bhagwa is more popular among the farmers. Application of FYM with chemical fertilizers (N, P and K) was common practice followed by the growers. However, some of the growers applied micronutrients too. Drip irrigation with two drippers was general method for irrigation. Mainly layered plants are used for planting. *Ambe, mrig* and *hasta bahars* are commonly taken in Maharashtra. However, *Hasta* and *Ambe bahars* are most popular. Multi-stem system with 2-6 branches is preferred. Generally, 40-60 days stress is given to plants for flower induction by withholding water and using defoliant. The suckers arising from the ground are removed regularly (2-3 times/year) besides, light pruning of twigs and diseased branches. Soil physico-chemical properties revealed that the surveyed areas were suitable for pomegranate cultivation and their pH (7.4 - 8.8), EC (0.1 - 1.7 dS/m), OC (0.15 - 1.53%), $CaCO_3$ (5 - 23%), N (169-482 kg/ha) and K (134 - 1052 kg/ha) were recorded in permissible range. Micro nutrient deficiency particularly of iron and zinc was noticed in some orchards. About 10-15 % on farm losses of fruits were recoded. The major portion of the produce is sold in local market and also exported in middle east Asian or European countries.

An attempt was made to standardize the media for raising of pomegranate seedlings. Root development was better in all the treatments except Soil+ Sand and Sand alone. Soil + Vermicompost (1:0.5) and Soil + Sand + Vermicompost (1:1:0.5) were at par with respect to root and shoot weight and total bio-mass production. However, Soil + Sand + Vermicompost (1:1:0.5) ratio proved to be beneficial for raising of pomegranate seedlings.

Crop Protection

Survey of major pomegranate growing areas in Maharashtra and Andhra Pradesh was conducted during December, 2005 to March, 2007 to assess disease and insect pest scenario in these regions. Bacterial blight was the major disease threatening pomegranate cultivation followed by wilt. It was severe in Solapur and Latur districts, whereas, Ahmednagar and Satara were free. It was observed to be severe in rainy season crop. Wilt was serious in Satara, Pune, Nashik and Ahmednagar having incidence between 50.0-91.7 %. Jalana was free from wilt. Leaf and fruit spots were present in more than 58% orchards in affected districts, though incidence was in traces to moderate form. Fruit rot was not a serious problem, except in Satara where upto 50% orchards were severely affected. In Anantpur district of Andhra Pradesh, 23 orchards were surveyed. Bacterial blight was present in 43.5% orchards, wilt in 8.7%, leaf and fruit spots upto 52.2% and fruit rots in 39.1% orchards. Solapur, Sangli and Satara were the only districts affected with disorders like internal break down of arils, sun scald and fruit cracking.

Among insect pests, sucking pests (Aphids, thrips, mites etc.) were most prevalent affecting 41.7 to 90.9% orchards. Fruit borer was observed in all the districts, except Ahmednagar and was observed in 9.5% orchards in Nashik to 66.7% orchards in Osmanabad. Fruit sucking moth, shot hole borer and stem borer were not the major problem in most of the affected districts as infestation was mostly in traces. Nematode infestation was severe in Sangli and Solapur districts in just 9.1 - 14.7% orchards.

Bacterial blight caused by *Xanthomonas axonopodis pv punicae* and Cercospora spots were often confused by farmers and differences were studied and listed. Field ooze test was developed to identify bacterial blight in field. Etiology and pathogenicity of bacterial blight were conclusively proved in pot culture experiments.

Bacterial blight was observed throughout the year in temperature range from 6-42^{0} C with higher severity during rainy season. Among different spray schedules, Streptocycline (500ppm) + Bavistin (0.2%), Streptocycline (750 ppm) + Bavistin (0.2%) and Streptocycline (500ppm) checked bacterial blight upto 50% in field experiments.

External and internal symptoms of wilt were studied. *Ceratocystis fimbriata* was isolated from wilted stems showing discoloration of wood. *Rhizoctonia solani, Macrophomina, Phytophthora* and *Fusarium* were also isolated from some wilted plants. *Cercospora punicae, Colletotrichum sp., Dreschslera rostrata, Alternaria alternata, Pestalotia sp. Pseudobeltrania sp., Aspergillus niger, Penicillium sp.* were recorded from different types of leaf/ fruit spots and fruits rots. *Aspergillus* and *Penicillium spp.* were found in isolations from arils affected by internal break down.

Agricultural Extension and Transfer of Technology

One day meeting of pomegranate growers association and farmers was arranged at the centre in January, 2006. Farmers from Maharashtra, Karnataka and Andhra Pradesh visited the centre and interacted with the scientists of different disciplines. *Kisan Gosthi*, on the eve of the first foundation day of the centre on September 25, 2006 was organized. More than 150 farmers and scientists from MPKV, CRS (NRCS), Solapur etc. attended the function. Lectures on various aspects of pomegranate cultivation and protection were delivered for quality production. Folders on bacterial blight and wilt management in vernacular and technical bulletin in English were distributed for the benefit of the farmers.

Scientists of the centre made on farm visits to different pomegranate orchards in Maharashtra, Andhra Pradesh and Karnataka to assess and solve the problems of the farmers. Dignitaries of ICAR, State Departments and SAUs met at several high level meetings organized by the centre to discuss losses caused due to bacterial blight and finalize the strategies to combat the disease.

Media coverage on various aspects of pomegranate cultivation was given regularly through local newspapers, television channels and magazines to promote pomegranate cultivation in traditional and non-traditional areas. Many farmers and government officials visited Plant Pathology laboratory and they were guided to combat bacterial blight, wilt, leaf and fruit spot and other diseases. Besides, they also visited Soil Science and Crop Production laboratories. Scientists of this centre were invited by various R&D organizations to deliver lectures and impart training on orchard management and disease and insect pest management throughout the year.

Introduction

India is one of the world's leading countries in pomegranate (*Punica granatum* L.) production and more than 1.25 lakh hectare area is under pomegranate of which 87,000 hectare area is covered in Maharashtra state alone. Besides, parts of Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat and Rajasthan are also suitable for quality production of pomegranate in India. However, it is a very popular fruit of tropical and subtropical regions and has a versatile adaptability to a wide range of climatic conditions. Particularly its hardy nature, response to high technological practices, high yield, better table and therapeutic values, excellent keeping quality and high export potential have made this crop highly lucrative and remunerative. Therefore, it was thought worth while to exploit its potential in the country through conducting basic and strategic research for increasing its production, productivity, profitability and utilization.

Genesis

Originally the NRC on Pomegranate (NRCP) was approved as an independent establishment during the terminal year (2001-2002) of IXth Five year plan, but it could not be established then due to administrative formalities. The planning commission too had supported for the establishment of NRCP and accorded its approval in principle. It was, however, decided during IXth plan to confine it to the status of a regional centre of Central Institute of Arid Horticulture (CIAH), Bikaner in Rajasthan. Subsequently, it was decided to have an independent establishment of NRCP instead of having a regional centre of CIAH. Thus, the Indian Council of Agricultural Research (ICAR), New Delhi established National Research Center on Pomegranate on June 16, 2005 at Kegaon in Solapur district of Maharashtra during Xth plan.

Historical Background

Considering the tremendous potential for the production of pomegranate, both for domestic consumption and export, it has been thought worthwhile to exploit its potential in the country through conducting basic and strategic research for increasing it's production, productivity, profitability and utilization. Consequently, it was decided by the ICAR to conduct mission-oriented research for quality production of pomegranate through breeding superior varieties, developing better production technologies, resolving biotic and a-biotic stresses, developing pomegranate based cropping system and to act as a repository of information related to pomegranate. Accordingly, the Planning Commission has agreed to establish the National Research Centre on Pomegranate in Maharashtra. In 2001, the Secretary Agriculture, Govt. of Maharashtra, Pune had proposed a few sites in the district of Solapur to establish the NRC on Pomegranate. In accordance to this, the Council had constituted a site selection committee for inspecting various sites in Solapur district. Finally, the committee recommended a site at Kegaon and Hiraj in North Solapur *Tehsil* of the Solapur district. After detailed negotiation and discussion with the district administration and revenue department, the above site was taken over by the Director, CIAH, Bikaner on 9.11.2004 and it was finally handed over to the

National Research Centre on Pomegranate, Solapur. The centre started functioning after joining of scientists in August, 2005 and later on it was formally inaugurated by Hon'ble Shri Sharad Pawar, Central Agricultural Minister, on 25 September, 2005 at Kegaon, Solapur.

Location

NRCP, Kegaon, Solapur is located on Pune - Hyderabad National Highway, 15 km away from Solapur Railway Station. Solapur is well connected to all parts of the country by road and rail. The nearest airports are at Pune (250 km), Aurangabad (298 km) and Hyderabad (300 km). The Government of Maharashtra has provided 59.33 ha of land in Kegaon and Hiraj villages in two blocks. One block of 15.83 ha of land is at Kegaon along the National Highway No. 9 and the other block of 42.95 ha is in Hiraj village with provision of 0.55 ha land for a connecting road between these two blocks.

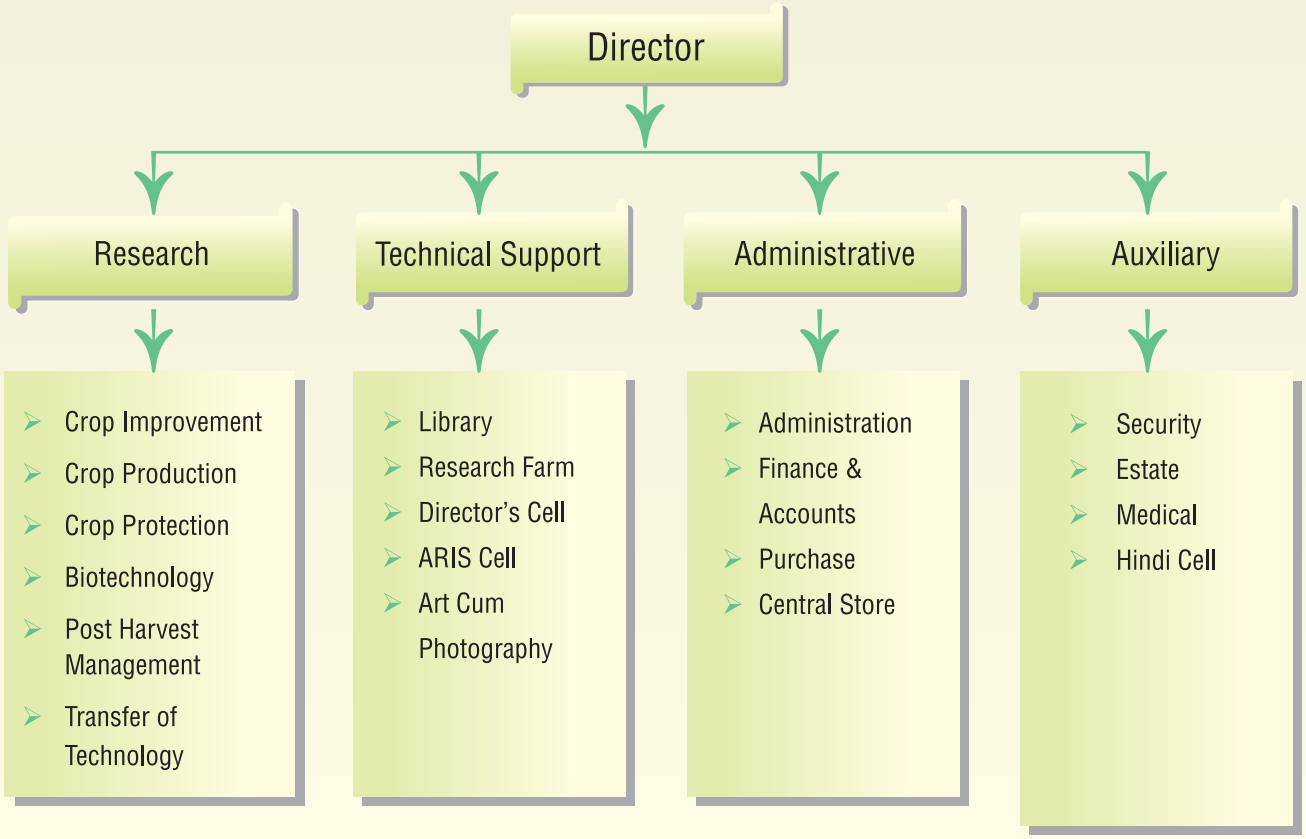
Mandate

- To develop suitable varieties with high yield potential of quality fruits having resistance to biotic and abiotic stresses.
- To undertake basic, strategic and applied research for developing production and post harvest technologies.
- To act as national repository of pomegranate.
- To provide consultancy on pomegranate.
- To transfer technology to pomegranate growers.

Mission

To establish repository of pomegranate genetic resources and develop suitable technologies for sustainable production and utilization to meet domestic and export demand.

Organizational Setup



Salient Achievements

- Thirteen accessions of native germplasm of pomegranate were collected from Nainital, Almora, Ranikhet, Bageshwar and Chamoli districts of Uttaranchal.
- A total number of 119 germplasm of pomegranate was collected and a National Field Gene Bank of Pomegranate was established.
- Seeds of Ganesh and Bhagwa were irradiated with 0-30 kR gamma rays in order to create variability. The germination reduced at 9-30 kR treatments. However, survival of seedlings was significantly higher at 0-15 kR in Ganesh (92.1-95.4%) and at 0-24 kR in Bhagwa (92.9-98.9%).
- For raising of pomegranate seedlings, Soil + Sand + Vermicompost (1:1:0.5) proved to be beneficial.
- Pomegranate growing areas in Maharashtra, Andhra Pradesh and Karnataka were surveyed and information on existing cultural practices, nutritional status, diseases and insect pests and post harvest losses was collected.
- Bacterial blight, wilt, fruit borer, sap sucking insects, spoilage of fruits etc. were the important problems identified, however, bacterial blight and wilt were the most threatening diseases, causing economic losses.
- Methods to diagnose bacterial blight in field were developed. Etiology and pathogenicity of bacterial blight were conclusively proved.
- Streptocycline (500 ppm) + Bavistin (0.2%), Streptocycline (750 ppm) + Bavistin (0.2%) and Streptocycline (500 ppm) checked bacterial blight upto 50% in field experiments.
- *Ceratocystis fimbriata, Rhizoctonia solani, Macrophomina, Phytophthora* and *Fusarium* were found associated with wilted plants, however, *Ceratocystis* was the major pathogen.
- *Cercospora punicae*, *Colletotrichum sp.*, *Dreschslera rostrata*, *Alternaria alternata*, *Pestalotia sp. Pseudobeltrania sp.*, *Aspergillus niger, Penicillium sp.* were found associated with different types of leaf / fruit spots and fruits rots.
- *Aspergillus* and *Penicillium spp.* were found in isolation from arils affected by internal break down.

Staff Position

The centre has a total sanctioned strength of 41, including 1 RMP, 9 scientific, 14 technical, 7 administrative and 10 supporting. Out of 41 sanctioned posts, only 13 posts have been filled up upto March, 2007 (Fig.1).

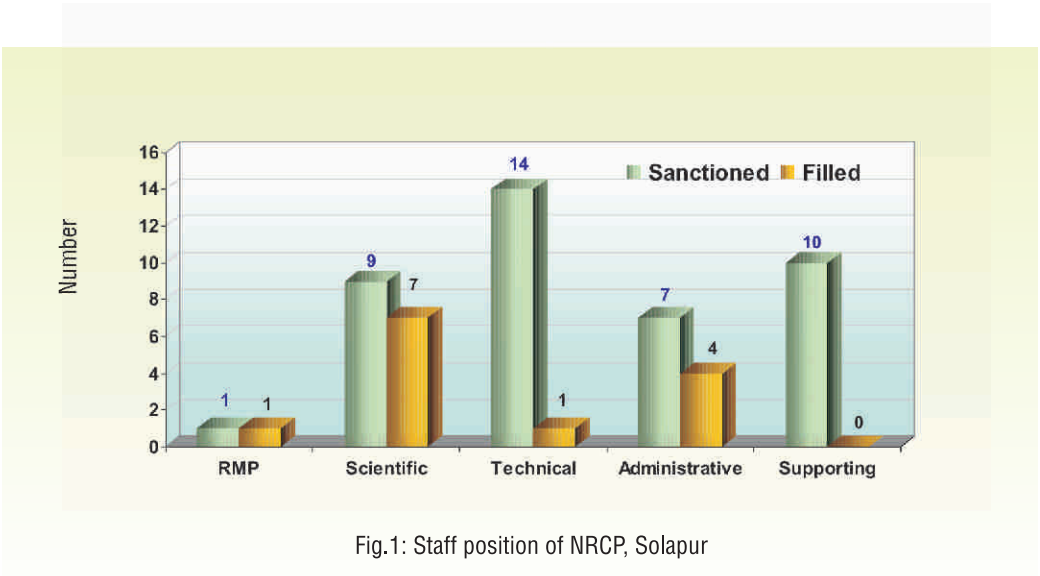


Fig.1: Staff position of NRCP, Solapur

Budget

A total financial outlay of Rs. 325.50 lakh was initially sanctioned in X[th] five year plan which was subsequently revised to Rs. 692.50 lakhs (Table 1).During 2006-07, an amount of Rs. 99.99 lakhs was incurred (Table 2).

Table 1: Financial outlay (X[th] Plan)

Rs. in lakhs

S. No	Head	Plan outlay		Non-plan	Total
		X[th]	Revised		
A	Recurring contingencies				
i	Establishment	28.00	44.00	-	44.00
ii	TA	06.00	6.00	-	6.00
iii	Contingencies (Other Charges)	65.00	49.00		49.00
iv	HRD	01.00	1.00	-	1.00
B	Non recurring contingencies				
i	Equipment	75.00	105.00	-	105.00
ii	Works	133.0	470.00	-	470.00
iii	Library	04.50	4.50	-	4.50
iv	Vehicle (Staff Car)	07.00	7.00	-	7.00
v	Furniture/Fixture	06.00	6.00	-	6.00
vi	Land	—	-	-	-
vii	Live stock	—	-	-	-
	Total	325.50	692.50	-	692.50

Table 2: Actual Utilization in X[th] Plan (2004-05, 2005-06 and 2006-07)

	Head	Fund utilization (Plan) Rs. in lakhs		
		2004-05	2005-06	2006-07
A.	Recurring			
	Pay and allowances	—	8.87	35.13
	TA	—	2.25	3.75
	Contingencies	—	8.25	40.44
	HRD	—	—	1.00
	Total (A)	—	19.37	80.32
B.	Non-Recurring			
	Other charges including Equipments	0.31	34.50	70.50
	Works	—	43.40	426.60
	Land	—	—	—
	Library books/journals	—	0.73	3.77
	Vehicles	—	—	7.00
	Furniture/Fixtures/Others	—	1.99	4.01
	Total (B)	0.31	80.62	511.88
	Grand Total (A+B)	0.31	99.99	592.20

Research Achievements

Crop Improvement

Germplasm collection and establishment of National Field Gene Bank of Pomegranate

A total number of 119 germplasm of pomegranate viz. 29 from IIHR, Bangalore, 41 from MPKV, Rahuri, 16 from NBPGR Regional Station, Bhowali and 27 from NBPGR Regional Station, Shimla and 6 from Maharashtra were collected and multiplied (Table 3).Thirteen accessions of native germplasm of pomegranate growing wildly in Uttaranchal were collected in collaboration with NBPGR Regional Station, Bhowali. Survey of Nainital (Fig. 2), Almora, Ranikhet, Bageshwar and Chamoli districts of Uttaranchal was conducted. Distribution pattern of pomegranate was much higher in Kainchi, Nainital to Bazol and Almora. Very scanty distribution was noted from Ranikhet to Almora. Abundant population was found in Someswar and Garur valley. Very scanty population was noticed from Simili to Nandprayag and about none from Someswar to Simili. However, partial distribution was observed from Simili to Adibadri and restricted pockets were seen in Agarchatti to Mehalchauri and none from Adibadri to Garisen. Further, partial distribution was noted from Khirkhet to Ranikhet and Sauni to Majhera. Variability in plant height, leaf and fruit size, stem, rind and aril colour, number of thorns and their size, TSS and acidity etc. was recorded. Of the total germplasm collected from different sources, one hundred six germplasm could survive (89%). After multiplication, 67 accessions were planted in a newly established National Field Gene Bank of Pomegranate in February, 2007 at Kegaon, Solapur (Fig.3). Double and single types of flowers are found in pomegranate (Fig.4). A pomegranate genotype (Nana) can be exploited as dwarfing root stock (Fig. 5).

Table 3 : Survival (%) of pomegranate germplasm

Source	Acc./ collection (No.)	Survival (%)
IIHR, Bangalore	29	65.50
NBPGR, Bhowali	16	93.75
NBPGR, Shimla	27	92.59
MPKV, Rahuri	41	100.0
Maharashtra	6	100.0
Total	**119**	**89.0**

Fig. 2 : Scientists collecting native germplasm of pomegranate from Nainital (Uttaranchal)

Fig. 3 : Newly established Field Gene Bank of Pomegranate at Kegaon, Solapur

Fig. 4: Variability in pomegranate flower colour and shape

Fig. 5 : Nana- a dwarf pomegranate (*Punica granatum* L. var. nana) suitable for dwarfing root stock

Effect of gamma irradiation

In order to create variability in pomegranate cultivars (Ganesh and Bhagwa), the seeds of both the cultivars were irradiated with gamma rays at 0-30 kR. The seed germination was significantly influenced by different irradiation treatments (Fig. 6). However, the germination was not synchronised in both the cultivars. In general, the germination started from 8-10 days after sowing (DAS) and continued up to 28 DAS. Interestingly, 0-6 kR treatments did not show any significant difference on seed germination from 10-28 DAS in both the cultivars and subsequently, the germination was reduced at 9-30 kR treatments in both the cultivars, indicating that these treatments had negative effect on germination. The germination recorded at 26 DAS between 0 and 6 kR treatments were at par to each other and their values ranged from 61.5-67.5% in Ganesh and 75.5 - 79.0% in Bhagwa. As far as survival of seedlings was concerned, upto 15 kR treatments were at par and their values ranged from 92.1- 95.4% in Ganesh, while similar result was found upto 24 kR treatments in Bhagwa and their values ranged from 92.9- 98.9% (Fig. 7). This shows that seedlings of Ganesh were more sensitive to gamma irradiation at higher doses than Bhagwa.

Fig. 6 : Effect of gamma irradiation on seed germination

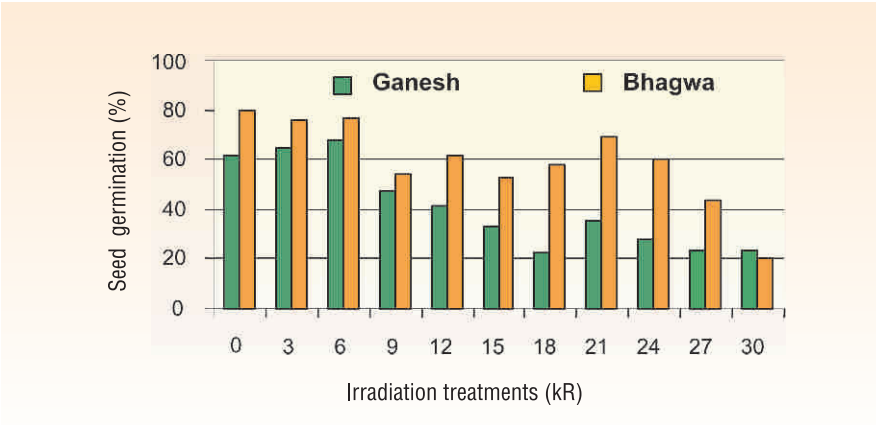
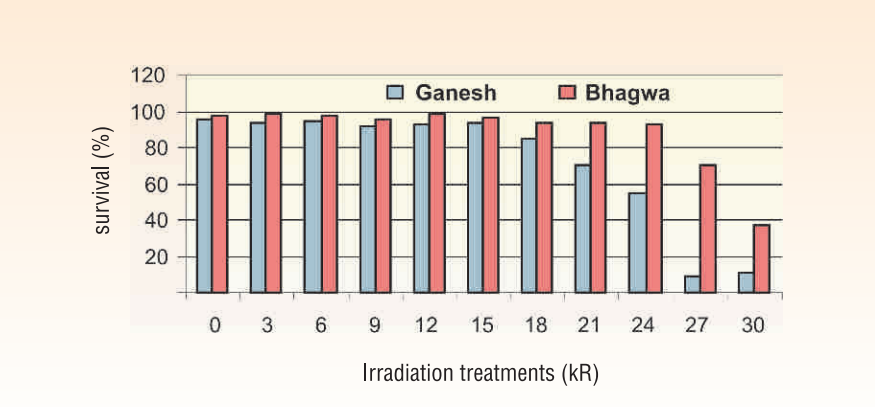


Fig. 7 : Effect of gamma irradiation on survival of seedlings



Crop Production

Survey of pomegranate orchards

Some parts of Solapur district in Maharashtra, particularly Akalkot and South Solapur, also a part of Koper, Chitradurg and Bijapur districts of Karnataka and Anantpur district of Andhra Pradesh were surveyed to collect information on existing cultural practices, nutritional status of pomegranate orchards and post harvest losses. In general, the crop is grown in sub marginal and dry areas in black, red and gravel type of soils. Land holding under pomegranate ranged from 1- 200 acres, but majority of the farmers had more than 5 acres of orchards. Medium density (520-750 trees/ha) planting was more common. Bhagwa and Ganesh were the commercial varieties (Fig. 8), but Bhagwa occupied maximum area. Application of FYM (10 kg/tree) with chemical fertilizers particularly N, P and K was common practice followed by the growers but some of the growers applied micronutrients too. Drip irrigation with two drippers was general method for irrigation. Mainly layered plants are used for planting. All the three *bahars* viz *Ambe*, *Mrig* and *Hasta* are taken. But *Hasta* and *Ambe bahars* are most popular. Profuse flowering and fruiting are observed in *Ambe bahar* in cv. Bhagwa (Fig. 9). As far as training is concerned, multi-stem system with 2-6 branches is followed. Generally, 40 -60 days stress is given to plants for flower induction by withholding water and using defoliant. Pruning is done at the time of flower regulation. The suckers arising from the ground are removed regularly (2-3 times/year) besides, light pruning of twigs and diseased branches. Raising of soil of about 1m width and 15-20 cm height along the plant rows is a quite prevalent system in Solapur district. However, intercropping was not common in surveyed areas, but in some orchards, water melon (Fig. 10), gram (Fig. 11), onion, garlic etc. are grown as inter crops. Pomegranate + mango, pomegranate + ber (Fig. 12), pomegranate + Sapota farming systems are also followed in Solapur on a limited scale.

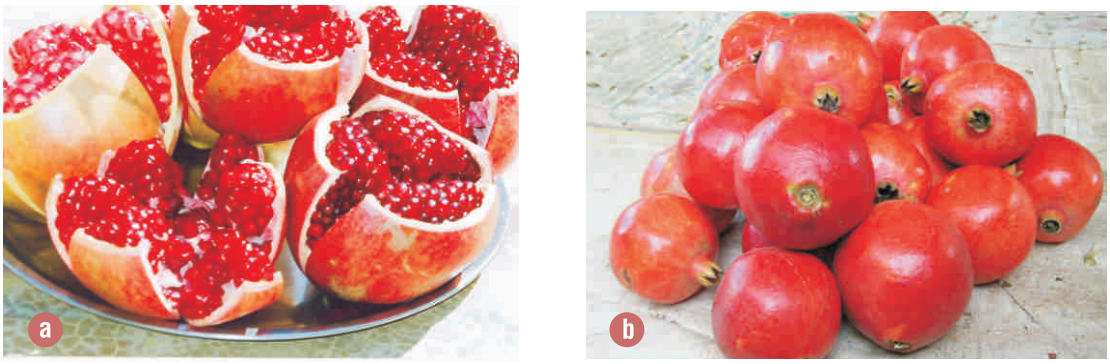


Fig. 8 : Ganesh (a) and Bhagwa (b) show promise in Maharashtra

Fig. 9 : Profuse flowering and fruiting in Bhagwa variety

Fig. 10 : Pomegranate + watermelon intercropping

Fig. 11 : Pomegranate + gram intercropping

Fig. 12 : Pomegranate + ber farming system

The soil and plant samples collected from surveyed areas were analysed and are presented in Table 4. Soil physico-chemical properties revealed that surveyed areas were suitable for pomegranate cultivation and their pH (7.4 - 8.8), EC (0.1 - 1.7 dS/m), OC (0.15 - 1.53%), $CaCO_3$ (0.5 - 23%), N (169-482 kg/ha) and K (134-1052 kg/ha) were recorded in permissible range. Micro nutrient deficiency particularly of iron (Fig. 13) and zinc was noticed in same orchards. About 10-15 % on farm losses of fruits occur due to inadequate storage and processing facilities. The major portion of the produce is either sold in local market or exported (Fig.14) to middle east Asian or European countries. Hardly 2% fruits are processed. Establishment cost of orchard varied from about 45,000 to 1,00,000 /ha and net income was from 50,000 to 1,50,000/ha from 4 to 10 years old orchards.

Fe deficiency(early)

Fe deficiency(late)

Fig. 13 : Iron deficiency symptoms

Fig. 14 : Fruit grading and packing in paper boxes by farmers for marketing

Table 4 : Soil properties and available nutrients in different surveyed areas

Area	No. of orchards surveyed	pH	EC (dS / m)	Organic Carbon (%)	$CaCO_3$ (%)	Nitrogen (kg/ha)	Potash (kg/ha)
Karnataka	03	7.85-8.72	0.35-0.58	0.36-1.07	7.4-22.5	244-482	319-1052
Andhra Pradesh	10	7.48-8.66	0.14-0.45	0.26-1.53	1.3-6.1	175-301	257-655
Maharashtra (Nashik)	09	7.81-8.65	0.15-1.73	0.76-1.28	5.9-18.6	181-439	291-918
Maharashtra (Akalkot)	08	7.75-8.80	0.13-0.19	0.30-0.76	4.9-22.7	169-244	330-856
Maharashtra (South Solapur)	09	7.90-8.67	0.09-0.24	0.15-0.59	2.2-11.4	188-238	134-336
Maharashtra (North Solapur)	03	7.35-8.00	0.29-0.55	0.29-0.55	0.5-3.7	244-301	677-1024

Standardization of potting media

A pot trial was conducted to standardize media for raising of pomegranate seedlings. Seven potting media were tested. Data on shoot and root growth, bio-mass partitioning, nutrient content and soil physico-chemical properties were recorded (Table 5). The initial values of pH, EC, OC, $CaCO_3$ and Nitrogen in different potting media ranged from 7.1 - 8.7, 0.25-1.04 dS/m, 0.08-7.50% , 7.5- 42.4% and 37.6- 765.1 kg/ha, respectively. The maximum plant height of 1 year old seedling was 67.7cm with Soil + Vermicompost (1:0.5). Root development was good in all the treatments except Soil+ Sand and Sand alone. Soil + Vermicompost (1:0.5) and Soil + Sand + Vermicompost (1:1:0.5) were at par with respect to root and shoot weight and total bio-mass production (Fig.15 and 16). However, Soil + Sand + Vermicompost (1:1:0.5) proved to be beneficial for raising of pomegranate seedlings.

Fig. 15 : Root and shoot development in pomegranate seedling (a) Soil (b) Soil+ Sand + Vermicompost (1:1:0.5) mixture

Table 5 : Effect of different media on plant growth parameters of 12 month old seedlings.

Treatment	Plant height (cm)	No of roots / plant	Root length (cm)	Root wt. (g)	Shoot wt. (g)	Shoot : root
T1 Soil	43.50	12.33	64.42	04.61	08.09	01.78
T2 Soil + FYM (1:1)	60.19	11.67	55.14	10.23	18.23	01.78
T3 Soil+ Vermi.* (1:0.5)	67.70	11.33	50.75	17.23	26.38	01.53
T4 Soil + Sand (1:1)	37.67	06.08	45.75	04.36	07.59	02.02
T5 Soil + Sand+ FYM (1:1:1)	57.08	11.33	47.00	12.95	17.82	01.39
T6 Soil+ Sand+ Vermi* (1:1:0.5)	59.67	14.50	57.75	13.89	25.43	01.84
T7 Sand	38.50	06.92	41.42	06.89	07.69	01.10
CD (0.05)	06.83	03.76	09.33	03.34	02.39	NS

*vermocompost

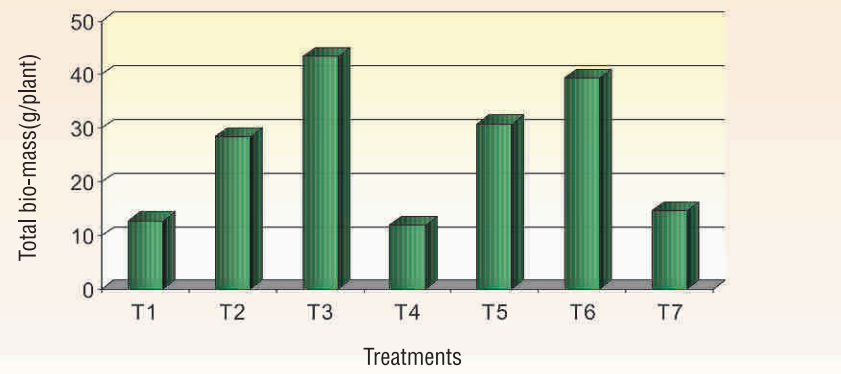


Fig. 16 : Effect of different media on total bio-mass production

Analysis of rainfall at NRCP, Solapur

Rainfall analysis has been done to estimate occurrence of drought based on 37 years data of watershed of Solapur district. Analysis shows that mean annual rainfall of watershed was 712.15 mm with 85 per cent variation. The study reveals that 49 per cent of the years were drought, 39 per cent normal and 12 per cent surplus years implying that there is a likelihood of one drought year in a four years span.

In a period of 37 years, 24 per cent months of monsoon seasons (June - September) were drought months. Probability analysis of drought months indicates that in any year, there are strong chances of occurrence of 9 drought months with 80 per cent probability. It was found that September was the wettest (224.65 mm) month followed by August (162.24 mm). Total annual rainfall shows the peak value of 1295.81 mm and lowest value of 133.24 mm during last 37 years.

Crop Protection

Status of important pomegranate diseases, disorders and insect pests

Survey in major pomegranate growing areas of Maharashtra and Andhra Pradesh were conducted during December 2005 to February 2007 to assess disease scenario in these regions. Bacterial blight was the most prevalent disease and was present in mild to severe form, covering up to 88% in some districts like Solapur. Leaf and fruit spots were also observed to cause severe losses in some orchards. Fruit cracking, internal breakdown of arils and sun scald were important disorders in some areas. Among insect pests, fruit borer and sap sucking pests caused economic losses.

Disease scenario in Maharashtra during December, 2005 to September, 2006

In three major pomegranate growing districts of Maharashtra, on an average 72.6% orchards were affected with bacterial blight. Among them, Solapur was the most affected district. Wilt was found in 53.3% orchards in Nashik, 33.3% in Osmanabad and 33.4% in Solapur. Incidence of fruit and leaf spots was highest in Nashik (66.7%), followed by Solapur (59.1%). Fruit rots were not a major problem, and highest incidence of 12.1% was recorded in Solapur (Fig. 17).

Disease and insect pest scenario in Maharashtra during February 2007

Survey in pomegranate growing areas of Maharashtra was conducted from February 19-22, 2007 by a team of scientists from NRCP, Solapur, IIHR, Bangalore, College of Agriculture, Pune, MPKV, Rahuri and Plant Protection Officers from Karnataka and Maharashtra. The survey programme was co-ordinated by Dr. VT Jadhav, Director NRCP, Solapur. A total of 113 orchards were surveyed in 10 districts of Maharashtra. The surveyed orchards were categorized into four grades.

Diseases

Bacterial blight

Severe attack of bacterial blight was recorded in less than 20% orchards in Solapur and Latur districts. The disease severity was moderate or in traces in rest of the affected orchards (Fig. 18). Ahmednagar and Satara were free from bacterial blight.

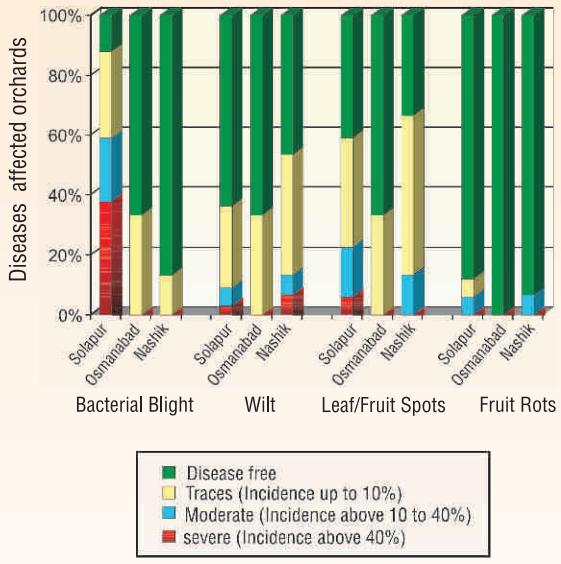


Fig. 17 : Per cent pomegranate orchards affected with different diseases in the three districts of Maharashtra during December, 2005 September, 2006

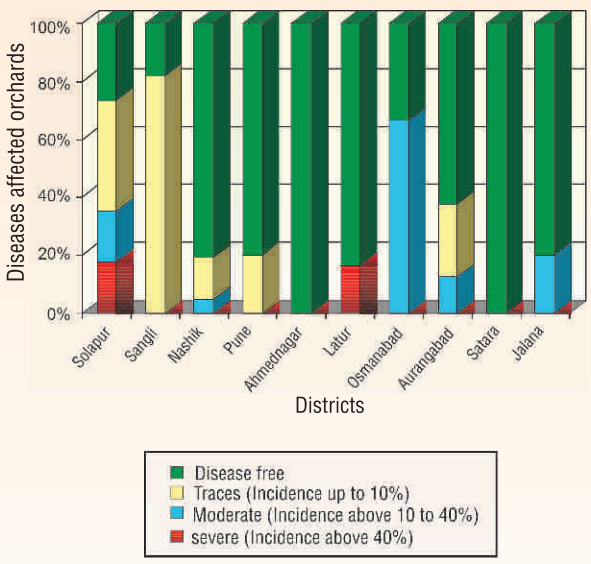


Fig.18 : Per cent pomegranate orchards affected with bacterial blight

It was also observed that severity of bacterial blight was more during rainy season than in winter season crop (Fig. 19). More number of severely and moderately affected orchards and less number of blight free orchards were present in Solapur district during rainy season.

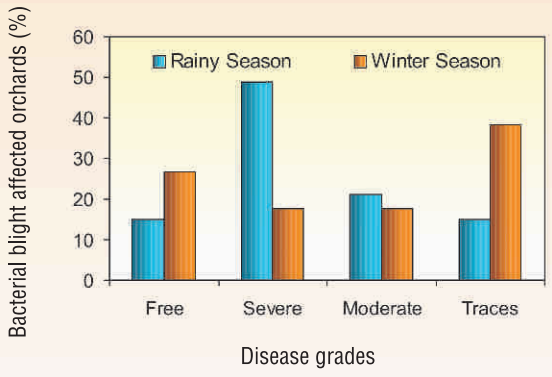


Fig. 19 : Bacterial blight affected orchards in Solapur during rainy season (July- September, 2006) and winters (February 2007)

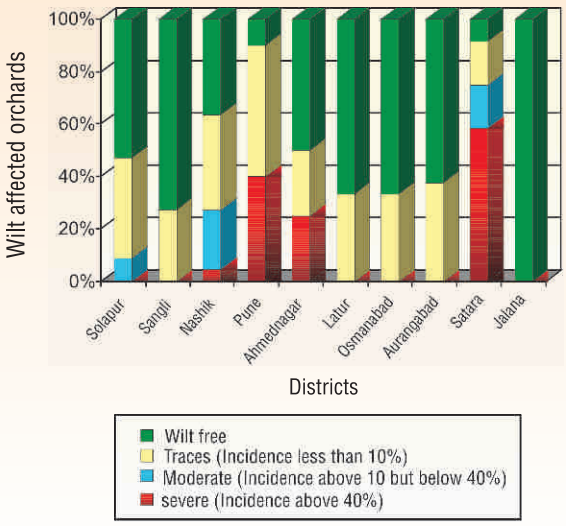


Fig. 20 : Per cent pomegranate orchards affected with wilt

Wilt

In Satara, Pune, Nashik and Ahmednagar wilt was a serious problem with prevalence of 91.7, 90.0, 61.9 and 50%, respectively, out of which 58.3, 40, 4.8 and 25% orchards recorded severe (>40%) incidence. Wilt was not observed in Jalana. In Solapur, 47% orchards were affected with wilt in traces to moderate form, whereas, in rest of the districts it was present in traces (≤ 10% incidence) between 27.3% orchards in Sangli to 37.5% orchards in Aurangabad (Fig. 20). In Maharashtra, on an average 48% orchards were affected, out of which only 8% were severely affected (Fig. 21). During February 2006 to February 2007 wilt was observed to increase by 11.9% in Solapur and 26.42% in Nashik districts (Fig. 22) Abiotic factors were found to affect wilt development. All the cultivars namely Bhagwa, Ganesh, Mridula, Arakta and G 137 were found susceptible to wilt. Wilt infections were predominant on trees of all ages, but were more severe between trees of 2 and 20 years age. Planting distance did not seem to affect wilt severity. Wilt was prevalent in orchards with both minimum spacing of 3.5m x 2 .4.m and wide spacing of 4.5m x 3.5m. Systematic studies are however, to be conducted for further confirmation. In general, wilt infections were prevalent in all soil types. Higher incidence of wilt in Pune, Ahmednagar and Nashik districts could be attributed to pomegranate plantation in deep heavy clay loam to clay soils. Wilt infections were prevalent in crops of all the three major seasons viz. *Ambe, Mrig* and *Hastha Bahar*. The trees undergoing rest period also showed wilt infections in some orchards.

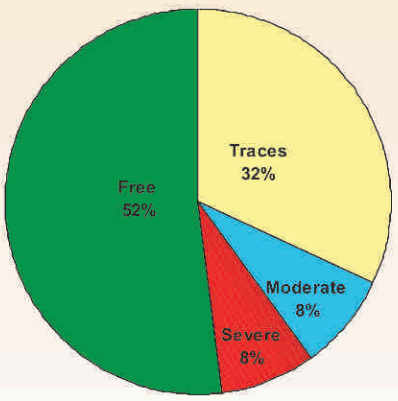


Fig. 21 : Wilt prevalence and severity in Maharashtra

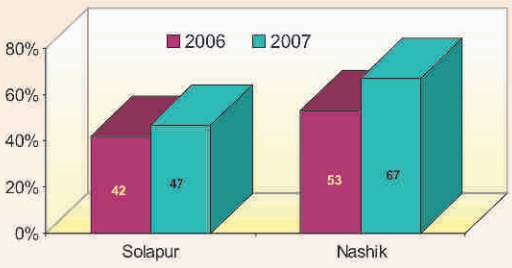


Fig. 22 : Wilt progress in Solapur and Nashik districts during 2006 and 2007

Leaf and fruit spots

All the districts except Jalana recorded leaf and fruit spots due to fungi in traces to moderate forms, though a very low percentage of orchards in Solapur were also affected severely. The disease was present in traces to moderate forms in more than 58% orchards in affected districts. In Ahmednagar, moderate incidence of leaf and fruit spots was recorded in upto 75% orchards. In Pune, incidence was in traces in 60% orchards (Fig. 23 A.).

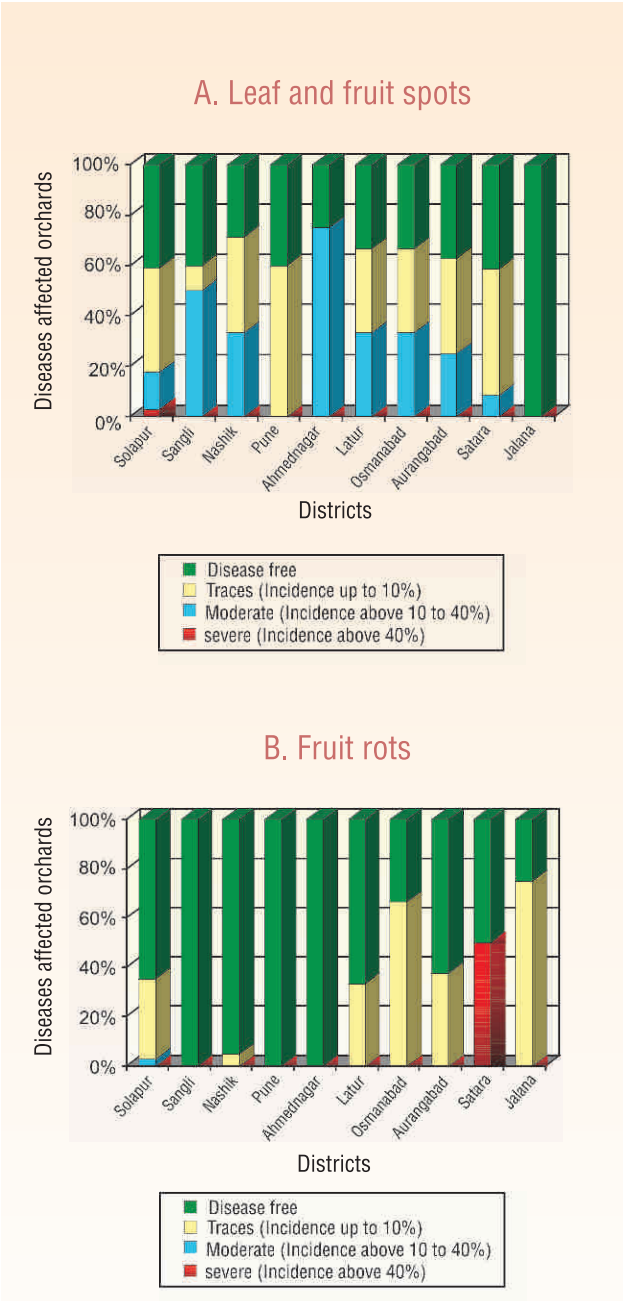


Fig. 23 : Per cent pomegranate orchards affected with leaf/fruit spots and fruit rots

Fruit rots

Orchards in Sangli, Pune and Ahmednagar districts did not show any fruit rot during survey period. The fruit rotting was a serious problem in Satara with 50% orchards recording severe incidence. In Solapur it was present in around 35% orchards, including about 2.5% orchards with moderate incidence. In all other orchards, it was present in traces between 4.8% in Nashik and 75% in Jalana (Fig. 23 B).

Disorders

Internal breakdown of arils

It was a problem in 54.6 % orchards (incidence in traces) in Sangli and 23.8% (trace to moderate incidence) in Solapur (Fig. 24).

Sun scald

Solapur, Sangli and Satara were the only affected districts with sun scald. In Solapur, 61.8% orchards recorded the disorder in traces to severe form. In Sangli, 45.5% orchards had the disorder in traces to Moderate form and in Satara only 8.33% orchards were affected, that to in traces (Fig. 25A).

Fruit cracking

It was serious only in Solapur, Sangli and Satara districts. In Solapur, 58.8% orchards recorded the disorder with only 8.8% orchards affected severely In Sangli, all 63.6% orchards affected had the problem in traces and in Satara, only 8.47% orchards had moderate incidence (Fig.25B).

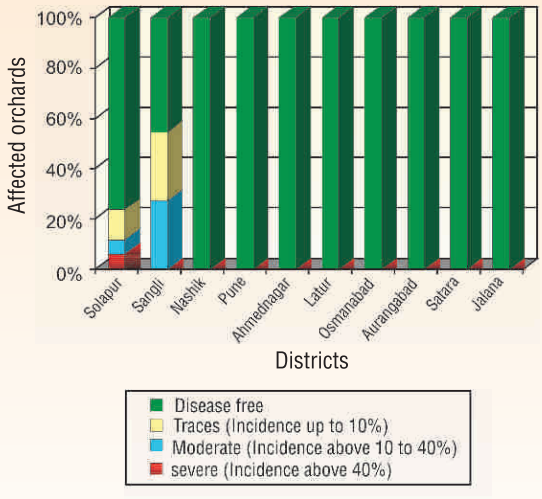


Fig. 24 : Per cent pomegranate orchards affected with internal break down of arils

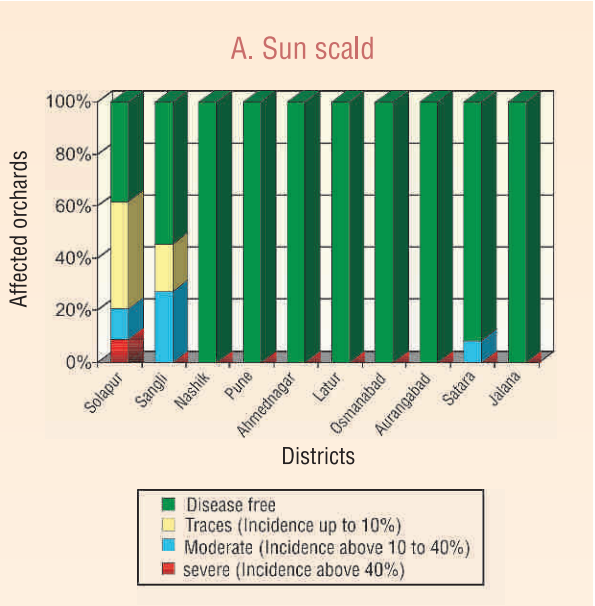


Fig. 25 : Per cent pomegranate orchards affected with sun scald and fruit cracking

Insect pests

Fruit borer

In Osmanabad, 66.7% orchards were infested with fruit borer, though incidence was in traces. Lowest infestation was in Nashik (9.5%) and Ahmednagar was free from this pest (Fig. 26).

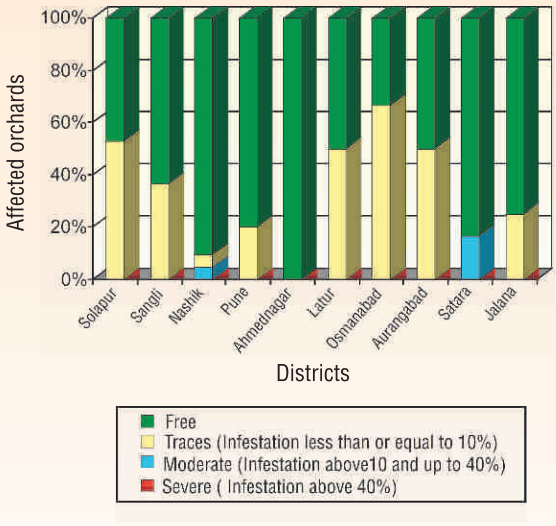


Fig. 26 : Per cent pomegranate orchards affected with fruit borer

Sucking Pests (Aphids, thrips, mites etc)

Sucking pests were the most important pests of pomegranate affecting orchards in almost all areas. All the orchards surveyed in Ahmednagar, Latur, Osmanabad, Aurangabad and Jalana districts were infested with sucking pests having incidence in traces to severe form, In Sangli, sucking pests were prevalent in 90.9% orchards, but incidence was in traces. In other areas prevalence ranged from 41.7% orchards in Satara to 76.7% in Solapur with incidence in traces to severe form (Fig. 27).

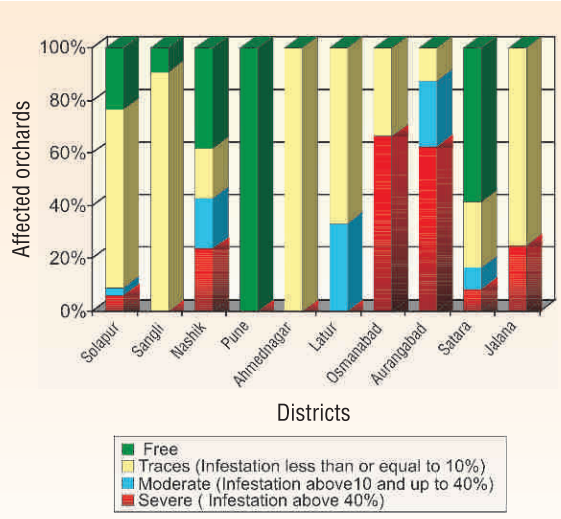


Fig. 27 : Per cent pomegranate orchards affected with sucking pests

Fruit sucking moth

It was not a major problem in most of the areas. Aurangabad had highest prevalence of 33.3%, but incidence was in traces (Fig. 28).

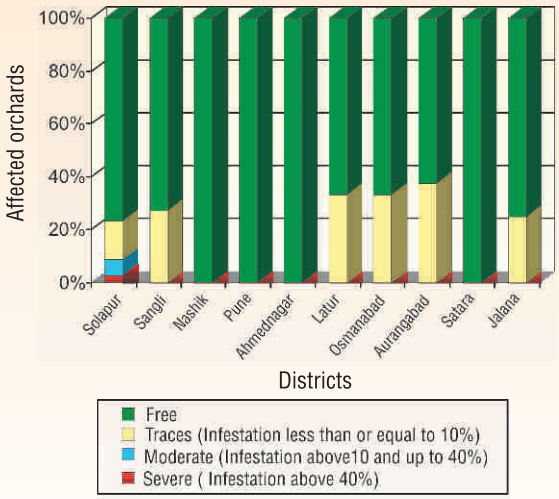


Fig. 28 : Per cent pomegranate orchards affected with fruit sucking moth

Stem borer

It was prevalent in all the orchards surveyed in Jalana but infestation was in traces, Latur, Osmanabad and Satara were free from this insect pest. In all other districts 17.7 to 50% orchards were affected, having incidence mostly in traces (Fig. 29).

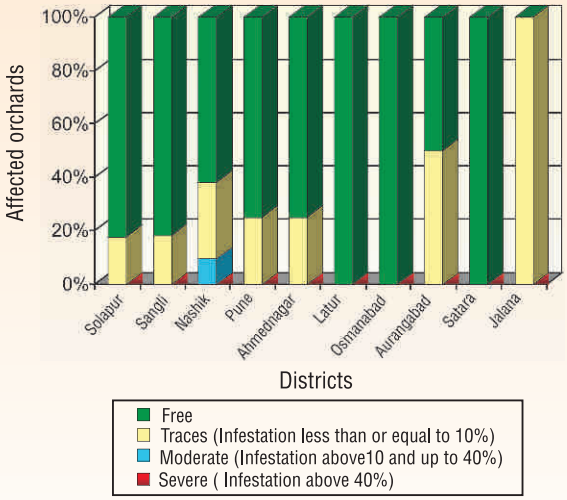


Fig. 29 : Per cent pomegranate orchards affected with stem borer

Shot hole borer

This pest was observed in traces in Solapur, Latur, Osmanabad, Aurangabad and Jalana. In Jalana 100% orchards were affected, whereas in other affected districts infestation was only 8.8 -33.3%. Rest of the districts were free (Fig. 30).

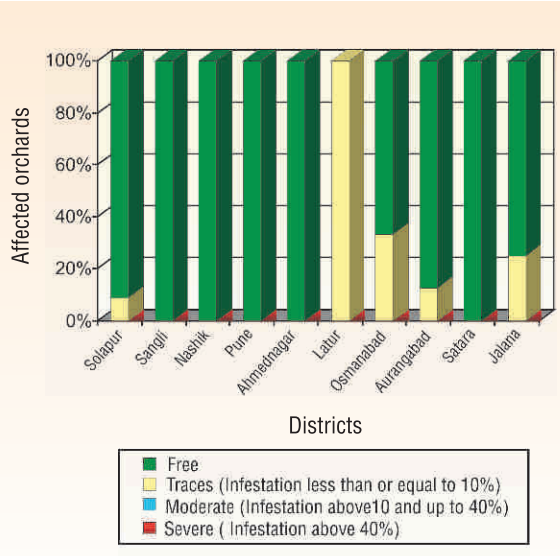


Fig. 30 : Per cent pomegranate orchards affected with shot hole borer

Nematodes

In Solapur, 14.7% orchards were severely affected and in 2.94% orchards, it was in traces. In Sangli, 9.1 % orchards were severely affected. In Nashik and Satara districts, it was present in moderate to trace forms in 14.3 to16.7% orchards (Fig. 31).

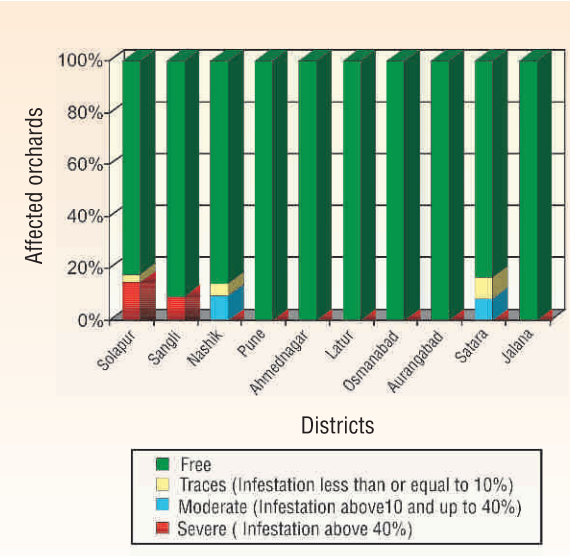


Fig. 31 : Per cent pomegranate orchards affected with nematodes

Disease scenario in Andhra Pradesh

The survey was conducted in Anantpur district of Andhra Pradesh during January - February, 2007. In the 23 orchards surveyed, 13 orchards were free from bacterial blight, 21 from wilt, 11 from fruit spots and 14 from fruit rots. (Table 6).

Table 6 : Pomegranate disease scenario in Andhra Pradesh

Disease	*Orchards affected with disease (%)			
	Severe	Moderate	Trace	Free
Bacterial blight	17.39	21.73	4.34	56.52
Wilt	0	0	8.70	91.30
Leaf and fruit spots	4.34	39.13	8.69	47.82
Fruit rots	4.34	34.78	0.00	60.86

* Calculated over 23 orchards surveyed

Diagnosis of bacterial blight and other diseases

Bacterial blight

Symptoms

Typical bacterial blight symptoms were observed on all the above ground parts of the plant (Fig.32). Spots were observed on some roots of infected plant, however, more studies are required to confirm this.

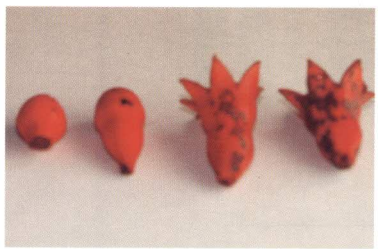


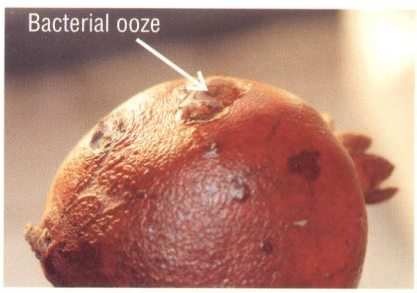
Fig. 32 : Symptoms of bacterial blight on above ground parts of plant

Ooze test

Preliminary diagnosis of bacterial blight disease of pomegranate was done with Field and Laboratory ooze tests (Fig.33). This is a preliminary test confirming bacterial infection.

Field ooze test

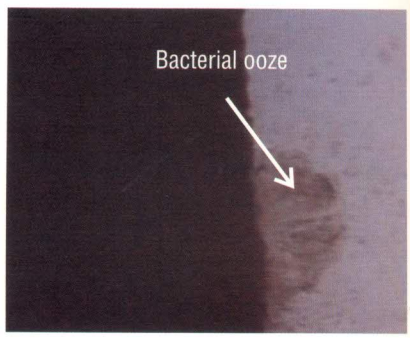
A thick sticky turbid liquid (bacterial ooze) was observed when a water drop was placed on a bacterial blight spot on fresh fruit and left undisturbed and covered with a beaker for an hour. This ooze was not seen on fungal spots. This test can be easily done by farmers to identify the disease and plan their spray schedule.



Field ooze test

Laboratory ooze test

A cloud like bacterial ooze was seen coming out, when a thin section taken from the intersection of necrotic and healthy tissue was kept on a microscopic slide, in a drop of water and covered with a micro cover slip, and observed under the microscope.



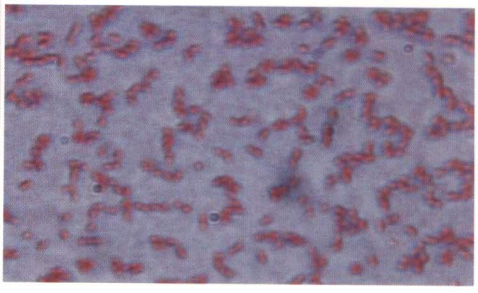
Laboratory ooze test

Fig 33 : Diagnostic tests for bacterial blight

Isolations

Nutrient Glucose Agar, Yeast Dextrose Carbonate Agar were used to Isolate bacterial blight pathogen from diseased tissues. Isolations resulted in shining yellow colonies. Twenty four single colony isolates were maintained in pure culture. Among 24 bacterial isolates from bacterial blight affected leaves, twigs and fruits collected from different localities, colony characters of 13 isolates resembled *Xanthomonas* and rest 11 were other shades of yellow (Fig. 34A). Gram stain test (Fig. 34B) confirmed their gram negative character. KOH test confirmed formation of mucous around the cells, as well as confirmed gram negative character of the pathogen.

A : Bacterial blight isolates



B : Gram negative bacteria of bacterial blight pathogen in gram stain

Fig. 34 : Bacterial blight pathogen (*Xanthomonas axonopodis pv. punicae*) in culture and under microscope

Difference between oily spot and Cercospora Spot

The bacterial blight symptoms, specially on fruits, are often confused with Cercospora spots. The differences were studied and are being tabulated below (Fig. 35).

Symptoms	Cercospora Spots	Oily Spots
Leaf Spots	1. Reddish brown irregular	1. Dark brown to black regular to irregular
	2. Smaller and numerous (few-50 spots)	2. Larger and fewer (14-15, usually 4-6).
Fruit Spots	1. Irregular dark black without cracks	1. Irregular brown- black with small L-Y shaped cracks or fruit splitting.
	2. Individual spots distinct even when they lie close together	2. Several spots coalesce to form larger spots.

Fig. 35 : Differentiating symptoms of Cercospora spots (a and c) and Bacterial Blight (b and d)

Pathogenicity of bacterial blight isolate

Pathogenicity tests on detached leaves

Blight symptoms were observed on abaxial surface of inoculated leaf of cv. Ganesh on 3rd day after inoculation and later along midrib.

Pathogenicity tests on detached twigs

Bacterial inoculum was sprayed on detached twigs, kept in flask with water and then covered with polythene. Symptoms were observed on 8th day after inoculation.

Pathogenicity tests on detached fruits

In pathogenicity tests with 11 bacterial blight isolates, black lesions were produced on small fruits (lemon size), however, these did not produce ooze hence, need to be repeated.

Pathogenisity tests on potted plants

Two bacterial blight isolates 1-OS-F and 2-OS-F were inoculated on 8 month old potted plants of cv. Bhagwa using pin prick method. Typical blight symptoms (Fig. 36) started appearing after 25 days and severity continued to increase with time. The test confirmed etiology of the disease.

Fig. 36 : Bacterial blight symptoms produced in pathogenicity test on potted plants

Wilt

External symptoms

The wilted plants showed yellowing of leaves in some twigs or branches in partially wilted (Fig. 37.b) plants, followed by drooping and drying of leaves. In completely wilted plants the entire tree died with dried fruits hanging on the tree. In many orchards diseased trees were observed dying in patches (Fig. 37.a), thereby, indicating the spread of disease from tree to tree. However, in some orchards wilt infected plants were not at one place but were spotted unevenly at different locations. In some cases tree developed wilt symptoms suddenly and died quickly within a few weeks. Sudden wilting of the trees was normally observed during the fresh flowering and fruiting stage of the tree, when the entire tree died within a short period. Root rotting also resulted in symptoms of wilting, because of destruction of feeder roots.

Internal symptoms

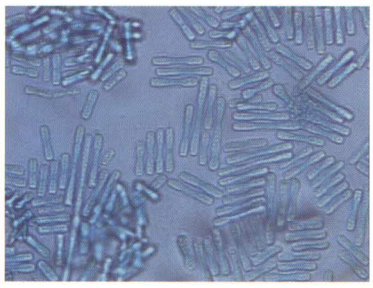
Cross and longitudinal section of infected wood in some samples showed dark grayish brown discolouration of wood (Fig. 37.c and d). Isolation from such samples resulted in *Ceratocystis fimbriata*

Fig 37 : Wilt symptoms (a) severely wilt infected trees in patches (b) partially wilt infected tree (c and d) vascular discolouration in cross and longitudinal sections of wilted stem

Isolations

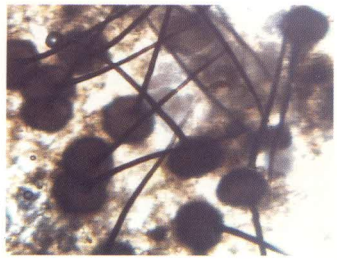
PDA, Carrot agar and fresh carrot pieces were used for isolations from wilted plants (stems, roots and rhizoplane soil). Ceratocystis was isolated from 11 out of 17 samples collected from Solapur and Nashik. The isolates were maintained in pure culture (Fig. 38). Isolations on agar media from wilted plants also resulted in isolates of Phytrophthora, Rhizoctonia solani, Macrophomina and Fusarium sp.(Fig. 39).

Endoconidia



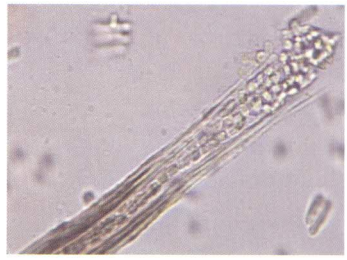
Ellipsoidalconidia

Aleroconidia



Perithesia with long necks

Neck with Ascospores oozing out



Ascospores (x 1000)

Fig. 38 : Propagules of *Ceratocystis fimbriata* in culture as seen under microscope

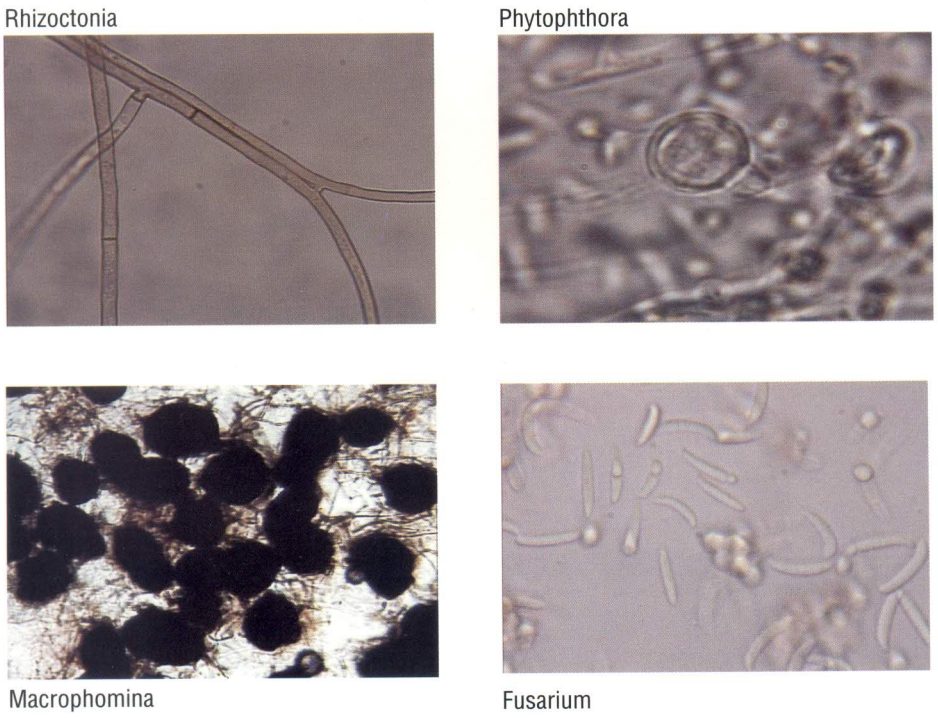
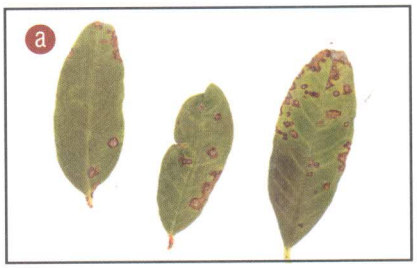


Fig. 39: Isolates from roots of wilted plants from different locations

Leaf and fruit spots

Forty two fungal isolates were collected from 8 types of fruit and 4 types of leaf spots from different localities (Fig. 40, 41, 42 and 43). Species of *Cercospora punicae*, *Colletotrichum* sp, *Dreschslera rostrata, Alternaria alternata, Pestalotia* sp. *Pseudobeltrania, Aspergillus niger* and some unidentified genera were found associated with leaf and fruit spots.



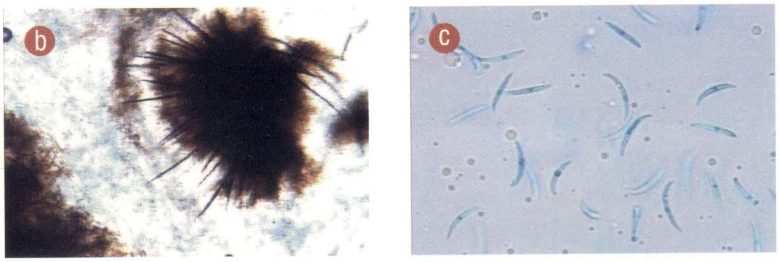


Fig. 40 : *Colletotrichum* (a) leaf spots (b) leaf isolate Acervuli with setae and (c) Conidia (1000x) in culture (d) Fruit spots (e) conidia of fruit isolate *C. gloeosporioides*

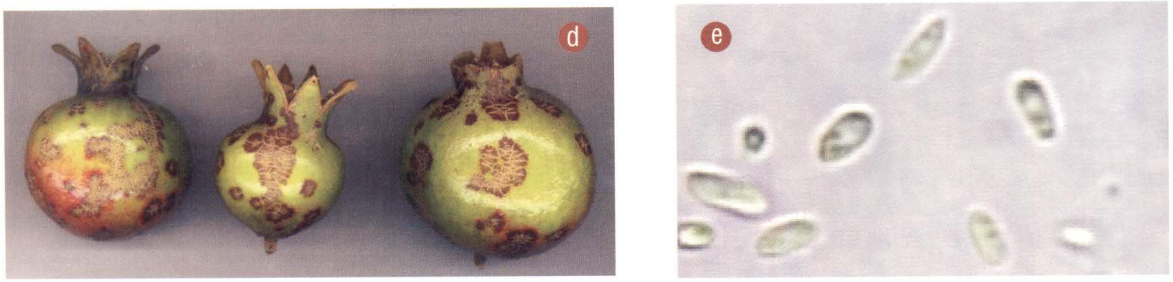


Fig. 41 : (a) Alternaria spots on leaves and (b) Fungus in culture

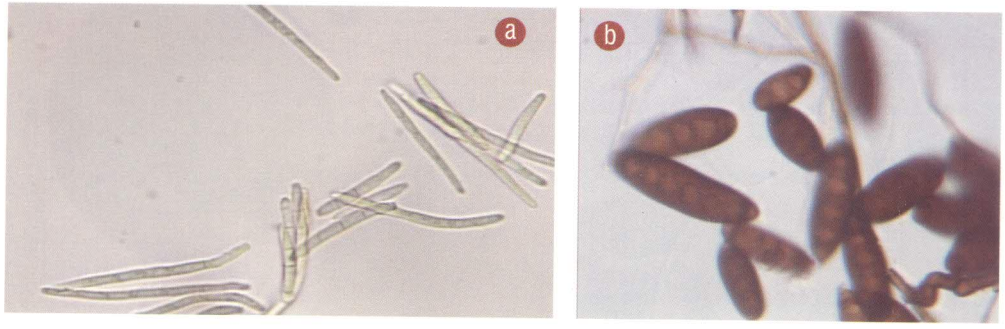


Fig. 42 : Conidia of (a) *Cercospora* and (b) *Drechslera rostrata* from fruit spots

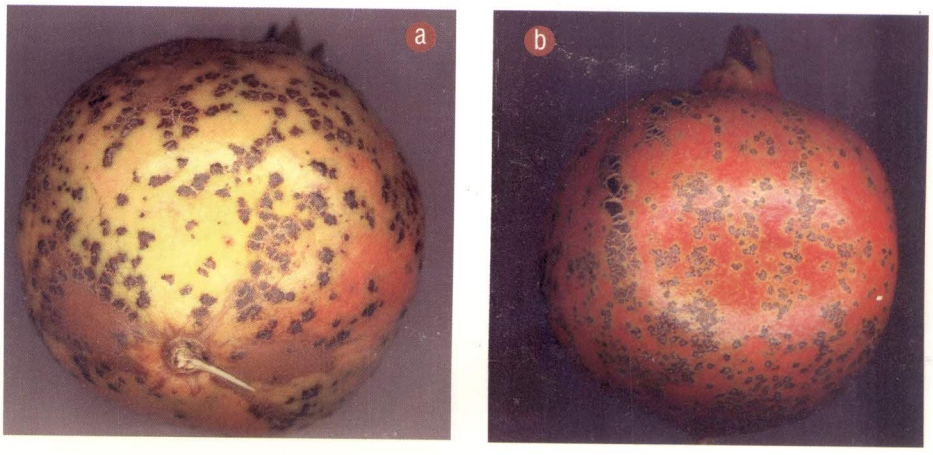


Fig. 43 : Pomegranate (a) Scab ((b) Dreschlera Spots on Fruits

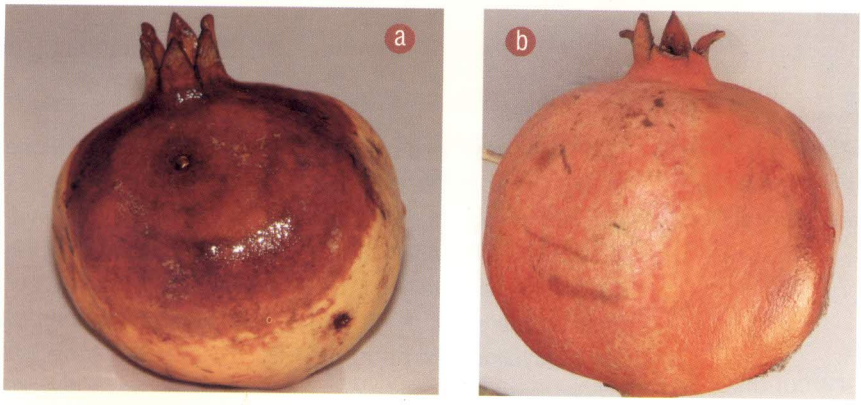


Fig. 44 : (a) Dry reddish brown fruit rot due to *Colletotrichum gloeosporioides* (b) Wet fruit rot due to *Aspergillus/Penicillium* spp.

Fruit rots

Seven fungal isolates collected from dry and wet fruit rots were species of *Colletotrichum, Fusarium, Penicillium, Aspergillus* and an unidentified isolate (Fig. 44).

Fruit Disorders

Isolations from arils affected with internal breakdown resulted in 2 species of *Aspergillus*, 1 *of Penicillium* and 1unidentified genera (Fig. 45 and 46).

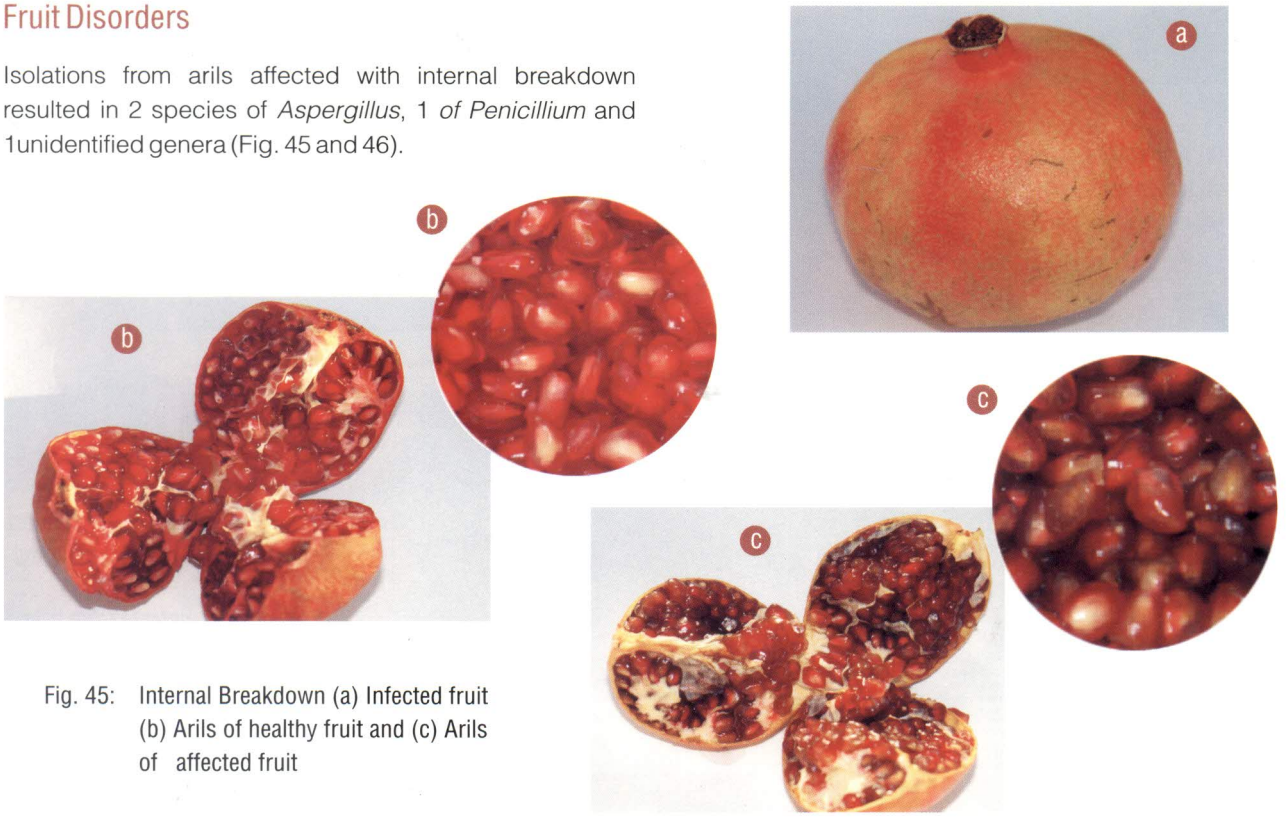


Fig. 45: Internal Breakdown (a) Infected fruit (b) Arils of healthy fruit and (c) Arils of affected fruit

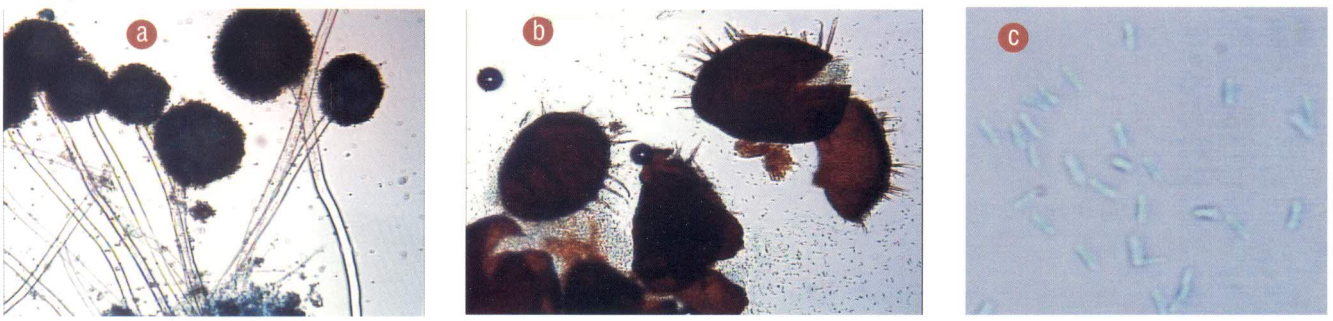


Fig. 46: Fungal isolates from internal breakdown (a) *Aspergillus* (b & c) Unidentified isolate

Epidemiology of bacterial blight

The disease was observed throughout the year in temperature range of 6-42° C and with higher intensity during rainy season, indicating thereby that high humidity, rains and temperatures between 25-35°C are required for its development and spread.

Control of bacterial blight

Screening of antibiotics under laboratory conditions

Four antibiotics Streptocycline, Bactronol, Bactrinashak and Pronopol, were tested at 100, 250 and 500 ppm, with poisoned food technique. The growth of pathogen was inhibited at all the 3 concentrations tested *in vitro*.

Efficacy of spray schedules on the management of bacterial blight

The experiment was carried out at grower's field at Mohol during October, 2006 to January, 2007. Four sprays of 9 different spray schedules were given at 20 days interval, starting from October 18, 2006. Efficacy of different spray schedules was evaluated by recording disease severity on fruits in January, 2007. Spray schedule consisting of Streptocycline (500 ppm) + Bavistin (0.2%), Streptocycline (750 ppm) + Bavistin (0.2%) and Streptocycline (500 ppm) alone, were at par and provided ≥ 50% control of blight. Spray schedules with Bactronol were less effective.

Agricultural Extension and Transfer of Technology

Meeting with pomegranate growers

One day meeting of pomegranate growers association and farmers was arranged at the centre in January, 2006. Lectures were delivered by the Scientists of the centre and interactions among growers, technical directors and scientists were held.

Farmers' visit

Farmers from Maharashtra, Karnataka and Andhra Pradesh visited the centre and interacted with the scientists of different disciplines. Information on crop production, crop protection and soil and water conservation measures was provided to them.

Kisan gosthi

Our newly established centre organized *Kisan Gosthi* (Fig. 47) on September 25, 2006, on the eve of first foundation day. Dr. V.D. Patil, Director, Horticulture, Govt. of Maharashtra was the chief guest and Dr. Iresh Swami, VC, Solapur University (MS) presided over the function. Dr. K.H. Govindraj, Collector, Solapur, Mr. Prabhakar Chandane, President, Pomegranate Growers Association and Mr. Viswasrao Kachare, progressive farmer were the guests of honour. More than 150 farmers, scientists from MPKV Centre, KVK, CRS (NRCS), Solapur, etc. attended the function. Lectures on various aspects of pomegranate cultivation and protection were delivered for quality production followed by valedictory function. Folders on bacterial blight and wilt management in vernacular and technical bulletin in English were distributed for the benefit of the farmers.

Fig. 47 : Dignitaries and Farmers at a Kisan Gosthi organized by NRCP, Solapur

On Farm Visits

Scientists of the centre made visits to different pomegranate orchards in Maharashtra, Andhra Pradesh and Karnataka during the year to assess and solve the problems of the farmers. Technological information on pomegranate cultivation, soil and water conservation, disease and insect pest and post harvest management was provided to the growers for quality production and fruit utilization (Fig. 48 and 49).

Fig. 48: Scientists visit an orchard in Nashik

Fig. 49 : Meeting of scientists from NRCP, Solapur with Progressive pomegranate growers and officers of Horticulture Department in Andhra Pradesh

Visit of scientific groups and personalities

Dignitaries of ICAR, State Departments and SAUs met at several high level meetings organized by the centre to discuss losses caused due to bacterial blight and finalize the strategies to combat the disease (Fig. 50 and 51).

Fig. 50 : Dr. Mangala Rai, DG, ICAR at a high level meeting on bacterial blight held at Pune

Fig. 51 : Visit of DG, ICAR and other dignitaries to a pomegranate orchard in Solapur

Transfer of technology through media

Proper media coverage on various aspects of pomegranate cultivation was regularly given through local newspapers, television channels and magazines to promote pomegranate cultivation in traditional and non-traditional areas.

Management of pomegranate diseases

Many farmers and government officials visited plant pathology laboratory and they were guided to follow clean cultivation, proper orchard sanitation measures and recommended spray schedules to combat bacterial blight, wilt, leaf and fruit spot and other diseases.

Imparting training organized by Government, Semi Government and Non Government organizations

Scientists of this centre were invited by various R&D organizations to deliver lectures and impart training on orchard management and disease and insect pest management throughout the year.

Publications

Papers presented in Symposia, Conferences, etc.

Marathe RA, Chandra R and Kumar P. 2006. Soil types and micronutrient status of pomegranate orchards of Nashik region of Maharashtra. In: *National symposium on improving input use efficiency in Horticulture* held from August 9 -11, 2006 at IIHR, Bangalore. pp174-175.

Chandra R, Marathe RA and Kumar P. 2006. Present status of Pomegranate and its scope for crop diversification in arid and semi-arid region of Maharashtra. In: *National symposium on Agro-forestry for livelihood security environment protection and biofuel production* held from December 23- 25, 2006 at NRC for Agro-forestry, Jhansi. pp77-78.

Meshram DT, Chandra R and Jadhav VT. 2007. Drought estimation through rainfall analysis of Solapur District of Maharashtra State. In: *UGC sponsored National Seminar on Eco-friendly intervention in drought prone region* held from March 23-24, 2007 at Walchand College of Art and Science, Solapur.

Sharma KK, Jyotsana Sharma and Kumar P. 2006. Prevalence of important diseases of pomegranate and their impact on crop cultivation. In: *National symposium on Recent trends in diagnosis and management of chronic and emerging plant diseases* held from November.23-24, 2006 at CICR, Nagpur. pp 46-47.

Books and Chapters

Kumar P and Chandra R. 2006: *Annotated Bibliography of Pomegranate.*1966-2006, Publ. NRCP, Solapur. 263 pages.

Bulletin and Pamphlets

Kumar P and Chandra R. 2006. *NRCP at a Glance, NRCP, Solapur*, 16 pages.

Sharma KK, Jyotsana Sharma and Kumar P. 2006. *Important Diseases, Disorders and Insect-Pests of Pomegranate and their Management. Tech. Bull. 1.* Publ. NRCP, Solapur. 16 pages.

Sharma KK, Jyotsana Sharma and Kumar P. 2006. *Bacterial Blight (Oily Spot) of Pomegranate, Symptoms and Management Practices.* Publ. NRCP, Solapur, (English).

Sharma KK, Jyotsana Sharma and Kumar P. 2006. *Wilt of Pomegranate, Symptoms and Management Practices.* Publ. NRCP, Solapur, (English).

Sharma KK, Jyotsana Sharma, Kumar P and Marathe RA. 2006. *Dalimbavaril Bacterial Blight (Taliya) Rogacha Pradurbhav wa Upayayojana.* Publ. NRCP, Solapur, (Marathi).

Sharma KK, Jyotsana Sharma, Kumar P and Marathe RA. 2006. *Dalimbavaril Mar Rogacha Pradurbhav wa Upayayojana.* Publ. NRCP, Solapur. (Marathi).

Research Programmes and Projects

Project Title	Project Investigator (PI) and Associates
Survey, collection, evaluation, propagation and improvement of pomegranate	Dr. Ram Chandra (PI) Dr. R. A. Marathe Dr. (Mrs.) Jyotsana Sharma Dr. P. Kumar Mr. D.T. Meshram
Identification of suitable soils for sustained production and productivity of pomegranate	Dr. R.A. Marathe(PI) Dr. Ram Chandra Dr. P. Kumar
Pomegranate (*Punica granatum* L.) water requirement in Semi-Arid Region.	Mr. D. T. Meshram (PI) Dr. Ram Chandra Dr. R.A. Marathe Dr. V.T. Jadhav
Etiology, epidemiology and management of wilt of pomegranate	Dr. K.K. Sharma (PI) Dr. (Mrs.) Jyotsana Sharma Dr. V.T. Jadhav
Studies on economically important diseases of pomegranate with special emphasis on bacterial blight and their control	Dr. (Mrs.) Jyotsana Sharma (PI) Dr. K.K. Sharma Dr. V.T. Jadhav

RAC, IMC AND SRC Decisions

First Research Advisory Committee (RAC) Meeting, 2006

The first RAC Meeting of NRCP, Solapur was held on November 15, 2006 at Krishi Anusandhan Bhawan II, ICAR, New Delhi to review the ongoing research programmes and formulate the future line of research work. The meeting was attended by Dr. G. Kalloo, DDG (Hort.) as a special invitee, Dr S.N. Rao, Chairman, RAC and other members namely Dr. R.P. Kachru, Ex-ADG (Process. Engg.), Dr. D.M. Sawant, Associate Dean (Plant Pathology), College of Agriculture, Kolhapur, Dr. D.P. Waskar, Head, Division of Horticulture, MAU, Parbhani, Dr. P. Kumar, Director, NRCP, Shri Prabhakar Chandane, President, Pomegranate Growers' Association, India and Dr. K.K. Sharma, Senior Scientist (Plant Pathology), Member Secretary. Dr. Umesh Srivastava, Principal Scientist (Horticulture), ICAR also participated in the meeting. The following recommendations were made.

Research Advisory Committee

Chairman

Dr. S.N. Rao

Members

Dr. R.P. Kachru

Dr. D.M. Sawant

Dr. G.C. Srivastava

Dr. D.P. Waskar

Shri Prabhakar Chandane

Shri Vishvasrao Kachare

Member Secretary

Dr. K.K. Sharma
Sr. Scientist

Recommendations of first RAC meeting

- Maps of important diseases like bacterial blight and wilt be developed for each district.
- To harness potential of genetic resources of pomegranate related species and genera should be collected. The material should include root stock, scion, variety and wild accessions. Seedling selection should be experimented as much as possible from all the important cultivars for generating heterozygosity.
- Studies pertaining to standardization of soil substrate to achieve maximum yields and disease free produce should be conducted.
- Orchard should have microprocessor based drip irrigation system to study the water requirement of plants. Efforts should be made to use existing wells for drip irrigation purpose.
- As the plant is prone to wind breakage, planting of wind breaks around the orchard would be beneficial.

- Fruit maturity indices in respect of different areas be studied for forecasting time of harvest.
- Post Harvest Technology for value addition, mechanized harvesting, grading, peeling and extraction of arils and preparation of juice.
- Front Line Demonstration at research farm where only latest technology for achieving maximum flowering, fruiting, and production can be demonstrated.
- Research methodology for quarantine certified nurseries be developed to ensure availability of disease free planting material.
- NRCP, Solapur should act as a Global Repository of Pomegranate Germplasm.

Second RAC Meeting, 2007

The second meeting of the RAC of NRCP was held on February 8-9, 2007 at NRCP, Solapur under the Chairmanship of Dr S.N. Rao, former Director of Research, Acharya N.G. Ranga Agricultural University, Hyderabad. Dr R.P.Kachru, Former ADG (Procss. Engg), ICAR, New Delhi, Dr G.C. Srivastava, Principal Scientist (Plant Physiology), IARI, New Delhi, Dr D.P. Waskar (Horticulture), Head, Department of Horticulture, MAU, Parbhani, Dr. K.K. Sharma, Senior Scientist (Plant Pathology), Member Secretary. Shri Prabhakar Chandane, President Pomegranate Growers Association, Pune, Shri Vishvasrao Kachare, Progressive Grower, Mohol, Solapur attended the meeting (Fig. 52). On February 8, 2007, the Chairman and the Committee members along with the Scientists of the centre visited many orchards located in Solapur district to apprise themselves of various problems associated with pomegranate cultivation (Fig. 53). After field visit and discussion, the following recommendations were made.

Research Advisory Committee

Chairman

Dr. S.N. Rao

Members

Dr. R.P. Kachru
Dr. D.M. Sawant
Dr. G.C. Srivastava
Dr. D.P. Waskar
Shri Prabhakar Chandane
Shri Vishvasrao Kachare

Member Secretary

Dr. K.K. Sharma
Sr. Scientist

Fig. 52 : RAC Members and Scientists interacting with Press Reporters at Second RAC Meeting held at NRCP, Solapur

Fig. 53 : RAC members in a growers orchard at Hiraj, Solapur

Recommendations of second RAC meeting

- Studies on selection of elite rootstocks for cultivation of local promising cultivars like Bhagwa be carried out.
- Related genera and species should be collected for breeding high yielding and disease resistant varieties.
- Development of transgenics should be one of the project lines.
- Pomegranate branches are brittle and easily break, so wind breaks are required to be planted. They also agreed to the plantation of Karaunda (*Carissa carandas*) at NRCP, Solapur.
- Experiments on training of trees prior to bearing be also carried out to study the influence of training on yield and fruit quality.
- The centre should develop a protocol with regard to different unit operations and complete value chain of pomegranate from beginning to end be developed.
- Market problem needs to be solved so that growers could sell their produce at remunerative price.
- Work on water requirement during different stages be conducted. Production / unit cost of different inputs be calculated. Units could be of water, electric power, fertilizer land etc.
- Work on canopy optimization be done. Canopy analyzers should be used to analyse canopy for optimum yields.
- For NPK requirements, it is essential to develop colour charts so that fertilizers could be applied.
- Studies should be carried out to ascertain optimum level of pruning to achieve better yield and quality
- New molecules may be tested against bacterial blight pathogen for effective disease management.
- It was felt necessary to exploit different bio-agents in pomegranate productivity.
- It was agreed upon by the Committee to adopt blight affected orchard of Shri. Dongare at Hiraj for its rejuvenation and also for conducting other trials.
- Pruning for training of pomegranate at initial stages for proper shape and form of trees should be standardized.
- Species and varieties available especially in temperate regions of Iran may be got procured. Commercial varieties which are very popular in Europe may be introduced from Turkey.
- Survey of mutants in the farmers orchards and induction of new varieties by gamma irradiation be taken up.
- Since air layers are taken from old orchards before they are grubbed out, so enough care may be taken for not spreading the disease (nodal blight) through planting material.

Management Committee (MC) Meeting

The first Management Committee meeting of NRCP was held on February 2, 2006 under the Chairmanship of Dr. P. Kumar, Director (Officiating), NRCP, Solapur. Dr. M.S. Raut, Head, Rabi Sorghum Regional Research Centre, Solapur, Dr. S.D. Sawant, Sr. Scientist, Plant Pathology, NRC for Grapes, Pune, Dr. K.K. Sharma, Sr. Scientist, Plant Pathology, Dr. Ram Chandra, Pr. Scientist, Horticulture and Shri. T. Ashok Kumar, AAO, NRCP attended the meeting. Various issues related to the centre such as budget position and expenditure, major and minor works, purchase of vehicle, engagement of security guards, telephone connections, purchase of equipments / store and replacement items, appointment of authorised medical attendant/recognition of hospitals/pathological laboratories, creation of post of AF&AO, redeployment of Scientist (Soil and Water Conservation Agricultural Engineering), cadre strength and revision of SFC were discussed.

The Second Management Committee meeting was held on 10.10.2006. The meeting was conducted under the Chairmanship of Dr. P. Kumar, Director (Officiating), NRCP,

Solapur. Dr. M.S. Raut, Head, Rabi Sorghum Regional Research Centre, Solapur, Dr. S.D. Sawant , Sr. Scientist, NRC for Grapes, Pune, Dr. Ram Chandra, Pr. Scientist, NRCP, Solapur, Shri Prabhaksr Chandane and Shri Vishwasrao Kachare, Progressive farmers, Solapur, Shri R.K. Singh, FAO, CIRCOT, Mumbai, Shri T.Ashok Kumar, AAO and Dr. K.K. Sharma, Sr. Scientist, NRCP, Solapur and Shri A.S. Murthy, AF&AO, NRC for Grapes, Pune attended the meeting. Some vital issues pertaining to the centre like laying of pipeline for irrigation, purchase of vehicle, change of equipments/ instruments, creation of AF&AO post, field trial at farmer's field and dispute of land of Hiraj farm of NRCP were discussed.

Management Committee

Chairman

Dr. P. Kumar, Director (Officiating), NRCP, Solapur

Members

Dr. S.N. Pandey, ADG (Hort.), ICAR, N. Delhi

Director of Horticulture, Maharashtra

Mr. M. Jagdish, Director of Horticulture, Karnataka

Dr. A.L. Pharande, Professor, Agriculture Chemistry and Soil science, MPKV, Rahuri

Dr. M.S. Raut Head, CRS (NRCS), Solapur

Dr. Ram Chandra, Pr. Scientist, Horticulture, NRCP, Solapur

Dr. S.D. Sawant Sr. Scientist, Plant Pathology, NRCG, Pune

Dr. V.J. Shivankar, Pr. Scientist, Agri. Entomology, NRC for Citrus, Nagpur

Shri Prabhakar Chandane, President, Pomegranate Growers' Association, Pune

Shri Vishwasrao Kachare , Progressive Farmer, Mohol, Solapur

Shri R.K. Singh, Finance and Account Officer, CIRCOT, Mumbai

Member Secretary

Shri T. Ashok Kumar, AAO, NRCP, Solapur

Staff Research Council (SRC)

The first Staff Research Council meeting was held on June 28, 2006 at NRCP, Solapur to finalize research projects and the technical programmers for the ensuing year 2006-07. There were only five research projects presented and all were approved. The Chairman emphasized that the scientists should solve the major problems of the pomegranate growers. It was also decided that pomegranate repository be established at the centre which could include native and exotic collections for further utilization in crop improvement programme.

Staff Research Council

Chairman

Dr. P. Kumar, Director (Officiating)

Member

All scientists of the centre

Member Secretary

Dr. Ram Chandra, Pr. Scientist (Horticulture)

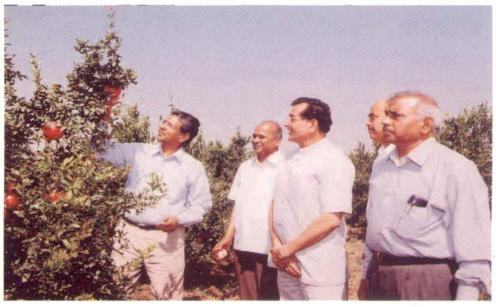
Meetings, Conferences, Seminars, etc.

	Name of meeting /conference /Seminar, etc.	Venue and date	Name of participant/s
1	Technical Committee of the State Pomegranate Growers Association , Pune	NRCP, Solapur on January 31, 2006	Drs. P. Kumar, K.K. Sharma, Ram Chandra and R.A. Marathe
2	National Conference on Microbial Technology for Sustainable Agriculture	Dayanand College of Arts and Science, Solapur (MS) from January 23 -24, 2006	Drs. P. Kumar and K.K. Sharma
3	Farmer's Training Programme on Pomegranate	Draksh Bhavan, Sri. Siddheshwar Market Yard Solapur on February 25, 2006	Drs. K.K. Sharma and R.A. Marathe
4	Meeting of Andhra Pradesh Pomegranate Growers Association	Gadwal, Mehboobnagar, Andhra Pradesh on March 5, 2006	Drs. P. Kumar and K.K. Sharma
5	State Level Seminar on Pomegranate Production, Export Problems and its Pre- requirement	Deola Distt. Nashik on April 2, 2006	Drs. P. Kumar and K.K. Sharma
6	Meeting organized by the Director Horticulture, Maharashtra, Pune	College of Agriculture, Pune on July 25, 2006	Dr. K.K. Sharma
7	Meeting of Pomegranate Research Workers and Growers	Shakkar Sankul, Pune on January 20, 2007	Drs. V.T. Jadhav., P. Kumar, K.K. Sharma and Jyotsana Sharma
8	Training Programme in Arid Horticulture on Management of Bacterial Blight Disease	MPKVV, Rahuri on December 30, 2007	Dr. K.K. Sharma

	Name of meeting /conference /Seminar, etc.	Venue and date	Name of participant/s
9	NAIP meeting	NBSSLUP, Nagpur, on September 26, 2006	Dr. K.K. Sharma
10	Technical Meeting Organized by the Maharashtra State on Pomegranate Research Studies in India	Pomegranate Growers Association, Pune on September 29, 2006	Dr. K.K. Sharma
11	National Symposium on Improving Input use Efficiency in Horticulture	IIHR, Bangalore, from August 9 -11, 2006	Drs. P. Kumar, Jyotsana Sharma and R.A. Marathe
12	National Symposium on Agro-Forestry for Livelihood Security Environment Protection and Biofuel Production	NRC for Agro-forestry, Jhansi from December 23- 25, 2006	Drs. P. Kumar and Ram Chandra,
13	National Seminar on Eco-friendly Intervention in Drought Prone Region sponsored by UGC	Walchand College of Art and Science, Solapur from March 23-24, 2007	Er. D.T. Meshram
14	National Symposium on Recent Trends in Diagnosis and Management of Chronic and Emerging Plant Diseases Organized by Indian Phytopathological Society, West Zone	CICR, Nagpur from November 23-24, 2006	Dr. K.K. Sharma
15	Pomegranate Growers Association Mela	MAU, Malegaon on December 27, 2006	Dr. V.T. Jadhav
16	Residue Monitoring system	APEDA, Pune on December 28, 2006	Dr. V.T. Jadhav
17	Transmission and Epidemiology of Bacterial Blight of Pomegranate	MAU, Parbhani from January 26-27, 2007	Dr. V.T. Jadhav
18	Interactive Workshop to Combat Oily Spot Disease	FAMNICOM, Pune on February 23, 2007	Dr. V.T. Jadhav
19	Survey of Pomegranate disease and insect pests	FAMNICOM, Pune on February 24, 2007	Dr. V.T. Jadhav
20	Pomegranate Growers Meeting	MAU KVK, Tuljapur on March 16, 2007	Dr. V.T. Jadhav
21	Meeting of National Horticulture Mission and District Level Workshop on Pomegranate Bacterial Blight	Office of Deputy Director of Horticulture (Zilla Parishad), Bijapur on November 25, 2006	Dr .(Mrs) Jyotsana Sharma
22	Meeting of Pomegranate Grower's and Scientists on Management of Bacterial Blight	KVK (ICAR), Solapur on January 11, 2007	Dr. (Mrs) Jyotsana Sharma

Distinguished Visitors and other Activities

Dr. Mangala Rai, D.G. ICAR visits acold store at Sangola , Solapur



Dr. Mangala Rai, D.G. ICAR along with other dignitaries inspecting an orchard affected with fruit cracking problem at Sangola , Solapur

Dr. Mangala Rai, D.G. ICAR interacting with the Director , NRCP, Solapur on visit to bacterial blight affected orchard at Pandharpur, Solapur

RAC members at the inauguration of National Field Gene Bank of Pomegranate at Kegaon farm, Solapur

A team of scientists assessing loss occurred due to bacterial blight in pomegranate orchard at Mohol, Solapur

Dr. P Kumar, then Director (Officiating) addressing Hindi Diwas celebrated at NRCP, Solapur

Personnel

RMP

Dr. V.T. Jadhav	Director

Scientific Staff

Dr. P. Kumar	Principal Scientist
Dr. Ram Chandra	Principal Scientist
Dr. W.L. Barwad	Senior Scientist
Dr. K.K. Sharma	Senior Scientist
Dr. (Mrs.) Jyotsana Sharma	Senior Scientist
Dr. R.A. Marathe	Senior Scientist
Mr. D.T. Meshram	Scientist

Technical Staff

Shri Mahadev Gogaon	T-1 (Field Technician)

Administrative Staff

Shri T.A. Ashok Kumar	Assistant Administrative Officer
Shri K.S. Sharma	Superintendent
Shri Sagar Londhe	Lower Division Clerk
Shri Amolkumar Rathod	Lower Division Clerk

Nana- a dwarf pomegranate (*Punica granatum* var. nana) in full bloom.

National Research Centre on Pomegranate
National Highway- 9, Bypass Road, Shelgi
Solapur – 413 006 (Maharashtra), India

Telephone : 0217-2374262 (Director), 0217-2374330
Fax : 0217-2374533
E-mail : nrcpomegranate@indiatimes.com
director@nrcpomegranate.org
Website : http://www.nrcpomegranate.org