Annual Report
2007-2008

National Research Centre on Pomegranate
(Indian Council of Agricultural Research)
NH - 9 Bypass Road, Shelgi, Solapur - 413 006 (MS), India

Annual Report
2007-08

Compiled and Edited by
Dr. Ram Chandra
Dr. (Mrs.) Jyotsana Sharma
Dr. RA Marathe

Published by
Dr. VT Jadhav
Director

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

Designed & Printed by
AKASH PUBLICITY
Parbhani. Tell: 02452-229977

Printed
October-2008

Annual Report
2007-2008

National Research Centre on Pomegranate
(Indian Council of Agricultural Research)
NH - 9 Bypass Road, Shelgi, Solapur - 413 006 (MS), India

Preface

The role of pomegranate in arid and semi-arid regions has been recognized well in advance by the National Agricultural Research System that can help improve the livelihood of farmers, nutritional and environmental security, utilizing marginal and sub-marginal lands, creating employment opportunities and enhancing export avenues. Earlier pomegranate was considered as a minor fruit crop but its commercial cultivation started in 1980's. Consequently, area and production increased to 1.3 lakh ha and 11.5 lakh tonnes, respectively. Presently Maharashtra is the main producer of pomegranate followed by Karnataka and Andhra Pradesh. Now, it has become one of the important export fruit crops. Visualizing the increasing demand both for domestic consumption and export, it was felt necessary to address important constraints in production and post harvest management and thus, to over come such problems, National Research Centre on Pomegranate was established in 2005.

No doubt the centre is struggling to develop the infrastructural facilities for the last three years but research effort in germplasm collection, crop production and plant protection is noteworthy. The second Annual Report of the centre is a compilation of significant achievements for the period April 2007 to March 2008. The report covers research achievements pertaining to crop improvement, crop production, crop protection, agricultural extension and transfer of technology as well as other activities of the centre.

I shall be failing in my duty if I do not thank my staff for carrying out the various research activities as per plan and bringing out the results reflected in this report. 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 full co-operation and guidance in the development of this centre.

Date : - October, 2008 (V.T. Jadhav)

Place: - Solapur Director

Contents

Executive Summary

Crop Improvement

Exploration programme in collaboration with NBPGR and NRCP was conducted during 2007. Uttarakhand and J&K were surveyed and 36 native germplasm were collected. The major population of pomegranate in wild form was confined in areas between 800 and 1500 m above msl (altitude), but its distribution was also noticed up to an altitude of 2200 m above msl. Variability in plant height, canopy, leaf size, stem and petiole colour, density and length of thorns, flower colour, fruit size and number of fruits/tree, aril colour and size, TSS, acidity etc. were recorded. Besides, some collections were also made from IIHR, Bangalore, CAZRI, Jodhpur, CIAH, Bikaner, Karnataka, Maharashtra and NBPGR Regional Stations (Bhowali and Jodhpur). A unique landrace of pomegranate was also collected from Bagalkot (Karnataka), which has fruit weight of about 400-450 g, light pink and bold arils with high TSS (16.3^0 brix) and hard seeds. The germplasm collected from different sources were multiplied through stem cuttings for planting in Field Gene Bank (FGB).

Sixty one varieties /ecotypes/land races of pomegranate planted in February 2007 performed very well in FGB. After one year of planting, Jodhpur Collection, Spin Sakaharin, Bosckalinsi, Bedana Sedana, Spendanader, Maha, Jodhpur Red and IC-1199 showed higher plant growth. Among the genotypes evaluated, Nana was dwarf. More than 55% genotypes flowered within a year of planting.

Irradiated seeds were raised and evaluated seedling population of cvs. Bhagwa and Ganesh. Branching was more at lower doses of gamma irradiation (0-6 kR) and there was decreasing trend in branching habit with increase in irradiation doses beyond 6kR in Ganesh. However, higher doses (beyond 6kR) of gamma irradiation increased the branching in seedlings of cv. Bhagwa. The plant height in Ganesh and Bhagwa was not influenced by irradiation treatments at 0-9 kR and 0-18 kR, respectively. Interestingly, higher doses of gamma irradiation induced dwarfing effect at 27 and 30 kR in Ganesh and Bhagwa.

Crop Production

In Karnataka and Maharashtra, seventy orchards of pomegranate were surveyed and information on existing cultural practices and major problems of growers were recorded. In Karnataka, the crop is grown in sub marginal and dry areas particularly in red, grey, black and stony type of soils. About 42% orchards had red soils and 73% orchards were having soil depth more than 1m. Land holding of pomegranate growers ranged from 0.33-24.4 ha but majority of them had more than 2 ha of orchards. Medium density (500-750 trees/ha) planting was more common and 54% growers maintained 500-750 trees/ha. The main commercial varieties were Bhagwa and Ganesh. However, Bhagwa was most popular among the growers. Flat bed planting system was very common. Drip irrigation with two drippers was followed by 88% growers. Most of the growers used air layered plants. All the three *bahars* are common, but 62% growers preferred *Hastha bahar*. To induce flowering in pomegranate, spraying with ethrel or thio-urea or curacron is a common practice. In some newly established orchards, papaya, groundnut, sapota, mango, sweet orange, wheat, vegetables etc. were cultivated by some growers as intercrops. Drip irrigation in dry areas caused deposition of salts on upper surface of soil. Nutrient deficiency was observed in some of the orchards. More than 46.0% growers got a yield between 10.0-20.0 t/ha. Majority of the growers (58%) earned net income of Rs. 1.0-2.0 lakh/ha.

Soil and leaf samples collected from Bagalkot, Koppal and Bijapur districts showed interesting results. Soil pH, EC, OC, $CaCO_3$, available N, K, Fe, Cu, Mn and Zn ranged from 6.8-8.90, 0.13-1.41 dS/m, 0.37-1.93%, 0.13-10.24%, 83.9-335.6 kg/ha, 95.2-1741.6 kg/ha, 1.0-7.6 ppm, 0.6-15.0 ppm, 4.1-36.2 ppm and 0.3-14.0 ppm, respectively. In Bagalkot and Koppal districts, OC, K, Zn, Cu and Mn were found to be optimum to high in the soil, while N and Fe were deficient in majority of the orchards. Most of the orchards in Bijapur showed optimum to high levels of OC, K, Cu and Mn but were deficient in N, Zn and Fe contents. In general, optimum levels of leaf N, P, K, Fe and Mn contents were recorded in Bagalkot and Koppal districts, but Cu was found to be deficient. However, Zn content was optimum in Koppal and it was low in Bagalkot. In Bijapur, the leaf nutrient contents particularly N, K, Fe, Mn and Zn were in optimum levels.

Seven bio-agents were evaluated in a pot culture trial. Various growth and physiological parameters were significantly influenced by application of bio- agents. *Azospirillum* + *Pseudomonas striata*, *P. fluorescence*, *Trichoderma viride* and *Azospirillum* increased bio-mass production.

Pink pigmented facultative methylotroph (PPFM) was tested in pomegranate as a bio-fertilizer to promote growth and plant bio-mass. In six month old layered plants, plant height and spread, leaf, stem, root and total biomass were significantly increased by use

of PPFM. Total bio-mass and root bio-mass production were increased by about 46% and 49% with PPFM over control.

Two methods (Wedge and Tongue grafting) and five grafting dates viz, 15th December, 30th December, 15th January, 30th January and 15th February were evaluated during 2007-08. Higher graft success was achieved with wedge grafting and 30th January was found to be the optimum time for the grafting.

Different soil mixtures and their filling depth were evaluated in cvs. Ganesh and Bhagwa. In case of Ganesh, there was significant impact of different soil mixtures with respect to plant height and spread (E-W).

Seven potting media were tested of which, Soil + Sand + Vermicompost (1:1:0.5) was found to be effective for raising of seedlings.

In general, Bhagwa and Ganesh are commercial varieties of pomegranate in Maharashtra. All the three *bahars* viz. *Ambe*, *Mrig* and *Hastha bahars* are taken by growers. The quality parameters of these varieties were got analyzed from National Institute of Nutrition, Hyderabad. Overall quality aspect of Bhagwa was slightly superior to Ganesh in *Hastha bahar* fruits.

Crop Protection

Pomegranate crop has been observed to be vulnerable to many diseases of which bacterial blight and wilt posed serious threat to its cultivation due to their widespread occurrence resulting in huge losses. Besides, the crop also suffered from attack of several leaf and fruit spot and fruit rot causing pathogens, which at times were observed in severe proportions particularly in poorly managed orchards.

Survey of different districts of Maharashtra conducted during August 2007 revealed higher bacterial blight prevalence in Solapur (60.0%) followed by Nashik (39.12%). No blight was observed in Ahmednagar district. While maximum disease prevalence was recorded in Bijapur (77.7%), disease was recorded in mild to moderate intensities at Koppal (63.63%) and Bagalkot (40.0%) during the survey conducted in February 2008 in Karnataka.

On the basis of pathogenicity tests and molecular techniques, the identity of the bacterium was confirmed as *Xanthomonas axonopodis* pv. *punicae*. Twenty two isolates of bacterial blight from pomegranate and one from a affected cruciferous weed have been maintained in pure culture for further studies.

Bacterial blight was more severe in *Ambe bahar* (January-July 2007) as compared to *Hastha bahar* (October 07-April, 2008) as reflected from the AUDPC values which were 3285.1 and 885.1 in *Ambe* and *Hastha bahars*, respectively. Also, apparent infection rate 'r' was higher in *Ambe bahar*

(r=0.2/unit/day) as compared to *Hastha bahar* crop (r=0.08/unit/day). Bacterial blight incidence was more in cvs. Arakta and Bhagwa (72.0% each) than cv. Ganesh (41.0%) during *Hastha bahar*. Studies on mode of bacterial blight development during *Hastha bahar* 2007-08 revealed infection which took place from stem (pedicel) end in 37.6% of the fruits as compared to 11.59% infections from the calyx end of the fruits. Only 1.4% of the fruits revealed fresh lesions on surface with no indication of spread from either pedicel or calyx end. *Xanthomonas axonopodis* pv. *punicae* was able to survive in naturally infected leaves even after 9 months of incubation under laboratory conditions. Two out of 4 isolates of *X. axonopodis* pv.*punicae* showed resistance to streptocycline at low concentration (10ppm).

Different methods of inoculation were tested in February 2008 for screening of germplasm against bacterial blight. Simple spray which was found less cumbersome and time saving was found suitable for screening large number of germplasm.

Amongst 33 antibiotics (including streptocycline) tested using sensitivity disc method, 13 were significantly superior to streptocycline, 8 were at par and 11 less effective. All antibiotics except neomycin inhibited the pathogen even at lower concentrations between 0.1-2mcg, however, between 2-8 mcg, chloramphenicol was most effective followed by ceftriaxone, tetracycline, kanamycin and neomycin. Besides, bio-agents were also tried to control the bacterial blight disease.

Field trials in an adopted orchard for the management of bacterial blight were conducted during 2007-08 in *Hastha bahar* on cv Bhagwa by spraying streptocycline (500ppm) + carbendazim (0.15%) at 15 days interval. Bacterial blight incidence and severity in unsprayed crop was 100.0 and 38.0%, respectively as compared to sprayed one which revealed incidence and severity of 30.0 and 6.5%, respectively. Sprayed crop showed 82.2% bacterial blight control over the unsprayed one and thus, fruit yield of 16t/ha was recorded.

Wilt surveys were carried out in different districts of Maharashtra. The maximum disease prevalence was in Nashik (78.0%) followed by Solapur (40.0%) and Ahmednagar (30.0%). While the wilt was prevalent in 80.0% orchards in Bagalkot, 63.6% in Koppal and 22.2% in Bijapur districts of Karnataka. In Koppal district wilt was recorded in severe proportion whereas in other districts it was in mild to moderate proportion.

Studies on wilt etiology indicated presence of *Ceratocystis fimbriata* in 77.0% isolations made from disease samples (soil and infected plant parts) collected from Nashik, Beed, and Solapur districts of Maharashtra

and Bagalkot and Koppal districts of Karnataka. Roots and stems of wilt infected plants often revealed greyish discoloration of vascular bundles and adjoining tissues. Microscopic examination of sections of affected stem and root portion showed conidia of *C. fimbriata*. Based on various studies and pathogenicity tests, causal organism of wilt was identified as *Ceratocystis fimbriata*.

Occasionally isolations from roots and underground stems of wilt affected plants also revealed association of *Macrophomina phaseolina*, *Fusarium* spp., *Rhizoctonia* sp., *Pythium* sp., and *Phytophthora* sp. Some insects like stem borer (*Coelosterna* sp.), shot hole borer (*Xyleborus* sp.), bark eating caterpillar (*Inderbela* sp.) and nematodes (*Meloidogyne incognita*) were also prevalent in and around the roots of wilt infected plants. Wilt infections were evident in orchards of all ages from 2 years and above and in all cultivars grown in the region. Though wilt infected plants were prevalent in all soil types ranging from light sandy to deep clay and shallow to clay deep soils, but poor drainage revealed more wilt infections.

In vitro studies revealed 100% growth inhibition of *C. fimbriata* with fungicides namely hexaconazole, propiconazole, tricyclazole, myclobutanil, carbendazim at 1000 and 1500 ppm and mancozeb, zineb and captan at 1500 and 2000 ppm concentrations. Under field condition, wilt control was achieved by drenching wilt infected plants and adjacent healthy plants with mixture of carbendazim (0.2%) + chlorpyriphos (0.2%).

Leaf and fruit spots were invariably prevalent in all the orchards of Nashik and Ahmednagar from mild to severe proportion during August 2008. However, majority of the orchards in Ahmednagar (70.0%) and Nashik (47.8%) districts revealed spots in moderate proportion. In Solapur district, spots were observed in traces. In Karnataka, leaf and fruit spots were more prevalent in districts of Bijapur (88.8%) followed by Bagalkot (66.6%) and Koppal (54.5%).

Fruit rot prevalence was 60.0% in Ahmednagar and 30.0% in Nashik districts. In Karnataka, fruit rots were observed in traces in 30.85% orchards and in moderate proportion in 27.27% orchards. Isolations from leaf and fruit spots revealed association of different spot causing pathogens namely *Cercospora punicae*, *Colletotrichum* sp., *Drechslera rostrata and Alternaria alternate*. Fruit rots were caused by *Colletotrichum gloeosporioides* and *Aspergillus* sp.

Cercospora and *Colletotrichum* spots were severe during the humid conditions in July to September. However, *Cercospora* spots were also observed in Koppal district of Karnataka during February. *Alternaria* spots were observed throughout the year. Fruit scab was prevalent in severe form in

Ahmednagar district of Maharashtra in August 2007 and in Koppal district of Karnataka during February 2008. Fruit rots were prevalent throughout the year but incidence of the rots was common in rainy season. Control of leaf and fruit spots and fruit rots caused by different fungal pathogens was achieved by the sprays of fungicides namely carbendazim (0.15%) or mancozeb (0.2%) or copper oxychloride (0.25%) at regular intervals under field conditions.

Agricultural Extension and Transfer of Technology

Pomegranate growers from different districts of Maharashtra and Karnataka visited experimental field and enriched their knowledge in production and plant protection by interacting with the scientists. A bacterial blight affected orchard (cv. Bhagwa) was adopted to mitigate the disease during *hastha bahar*. An encouraging result with about 82.2% disease control was recoded in the orchard. A field day was organized at adopted orchard during 2007-08 and more than 500 farmers participated. The DDG (Horticulture) also participated in the field day programme and expressed his happiness over high degree of bacterial blight control.

On the eve of centre's establishment day, one day *Kisan Gosthi* was organized. More than 300 farmers, scientists from MPKV Centre, KVK, CRS (NRCS), Maharashtra State Agriculture Department Officials, Solapur etc. attended the function.

Lectures on various aspects of pomegranate cultivation and protection were delivered for quality production. Various bulletins and pamphlets on pomegranate production were distributed to the growers. The scientists of the centre made visits to different pomegranate orchards in Maharashtra and Karnataka during the year to assess and solve the problems of the pomegranate growers. During their visits to orchards, they also provided technical know how to the growers on quality production and value addition. The DDG (Horticulture), ADG (Horticulture) and dignitaries from Maharashtra Government visited the centre and gave valuable suggestions for improvement of the centre.

A high level meeting was held on November 4, 2007 at Pune to discuss the devastating situation created by bacterial blight disease in pomegranate. It was chaired by Shri Sharadchandra Pawar, Hon'ble Union Minister of Agriculture, Consumer Affairs, Food and Public Distribution. The purpose of the meeting was to take stock of current situation of bacterial blight, assess the impact of 'Orchard Health Management Package' formulated in February, 2007 and develop short term and long term strategies for effective management of bacterial blight in pomegranate. To promote pomegranate cultivation in traditional and non-traditional areas, proper media coverage on different aspects of its cultivation was regularly given through local newspapers, television channels and magazines.

Introduction

India is one of the world's leading countries in pomegranate (*Punica granatum* L.) production and more than 1.30 lakh hectare area is under pomegranate of which about 92,000 hectare area is in Maharashtra alone. Besides, parts of Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat and Rajasthan are also suitable for quality production of pomegranate in India. 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 2001-2002 of IXth Five year plan, but it could not be established due to some administrative reasons. The planning commission too had supported 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 Horticultural (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.

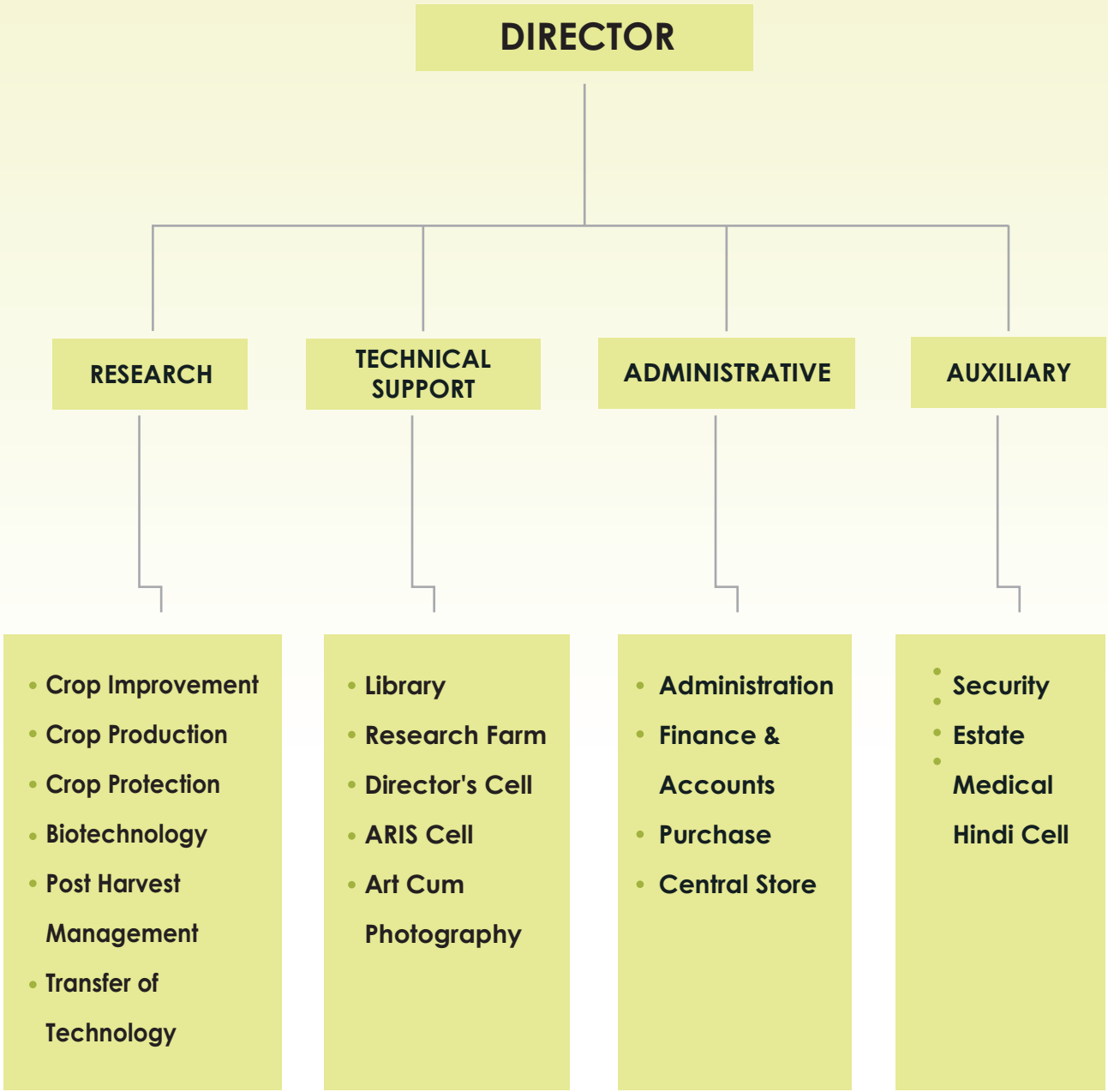
Mandate

- 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

- Uttarakhand and J&K were surveyed and 36 native germplasm were collected. The major population of pomegranate in wild form was confined in areas between 800 and 1500 m msl.
- Sixty one varieties /ecotypes/land races of pomegranate were evaluated after one year of planting. Among the genotypes evaluated, Nana was dwarf. More than 55% genotypes came into flowering.
- Branching was more at lower doses of gamma irradiation (0-6 kR) in Ganesh. However, higher doses of gamma irradiation induced dwarfing effect at 27 and 30 kR in Ganesh and Bhagwa.
- In Karnataka and Maharashtra, seventy orchards of pomegranate were surveyed and information on existing cultural practices and major problems of growers were recorded.
- *Azospirillum* + *Pseudomonas striata*, *P. fluorescence*, *Trichoderma viride* and *Azospirillum* have increased bio-mass production.
- Two methods (Wedge and Tongue grafting) and five grafting time viz, 15th December, 30th December, 15th January, 30th January and 15th February were evaluated during 2007-08. Better graft success was achieved with wedge grafting and optimum time for the grafting was 30th January.
- Out of seven potting media tested, Soil + Sand + Vermicompost (1:1:0.5) media was found to be suitable for the raising of seedlings.
- Overall nutritive quality aspect of Bhagwa was slightly superior to Ganesh in *Hastha bahar* fruits.
- Higher bacterial blight disease prevalence was in Solapur (60.0%) followed by Nashik (39.12%). However, in Karnataka maximum disease prevalence was in Bijapur (77.7%) followed by Koppal (63.63%) and Bagalkot (40.0%) in mild to moderate intensities.
- *Xanthomonas axonopodis* pv. *punicae was* confirmed as causal organism of bacterial blight. Twenty two isolates of blight bacterium from pomegranate have been maintained in pure cultures.
- Bacterial blight was more severe in *Ambe bahar* as compared to *Hastha bahar*. The disease incidence was more in cvs Arakta and Bhagwa (72.0% each) than cv Ganesh (41.0%) during *Hastha bahar*.
- *X. axonopodis* pv. *punicae* was able to survive in naturally infected leaves even after 9 months of incubation under laboratory conditions.
- Simple spray inoculation was found suitable for screening large number of germplasm against bacterial blight resistance. Thirteen antibiotics were found significantly superior to streptocycline to inhibit bacterial blight pathogen *in vitro*.
- In *Hastha bahar,* on cv Bhagwa, spraying with streptocycline (500ppm) + carbendazim (0.15%) at 15 days interval,

bacterial blight incidence and severity reduced and 82.2% disease control was recorded. Consequently, higher fruit yield (16t/ha.) with better quality was obtained.

- Wilt disease prevalence in Nashik was 78.0% followed by Solapur (40.0%) and Ahmednagar (30.0%) in Maharashtra. While in Karnataka, wilt was prevalent in 80.0% orchards of Bagalkot, 63.6% of Koppal and 22.2% of Bijapur districts. The main cause for wilt was presence of *Ceratocystis fimbriata*. However, *Macrophomina phaseolina*, *Fusarium* spp., *Rhizoctonia* sp., *Pythium* sp., and *Phytophthora* sp. were also associated with wilt. Under field conditions, wilt control was achieved by drenching wilt infected plants and adjacent healthy plants with a mixture of carbendazim (0.2%) + chlorpyriphos (0.2%).
- *Cercospora punicae, Colletotrichum* sp., *Dreschlera rostrata, and Alternaria alternata* were associated with fruit and leaf spots. However, fruit rots were observed to be caused by *Colletotrichum gloeosporioides* and *Aspergillus* sp. These diseases could be controlled by the sprays of fungicides viz. carbendazim (0.15%) or mancozeb (0.2%) or copper oxychloride (0.25%) at regular intervals under field conditions.

Staff Position

In Xth five year plan the total sanctioned strength was 41, including 1 RMP, 9 scientific, 14 technical, 7 administrative and 10 supporting. Out of 41 sanctioned posts, only 15 posts have been filled up, upto March, 2008 due to administrative reasons (Fig.1).

Budget

The actual fund utilization in plan and non-plan was Rs. 62.80 lakh and 98.26 lakh, respectively during 2007-08 (Table 1).

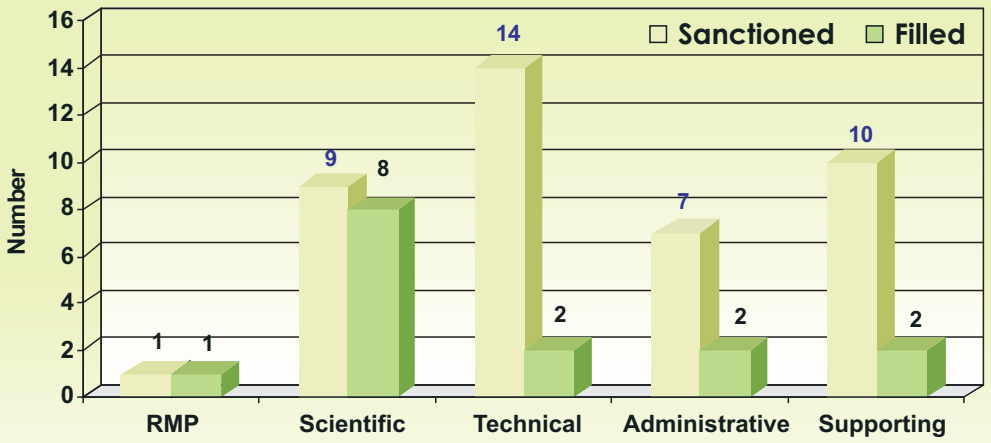


Fig.1: Staff position at NRCP, Solapur

Table 1: Financial outlay (2007-08)

Head	Rs. in lakhs					
A. Recurring	**BE**		**RE**		**Actual Utilization**	
	Plan	**Non-plan**	**Plan**	**Non-Plan**	**Plan**	**Non-plan**
Pay and allowances	5.00	35.00	--	62.00	--	54.37
TA	5.00	1.00	4.00	2.00	4.00	1.89
Contingencies	--	--	--	--	--	--
HRD	--	--	**--**	**--**	**--**	**--**
Total (A)	**10.00**	**36.00**	**4.00**	**64.00**	**4.00**	**56.26**
B. Non Recurring						
Other charges including Equipments	211.10	45.00	53.80	40.26	53.80	40.26
Works	152.90	2.00	--	1.74	--	1.74
Land	--	--	--	--	--	--
Library books/journals	--	--	5.00	--	5.00	--
Vehicles	--	--	--	--	--	--
Furniture/Fixtures/Others	1.00	--	--	--	--	--
Total (B)	**365.00**	**47.00**	**58.50**	**42.00**	**58.80**	**42.00**
Grand Total (A+B)	**375.00**	**83.00**	**62.80**	**106.0**	**62.80**	**98.26**

Crop Improvement

Survey and germplasm collection

Uttarakhand (Rishikesh, Nagina and Chila forest of Pawri Garhwal, Narendranagar, Fokot, Chamba, Tehri and Rani Chauri, Uttar Kashi, Lakhmandal, Chakarata, Dehradun and Manssoori) and J&K [Jammu, Khannyy, Kalidhar, Sunderbani, Rajouri and Udhampur (Samruli, Champra and Chenani)] were surveyed and collected 36 native germplasm. The major population of pomegranate in wild form was confined in areas between 800 and 1500 m above msl (altitude), but its distribution was also noticed up to an altitude of 2200 m above msl. The maximum distribution of the wild form was noted in Chamba (Fig.2), Barkot and Chakrata of Uttarakhand and Udhampur (Samruli, Champra and Chenani) of Jammu and Kashmir valley. Variability in plant height, canopy, leaf size, stem and petiole colour, density and length of thorns, flower colour, fruit size and number of fruits/tree, aril colour and size, TSS, acidity etc. was recorded. Spur formation in pomegranate was noticed in wild pomegranate growing in Sahiya, Uttarakhand (Fig.3). Disease infection was noted on leaves and fruits but fruits were severely infected. Among insect pests, fruit borer was most prevalent in Uttarakhand and Jammu and Kashmir and causing considerable fruit loss. In addition to collections made from Uttarakhand and Jammu and Kashmir, seventy two germplasm of pomegranate were also collected from IIHR, Bangalore, CAZRI, Jodhpur, CIAH, Bikaner, Karnataka and Maharashtra, NBPGR Regional stations (Bhowali and Jodhpur). A unique landrace of pomegranate was collected from Bagalkot (Karnataka) had fruit weight about 400- 450 g, light pink and bold arils with high TSS (16.3^{0}brix) and hard seeds (Fig.4). Altogether 108 germplasm collected from different sources (Table2) were multiplied through stem cuttings (Fig.5) for planting in Field Gene Bank (FGB).

Table 2: Germplasm collection from different sources

Source	Acc./ collection (No.)	No of accession survived	Survival (%)
IIHR , Bangalore	8	6	75.0
NBPGR, Bhowali	27	25	92.6
J&K	13	11	84.6
CIAH, Bikaner	34	31	91.2
CAZRI, Jodhpur	3	3	100.0
NBPGR, Jodhpur	11	11	100.0
Maharashtra	9	7	77.8
Karnataka	3	3	100.0
Total	**108**	**97**	**89.8**

Fig.2 : A vigorously growing wild pomegranate in Chamba (Uttarakhand)

Fig: 3 : Spur formation in wild pomegranate

Fig. 4: A landrace of pomegranate collected from Bagalkot (Karnataka)

Fig. 5 : Germplasm multiplied through stem cuttings

Evaluation of germplasm

Sixty one varieties /ecotypes/landraces of pomegranate were planted in February 2007 (Fig.6) and their data on growth parameters were recoded after one year of planting. Plant height and spread, stem diameter and girth, thorn length and leaf area significantly differed among genotypes (Table 3). Jodhpur Collection, Spin Sakaharin, Bosckalinsi, Bedana Sedana, Spendanader, Maha, Jodhpur Red and IC-1199 showed higher plant growth in terms of height and their values ranged from 222.7-249.6 cm and significantly lowest plant height (57 cm) was recorded in case of Nana. However, plant spread was higher in Kalpitya, IC- 318723, IC- 318728, IC- 318803 and IC-318705. About 28% genotypes had stem girth more than 12 cm and 11% genotypes had stem diameter of 4 cm and above, while more than 84% genotypes recorded longer thorns and none were found thornless type. Among different genotypes, Nana had smallest (3.3 cm) thorn. There were 54% genotypes which had broader leaves and their value ranged from 8.2- 10.3 cm^2. Maximum variability (19.3%) was recoded in respect of leaf area followed by plant spread and stem diameter (Table 4). In leaf size, higher variability was noticed (Fig.7). Among all the genotypes evaluated, Nana was dwarf and its growth parameters showed lowest values. Interestingly, the flowering was noticed in more than 55% genotypes.

Fig. 6 : Field visit by a team of scientists to one year old National Field Gene Bank of Pomegranate at NRCP, Solapur

Table 3 : Evaluation of growth parameters of pomegranate germplasm (2007-08)

S. No	Variety/ accession	Plant height (cm)	Plant spread (cm)	Stem diameter (cm)	Stem girth (cm)	Thorn length (cm)	Leaf area (cm^2)
1	2	3	4	5	6	7	8
1	Ganesh	172.9	133.4	2.5	8.0	8.2	10.3
2	Yercaud	211.2	170.3	3.5	11.2	6.1	7.6
3	Nimali	181.3	155.3	3.5	11.0	8.3	9.0
4	Kalpitya	207.1	239.7	2.8	9.9	9.4	8.1
5	Phule Arakta	193.9	168.2	4.3	14.0	9.0	7.8
6	Jodhpur Collection	249.6	182.7	4.0	12.9	10.1	8.5
7	Dholka	152.9	159.8	3.2	10.7	8.3	9.8
8	G-137	161.7	146.4	3.4	11.1	9.5	7.7
9	KRS	190.7	179.3	3.7	11.6	8.8	9.2
10	Damini	220.0	147.0	3.5	11.3	8.0	9.3
11	Jallore Seedless	194.9	178.6	3.5	11.7	10.1	8.1
12	Bhagwa	159.6	159.1	2.8	10.0	9.2	8.7
13	Co-White	163.9	181.7	4.5	14.3	8.7	9.8
14	Kabuli Yellow	172.8	168.3	3.6	10.9	8.5	7.2
15	Jyoti	184.8	163.1	3.9	12.3	9.4	10.2
16	Tabesta	206.4	161.0	3.1	10.8	8.6	7.8
17	Surat Anar	209.3	172.7	3.6	11.7	8.5	8.6

1	2	3	4	5	6	7	8
18.	Bassein Seedless	171.4	160.8	4.5	14.2	8.2	10.3
19.	Spin Sakaharin	231.2	164.3	3.1	10.2	7.0	8.4
20.	Bedana Suri	184.0	196.0	3.6	11.8	9.0	9.3
21.	Muscat	196.5	170.7	3.9	13.1	9.2	7.9
22.	Bosckalinsi	229.7	147.1	3.6	12.3	8.5	8.3
23.	Kabuli Canoor	218.1	146.8	3.2	10.2	7.6	9.9
24.	Bedana Sedana	225.4	162.2	3.5	11.2	8.2	8.8
25.	Patana-5	177.3	200.5	3.0	9.8	8.4	8.9
26.	Spendanader	239.7	158.5	3.1	10.0	8.4	7.6
27.	Dorsata	202.4	154.2	3.0	10.0	9.3	7.9
28.	AK Anar	202.9	127.4	3.6	11.3	7.4	9.0
29.	Bedana Thinskin	188.4	179.1	3.8	12.3	9.9	9.4
30.	Maha	2261	200.5	3.1	11.0	8.7	9.2
31.	P-23	171.8	177.3	3.9	12.8	8.5	9.7
32.	P-13	164.3	173.8	3.8	12.0	8.8	9.7
33.	Kasuri	181.0	171.1	3.6	12.0	9.0	8.9
34.	Alah	219.4	139.3	3.2	11.0	8.4	6.4
35.	Jodhpur Red	230.1	187.6	3.2	10.7	10.3	10.7
36.	Gulesha Red	189.2	152.1	3.2	9.8	7.5	9.1
37.	P-26	181.6	174.8	3.3	11.2	9.9	6.8
38.	P 16	165.4	166.7	3.3	10.7	8.5	6.3
39.	Shirin Anar	190.6	168.2	3.3	11.2	8.8	7.4
40.	GR Pink	208.8	169.3	3.4	12.0	9.1	8.5
41.	Mridula	191.8	161.1	3.6	12.0	9.6	7.6
42.	IC -1201	221.4	180.2	2.7	8.8	8.0	5.6
43.	IC -1203	204.2	209.3	3.2	10.0	9.1	7.1
44.	IC -1204	203.1	236.3	3.1	10.2	9.8	8.2
45.	IC- 1205	161.3	198.2	3.3	10.3	8.2	6.2
46.	IC -1199	222.7	184.6	2.5	8.5	9.8	6.8
47.	IC -1198	206.0	205.9	3.3	10.2	8.1	6.4
48.	IC -1196	191.9	208.4	3.1	10.9	9.9	5.0
49.	IC -1194	168.9	133.1	3.4	10.8	8.8	9.0
50.	Nana	57.0	52.1	1.5	5.5	3.3	1.0
51.	IC_318754	195.8	204.1	4.3	13.5	6.8	8.5
52.	IC-318723	180.4	225.4	4.0	12.8	8.7	8.4
53.	IC-318728	209.3	217.1	3.8	11.7	9.3	7.5
54.	IC-1182	174.9	176.9	2.6	8.5	7.3	7.4
55.	IC-318790	179.1	210.5	3.5	11.0	7.4	8.5
56.	IC-318803	184.4	219.4	3.6	11.5	7.7	8.0
57.	IC-318753	182.0	219.0	4.1	13.7	8.3	7.7
58.	IC-318779	184.3	199.5	3.9	12.5	9.7	8.2
59.	IC-318705	190.4	224.8	3.9	12.5	8.9	8.4
60.	IC-318718	159.2	185.5	3.2	10.5	8.2	6.7
61.	IC-318720	187.5	198.2	3.9	11.8	8.5	5.2
	Mean	191.5	176.5	3.4	11.1	8.6	8.1
	CD (P=0.5)	**28.08**	**27.25**	**0.70**	**2.25**	**2.17**	**2.11**

Table 4 : Range, mean and CV of growth parameters of pomegranate germplasm

Parameters	Range	Mean	CV (%)
Plant height (cm)	57.0- 249.6	191.5	14.8
Plant spread (cm)	52.1- 239.7	176.5	17.4
Stem diameter(cm)	1.5 - 4.5	3.4	15.0
Stem girth (cm)	5.5- 14.3	11.8	13.8
Thorn length (cm)	3.3- 10.3	8.6	12.8
Leaf area (cm^2)	1.0- 10.7	8.1	19.3

Fig.7 : Variability in leaf size of pomegranate germplasm

Influence of gamma irradiation

To create variability, seeds of cvs. Bhagwa and Ganesh were irradiated with 0-30 kR gamma rays and seeds were sown in polythene bags and growth of seedlings was recoded at 9 months after sowing. Branching was more at lower doses of gamma irradiation (0-6 kR) and there was decreasing trend in branching habit with increase in irradiation doses beyond 6kR in Ganesh (Fig.8a). Contrary to this, higher doses (beyond 6kR) of gamma irradiation increased the branching in seedlings of cv. Bhagwa (Fig. 8b). The plant height in Ganesh and Bhagwa was not influenced by irradiation treatments at 0-9 kR and 0-18 kR, respectively. But higher doses of gamma irradiation induced dwarfing effect at 27 and 30 kR in Ganesh (Fig.9) and Bhagwa. However, further evaluation is in progress.

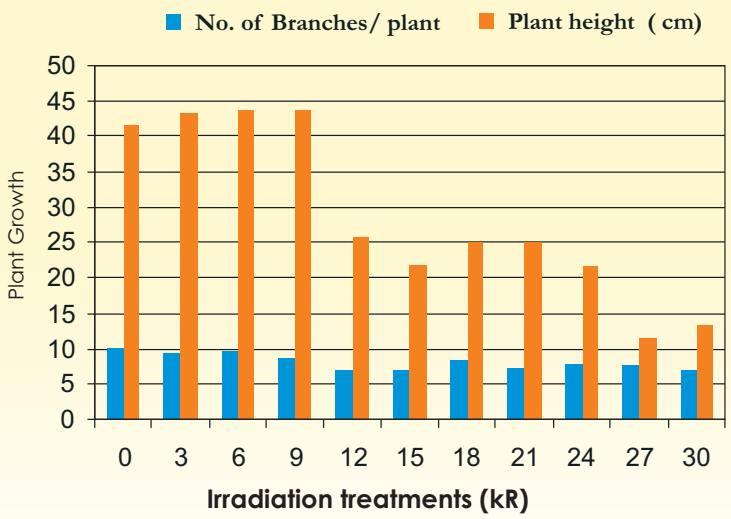


Fig.8a : Effect of gamma irradiation on plant growth at 9 month of planting in cv. Ganesh

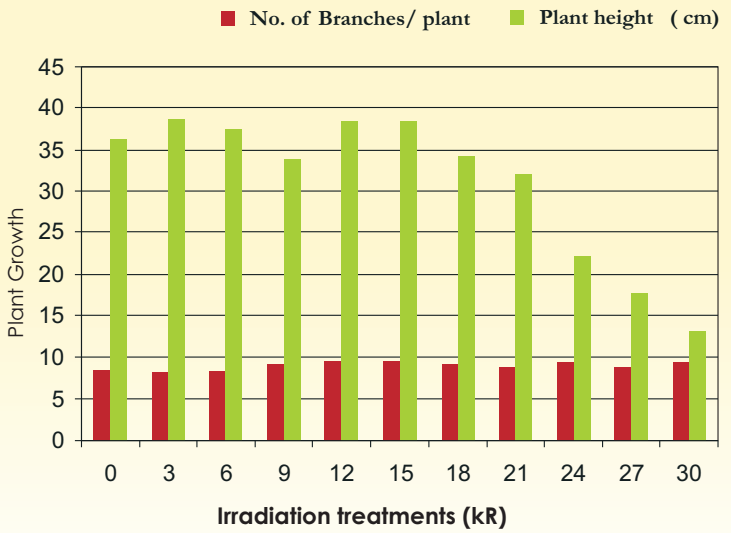


Fig: 8b : Effect of gamma irradiation on plant growth at 9 month of planting in cv. Bhagwa

Fig: 9 : Gamma irradiation at higher doses (27 kR and 30 kR) induced dwarfness

Crop Production

Survey of pomegranate orchards

Seventy orchards of pomegranate in Karnataka and Maharashtra were surveyed, information on existing cultural practices was collected and noted major problems of growers. In Maharashtra, Solapur, Osmanabad, Parbhani and Latur districts were surveyed. A part of Karnataka particularly Bagalkot, Koppal, Chitradurg, Gadag and Bijapur districts were also surveyed and information gathered on various aspects has been summarized. The crop is grown in sub marginal and dry areas in red, gray, black and stony type of soil. About 42% orchards had red soils and 73% orchards were having soil depth more than 1m. Land holding of pomegranate growers ranged between 0.33 and 24.4 ha but majority of them (38%) had more than 2 ha of orchards. Medium density (500-750 trees/ha) planting was more common and 54% growers maintained 500-750 trees/ha. Bhagwa and Ganesh were the commercial varieties but area under Bhagwa was maximum (80%). Flat bed planting system was most prevalent as 77% growers adopted this system. Application of FYM (5-50 kg/tree), neem cake, vermicompost with or without chemical fertilizers particularly N, P and K in the form of solid or liquid fertilizers was used by the growers. However, application of micro nutrients was also common. Drip irrigation with two drippers followed by 88% growers. Mainly layered plants were used for planting. All the three *bahars* viz *Ambe*, *mrig* and *hastha* are common, but *Hastha bahar* was followed by 62% growers. As far as training is concerned, multi-stem system with 2-5 stems was general practice. Mostly, 40 to 60 days stress was given for flower induction. During the stress period, defoliation is a common practice to induce flowering for which ethrel or thio-urea or curacron is sprayed. Pruning is done when flower regulation is followed. The suckers arising from the ground are removed regularly (2-3times/year). Papaya (Fig.10), groundnut (Fig.11), sapota (Fig.12), mango (Fig.13), sweet orange, wheat, vegetables etc. were cultivated in some pomegranate orchards. Mulching with locally available materials is used by some growers in their orchards (Fig.14). Drip irrigation in dry areas caused deposition of salts on upper surface of soil (Fig.15). Nutrient deficiency was observed in some of the orchards (Fig.16). Fruit yield ranged between 7.4 and 61 t/ha. More than 46.0% growers got a yield between 10.0 and 20.0 t/ha. Establishment cost of orchard varied from about Rs. 0.25-1.1 lakh/ha but 50.0% growers spent Rs 0.5-1.0 lakh/ha for establishment of orchards.Net income was from Rs. 0.25 - 2.65 lakh/ha from 2 to 10 year old orchards and majority of the growers (58%) earned net income of Rs. 1.0-2.0 lakh/ha. Bacterial blight and wilt diseases were the severe problems in surveyed areas. However, stem borer, fruit borer, thrips, aphids, white fly, sun scald, shot hole borer were also recorded causing loss to the pomegranate growers.

Fig. 10 : Pomegranate + Papaya

Fig. 11 : Pomegranate + Groundnut

Fig. 12 : Pomegranate + Sapota

Fig. 13 : Pomegranate + Mango

Fig. 14 : Mulching with maize straw in pomegranate

Fig. 15 : Salt accumulation on surface under drip irrigation system in Bijapur (Karnataka)

Fig. 16 : Severe nutrient deficiency on leaves

Pomegranate growing districts of Karnataka (Bagalkot, Koppal and Bijapur) were surveyed and the soil and plant (leaf) samples were collected from the orchards. The samples were analyzed and the soil physico-chemical properties and leaf nutrient contents (macro and micro) have been summarized (Table 5a, 5b and 6). Soil pH, EC, OC, $CaCO_3$, and available N, K, Fe, Cu, Mn and Zn ranged from 6.8-8.90, 0.13-1.41 dS/m, 0.37- 1.93%, 0.13-10.24%, 83.9-335.6 kg/ha, 95.2- 1741.6 kg/ha, 1.0-7.6 ppm, 0.6-15.0 ppm, 4.1-36.2 ppm and 0.3-14.0 ppm, respectively in the surveyed orchards of Karnataka. In Bagalkot and Koppal districts, OC, K, Zn, Cu and Mn found to be optimum to high in the soil, while N and Fe were deficient in majority of the orchards. Most of the orchards in Bijapur showed optimum to high levels of OC, K, Cu and Mn but deficient in N, Zn and Fe contents. In general, the surveyed orchards showed optimum levels of leaf N, P, K, Fe and Mn contents in Bagalkot and Koppal districts, but Cu found to be deficient in both the districts. However, Zn content was optimum in Koppal and it was low in Bagalkot. In Bijapur, the leaf nutrient contents particularly N, K, Fe, Mn and Zn were in optimum levels, while Cu and P found to be deficient.

Table 5a : Soil physical properties and available N in different pomegranate orchards in Karnataka

Area	No of orchards surveyed	pH	EC (dS /m)	OC (%)	CaCO3 (%)	N (kg/ha)
Bagalkot	9	7.03–8.39	0.18–0.70	0.37– 1.48	0.26–6.40	184.6–285.2
Koppal	8	6.80-8.17	0.13-0.25	0.39-0.79	0.13-2.05	201.3-318.8
Bijapur	9	7.88–8.9	0.19–1.41	0.71–1.93	1.15–10.24	83.9– 335.6

Table 5b : Available K and micronutrients in soils of pomegranate orchards in Karnataka

Area	No of orchards surveyed	K (kg/ha)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
Bagalkot	9	302.4 –1080.8	1.1-7.6	2.5-6.7	7.4-36.2	0.6-14.0
Koppal	8	95.2-593.6	1.8-7.4	0.6-15.0	6.5-19.2	0.6-3.3
Bijapur	9	212.8-1741.6	1.0-1.7	0.7-8.8	4.1-9.8	0.3-4.2

Table 6 : Nutrient status of leaves of pomegranate in Karnataka Orchards

Area	No of orchards surveyed	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)
Bagalkot	16	0.54-2.16	0.095-0.381	0.9-3.06	95-165.5	47.9-94.3	7.6-21.9	16.9-65.8
Koppal	9	0.9-2.62	0.07-0.190	0.8-1.55	151-253	52.2-81.9	6.8-21.5	19.8-69.0
Bijapur	10	0.85-2.31	0.06-0.176	0.46-1.33	98.9-361	46.6-65.3	7.1-48.6	16.6-37.8

Effect of bio agents

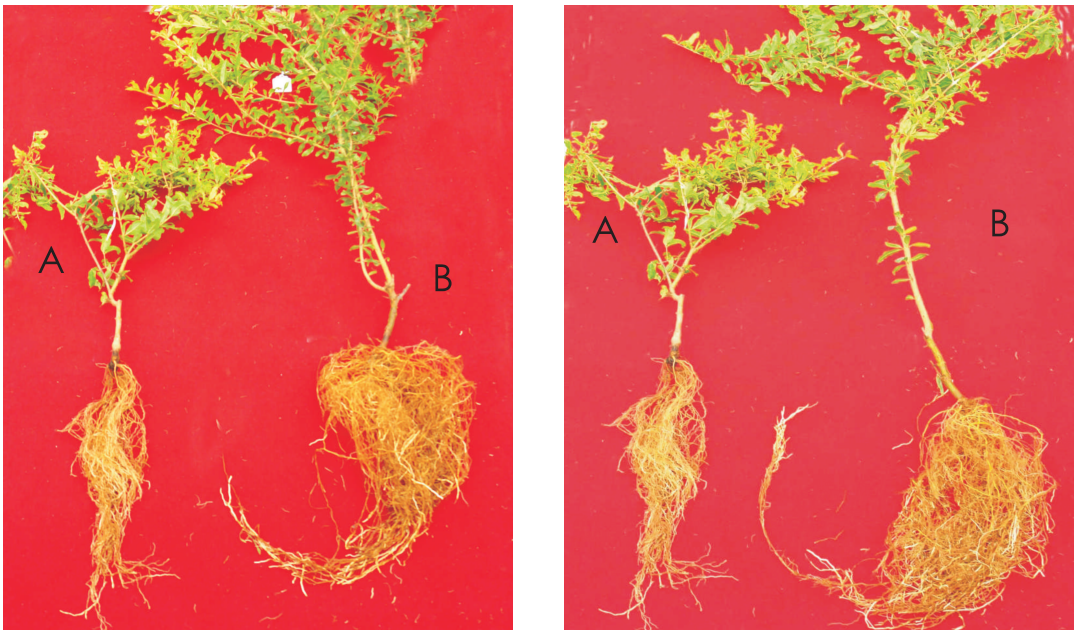
Seven bio-agents were tested on pomegranate layered plants in a pot culture trial. Plant height, roots/plant, root length, dry matter production (shoot and root) were significantly influenced by application of bio-agents (Table 7 and 8). Similarly physiological parameters (Photosynthetic rate, water use efficiency, stomatal conductance and transpiration rate) were also significantly influenced. *Azospirillum* + *Pseudomonas striata*, *P. fluorescence*, *Trichoderma viride* and *Azospirillum* increased bio-mass production significantly and these treatments were at par to each other. In these treatments, plant height, number of roots /plant, shoot, leaf and stem dry weight and water use efficiency were also enhanced significantly. However, P. *fluorescence and Azospirillum + P. striata* enhanced photosynthetic and transpiration rate and stomatal conductance also and their values ranged from 10.12 to 11.93 µ mol m^{-2} s^{-1} and 7.54 to 7.97 µ mol H_2O m^{-2} s^{-1} and 0.24 to 0.28 mol H_2O m^{-2} s^{-1} respectively. These treatments enhanced about 65% dry matter production as compared to control. Thus, *Azospirillum + P. striata*, P. *fluorescence, Trichoderma viride* and *Azospirillum* were found to be beneficial as bio-fertilizer (Fig.17). However, further studies are in progress.

Table 7: Effect of bio-agents on growth parameters in pomegranate

Treatments	Plant height (m)	Plant Spread (cm)	No. of roots/ plant	Root length (cm)
Acetobacter	0.88	41.32	10.00	29.33
P. striata	0.94	40.67	13.00	31.39
Trichoderma viride	0.95	43.57	10.67	32.11
P. fluorescence	1.06	47.75	11.67	37.44
Azospirillum + P. striata	1.05	46.32	13.33	29.33
Acetobacter + P. striata	0.94	46.42	12.00	29.17
Azospirillum	0.95	54.48	12.33	35.11
PPFM (Pomegranate)	0.90	48.83	10.67	34.22
PPFM (Cotton)	0.87	46.08	12.67	35.66
Control	0.78	42.17	8.00	48.67
CD. (P = 0.05)	**0.12**	**NS**	**2.38**	**6.24**

Table 8: Effect of bio-agents on biomass partitioning in pomegranate

Treatment	Dry matter (g/plant)		
	Shoot	Root	Total biomass
Acetobacter	32.16	6.93	39.11
P. Striata	30.92	10.15	41.07
Trichoderma viride	39.79	8.20	48.14
P. fluorescence	42.82	9.54	52.35
Azospirillum + P. striata	43.42	9.49	52.92
Acetobacter + P. Striata	35.19	7.23	42.42
Azospirillum	39.96	6.64	46.60
PPFM (Pomegranate)	35.79	8.20	42.92
PPFM (Cotton)	32.95	6.46	39.42
Control	26.83	4.88	31.70
CD. (P = 0.05)	**8.79**	**2.09**	**9.4**



A - Control, B - *P. flourescence*

A - Control, B - Azospirillum + *P. striata*

Fig. 17: Higher bio-mass production with bio-agents

Response of bio-agent (PPFM)

In a pot culture study, Pink pigmented facultative methylotroph (PPFM) was tested in pomegranate as a bio-fertilizer to promote growth and plant bio-mass. In six month old layered plants, plant height and spread, leaf, stem, root and total biomass were significantly increased by use of PPFM (Table 9). Total bio-mass and root bio-mass production were increased by about 46% and 49% with application of PPFM over control (Fig.18). However, PPFM did not influence root length, branching and rooting behaviour.

Table 9: Effect of PPFM on growth and bio-mass production in pomegranate

Treatment	Plant height (cm)	Plant spread (cm)	Bio- mass (g/plant)			
			Leaf	Stem	Root	Total
PPFM	66.36	42.22	13.51	23.48	11.57	48.56
Control	49.84	38.86	9.02	16.58	7.75	33.35
Mean	58.10	40.54	11.26	20.03	9.66	40.95
t-test	*	*	*	*	*	*

*Significant at 5%

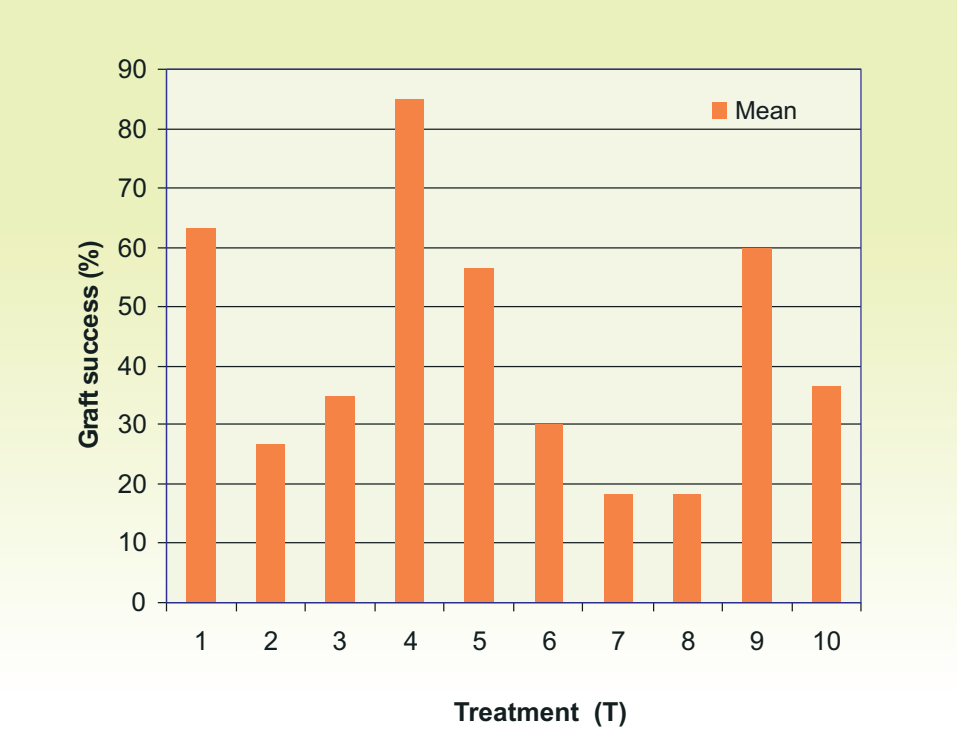
Fig. 18: Effect of PPFM in Pomegrana

Evaluation of grafting method and time

Looking into wilt problem of pomegranate, standardization of grafting method is utmost need in order to identify suitable wilt resistant rootstock. Therefore, in the present study, an attempt was made to evaluate two methods (Wedge and Tongue grafting) and five grafting time viz. 15th December, 30th December, 15th January, 30th January and 15th February during 2007-08 (Fig. 21). In case of wedge grafting, the success per cent ranged between 26.67 and 85.00 (Fig 19). However, significantly maximum graft success (85%) was recorded when grafting was done in the last week of January and subsequently the success reduced. While in case of tongue grafting, success per cent ranged between 18.33 and 60.00 with higher success (60%) in the last week of January. Thus, wedge grafting on 30th January found to be optimum time for grafting. In wedge grafting scion and root stock union found to be perfect after one year (Fig. 20).

Fig. 19: Wedge grafting very successful in nursery condition

Fig: 20: Perfect union in wedge grafting



T-1 Wedge grafting on 15th Dec.; T-2 Wedge grafting on 30th Dec.; T-3 Wedge grafting on 15th Jan.; T-4 Wedge grafting on 30th Jan.; T-5 Wedge grafting on 15th Feb.; T-6 Tongue grafting on 15th Dec.; T-7 Tongue grafting on 30th Dec.; T-8 Tongue grafting on 15th Jan.; T-9 Tongue grafting on 30th Jan.; T-10 Tongue grafting on 15th Feb

Fig.21: Grafting success in cv. Bhagwa

Evaluation of soil depth and different soil mixtures

Since pomegranate is grown in marginal and rocky lands in main pomegranate growing areas, there is need to standardize suitable pit filling mixtures for such areas. Therefore, different soil mixtures and their filling depth were evaluated in cvs. Ganesh and Bhagwa. In Bhagwa plant height and spread were not influenced by filling mixtures in one year old plantation. While in case of Ganesh there was significant impact of different soil mixtures on plant height and spread (E-W). Except T-1, T-5, T-9 and T-11, all other treatments were found to increase the plant height (Table10), however, further evaluation is in progress.

Table 10 : Effect of different soil mixtures and filling depth on plant height and plant spread in cv. Ganesh

Treatment	Plant height (m)	Plant spread (cm) EW	NS
T1- Light gravelly soil up to 30 cm	1.58	88.17	106.50
T2- Light gravelly soil up to 60 cm	1.73	104.33	117.67
T3- Sandy loam soil up to 60cm	1.74	105.33	89.33
T4- Medium (loamy) soil up to 60 cm	1.74	121.17	110.50
T5- Black soil up to 30 cm	1.67	108.83	109.00
T6- Black soil up to 60 cm	1.84	102.83	105.17
T7- Black soil up to 90 cm	1.85	105.83	107.00
T8- Black soil up to 120 cm	1.93	127.83	119.00
T9- Mixture of Black soil (50%) and sand (50%) up to 90 cm	1.64	104.17	103.83
T10- Mixture of Black soil (75%) and sand (25%) up to 90 cm	1.77	98.33	101.50
T11- Murrum	1.58	119.33	123.50
CD (P=0.05)	**0.21**	**19.0**	**NS**

Standardization of potting media

An attempt was made to standardize suitable potting media for raising of pomegranate seedlings. Seven potting media were taken for the present study. Growth, biomass partitioning, nutrient contents and soil physico chemical properties were recoded. The initial values of pH, EC, OC, CaCO3, N, Fe, Mn, Cu and Zn in different potting media ranged from 7.07-8.96, 0.1-1.86 dS/m, 0.02-3.31%, 2.9-20.9%, 18.9-577.6 kg/ha, 9.6-38.5 ppm, 9.7-64.8 ppm, 0.6-6.7 ppm and 0.4-8.6 ppm, respectively. Soil + Vermicompost, Soil + FYM and Soil + Sand + Vermicompost were at par to each other with respect to plant height, number of roots/plant, root and shoot dry weight and total dry mass production/plant (Table.11). The root development was better in all the treatments except sand (Fig. 22). The total biomass production was 5.87, 5.55 and 4.84 times higher in Soil + Vermicompost, Soil + FYM and Soil + Sand + Vermicompost over control, respectively. However, Soil + Sand + Vermicompost (1:1:0.5) found to be effective for raising of seedlings.

Fig.22: Response of various potting media on bio-mass production in one year old seedlings

Table 11 : Influence of different potting media on plant growth and biomass partitioning in seedlings cv. Ganesh (12 month old)

Treatment	Plant height (cm)	No. of roots/ plant	Root length (cm)	Root wt. (g/plant)	Shoot wt. (g/plant)	Total biomass (g/plant)
T-1 Soil	42.4	7.0	57.0	5.9	9.8	15.7
T-2 Sand	31.5	6.3	39.1	2.7	6.6	9.3
T-3 Soil + Sand (1:1)	41.8	7.7	56.6	4.6	8.5	13.1
T-4 Soil + VC* (1:0.5)	74.3	10.3	53.5	22.5	32.1	54.6
T-5 Soil +FYM (1:1)	71.3	10.3	49.5	21.5	30.1	51.6
T-6 Soil + Sand +FYM (1:1:1)	63.1	8.7	53.2	17.8	24.3	42.0
T-7 Soil +Sand +VC (1:1:0.5)	64.4	10.7	53.6	19.5	27.6	45.0
CD (P=0.05)	**10.74**	**1.83**	**10.01**	**4.9**	**7.33**	**11.54**

VC*: Vermicompost

Quality evaluation of promising varieties of pomegranate fruits

In general, Bhagwa and Ganesh are commercial varieties of pomegranate in Maharashtra. All the three *bahars* viz. *Ambe*, *Mrig* and *hastha* are taken by growers and information on their quality parameters are not available. Therefore, quality aspects of these varieties were got analyzed from National Institute of Nutrition, Hyderabad. Overall quality aspects of Bhagwa was slightly superior to Ganesh in *Hastha bahar* fruits (Table.12).

Table 12: Fruit quality of Bhagwa and Ganesh from *Hastha bahar*

Sl. No	Parameters		
		Bhagwa	**Ganesh**
1	Moisture (%)	81.27	81.17
2	Total Ash (%)	0.53	0.46
3	Protein (%)	1.41	1.21
4	Fat (%)	0.31	0.24
5	Crude fiber (%)	1.6	1.40
6	Carbohydrates (%)	14.88	15.52
7	Calorific Value (K cals/100g)	67.95	69.08
8	Minerals (mg/100g)		
i)	Iron	0.39	0.30
ii)	Zinc	0.26	0.19
iii)	Calcium	2.50	2.71
iv)	Magnesium	10.22	7.78
v)	Copper	0.26	0.28
vi)	Manganese	0.13	0.13
vii)	Phosphorus	34.73	28.23
9	Vitamins (mg/100g)		
i)	Thiamine	0.09	0.06
ii)	Niacin	0.22	0.25
iii)	Ascorbic acid	23.38	22.42
10	Total Carotenoids (µg/100g))	26	27

Crop Protection

Studies on important diseases of pomegranate

Bacterial blight

Bacterial blight prevalence

During the year 2007-08, surveys of Ahmednagar, Nashik and Solapur districts of Maharashtra and Bagalkot, Gadag, Koppal and Bijapur districts of Karnataka were carried out to assess the severity of bacterial blight.

Bacterial blight prevalence in Maharashtra

Surveys conducted during August 16-17, 2007 of Nashik and Ahmednagar districts revealed no blight incidence in Ahmednagar, where as blight was observed in mild to severe form in Nashik (Table13). Bacterial blight was in severe proportion only in Deola taluka of Nashik, where 14.2% orchards showed severe blight, 57.0% moderate and 28.5% in traces (Fig.23). In Satana taluka, blight was only in traces (22.2%). No blight was observed in Malegaon and Kalvan talukas of Nashik. Sangamner and Akola talukas of Ahmednagar were observed free from blight. In Solapur, blight was in 60% orchards, out of which 10%, 30% and 20% orchards revealed blight in severe, moderate and mild form, respectively (Fig.24). In general, blight prevalence was 39.6% in Maharashtra.

Blight prevalence in Karnataka

Bagalkot, Gadag, Koppal and Bijapur districts of Karnataka were surveyed for blight during February 3-6, 2008. The disease was prevalent in all the four districts in mild to moderate proportion. Bijapur district had the maximum disease prevalence (78%) followed by Koppal (64.0%) and Bagalkot (40.0%). Koppal and Bagalkot were most affected (Fig.25), as blight was in moderate form (11.0-40.0% intensity). In general, blight prevalence in Karnataka was 57.13% (Table 13). Based on pathogenicity tests, the causal organism of bacterial blight was identified as *Xanthomonas axonopodis* pv.*punicae*.

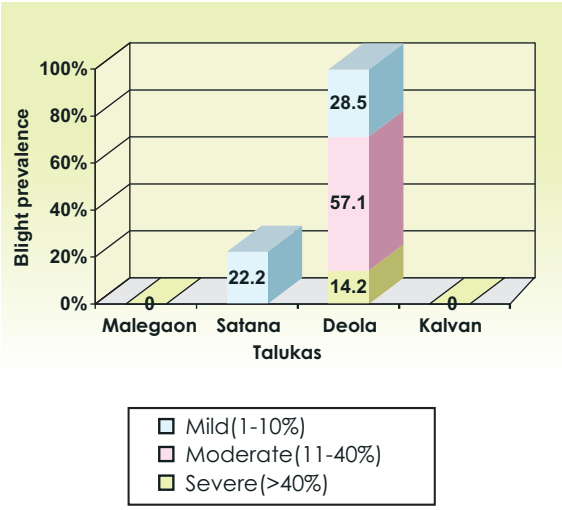


Fig.23: Bacterial blight prevalence in different talukas of Nashik district during August, 2007

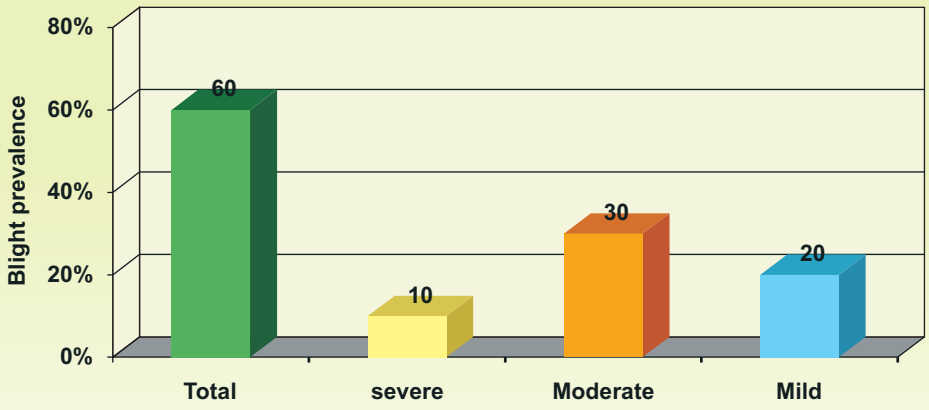


Fig.24: Bacterial blight prevalence in Solapur during 2007-08

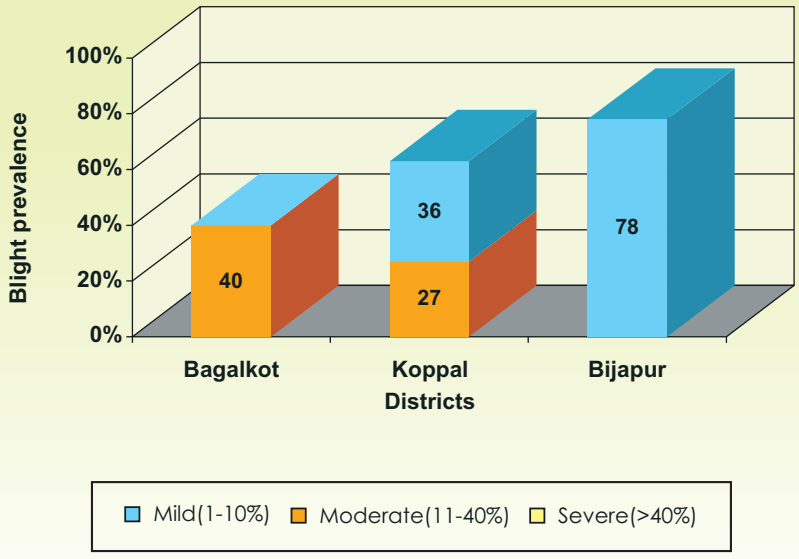


Fig.25: Bacterial blight prevalence in different districts of Karnataka during February, 2008

Table 13 : Survey of pomegranate orchards in Maharashtra and Karnataka for assessing bacterial blight prevalence and severity during 2007-08

State	District (No. of orchards surveyed)	Month/Date of survey	Disease prevalence (%)	Orchards affected with Blight (%) Severity grades			
				Severe	Moderate	Mild	Free
Maharashtra	Nashik (23)	August 16-18, 2007	39.12	4.34	17.39	17.39	60.86
	Ahmednagar (10)	August 16-18,2007	0.00	0.00	0.00	0.00	100.0
	Solapur (20)	May 2007 March 2008	60.00	10.00	30.00	20.00	40.00
	Total (A) (53)		**39.61**	**5.66**	**18.86**	**15.09**	**60.37**
Karnataka	Bagalkot (15)	February 3-6, 2008	40.00	0.00	40.00	0.00	60.0
	Koppal (11)	February 3-6,2008	63.63	0.00	27.27	36.36	36.36
	Bijapur (9)	February 3-6, 2008	77.77	0.00	0.00	77.77	22.22
	Total (B) (35)		**57.13**	**0.00**	**25.71**	**31.42**	**42.85**
	Total (A+B) (88)		46.58	3.40	21.59	21.59	53.40

Isolation and maintenance of associated microflora and their pathogenicity

Isolations were made from infected leaf and fruit samples. Twenty two isolates of bacterial blight of pomegranate and 1 isolate of bacterial blight of a cruciferous weed have been maintained in pure culture for further studies. The pathogenicity of three isolates of bacterial blight (BB1, BB3 and BB13p) was proved in pot culture experiments. Symptoms were produced throughout on different parts of the plant (Fig.26). One of the cultures was identified as *Xanthomonas axonopodis pv. punicae* from *CCRI,* Nagpur.

Fig. 26: Bacterial blight symptoms produced on different plant parts in pathogenicity tests

Bacterial blight on weed

A cruciferous weed in a pomegranate orchard was found to exhibit blight like symptoms (Fig.27). Symptoms were due to a bacterium *Xanthomonas sp*. On the basis of cultural characters, pathogenicity on the same weed has been proved but on pomegranate it is to be done.

Fig. 27 Bacterial blight on a weed

Standardization of pathogenicity tests for bacterial blight

Nine different methods of inoculation were evaluated in February 2008 to get a suitable method for screening of germplasm against bacterial blight (Fig.28). The 6 month old potted plants were inoculated with 48 hrs growth of *X. axonopodis* pv *punicae* in nutrient broth, which was diluted in 1:4 ratio before inoculation on February 21, 2008. The plants were predisposed to high humidity by covering with polythene bags, 24 hours before inoculation and 48 hours after and the results have been presented in Table14. Though symptoms were produced early and with high intensity in I-10 (Infusion method), all spray methods with or without injury exhibited high intensity 5 days later, hence using simple spray which was less cumbersome and time saving, was found suitable for screening large number of germplasm.

Table 14 : Effect of different methods of inoculation in the development of bacterial blight

Treatment	Method	First symptoms observed (DAI)	Disease intensity**
I-1	Control	--	--
I_2	Sprayed whole plant	15 days	High
I-3	Puncturedleaf midrib at 2-3 places and sprayed whole plant	15 days	High
I-4	Punctured upper part of stem and young petioles and sprayed whole plant	15 days	High
I-5*	Injected inoculum into leaves and stems with 24 gauge needle and syringe. One inoculation per leaf, and 8 leaves/ stem inoculated	15 days	Moderate
I-6*	Cut leaf lamina partially with scissors and dipped in inoculum	15 days	High
I-7*	Injected inoculum in axils with 24 gauge needle and syringe	30 days	Mild
I-8*	Inoculated with 100ml of inoculum, added to roots (soil removed)	No symptoms	No symptoms
I-9*	Injected young stems with syringe after removing the apical 3-4 inch stem	No symptoms	--
I-10*	Infuse inoculum into centre of leaf lamina on lower leaf surface and midrib using 24 gauge syringe, without needle and slight pressure till water soaked impression seen	8	High

DAI: Days after inoculation
** Mild:< 10%, Moderate: Between 10-40% , High:> 40%
* plants were not sprayed

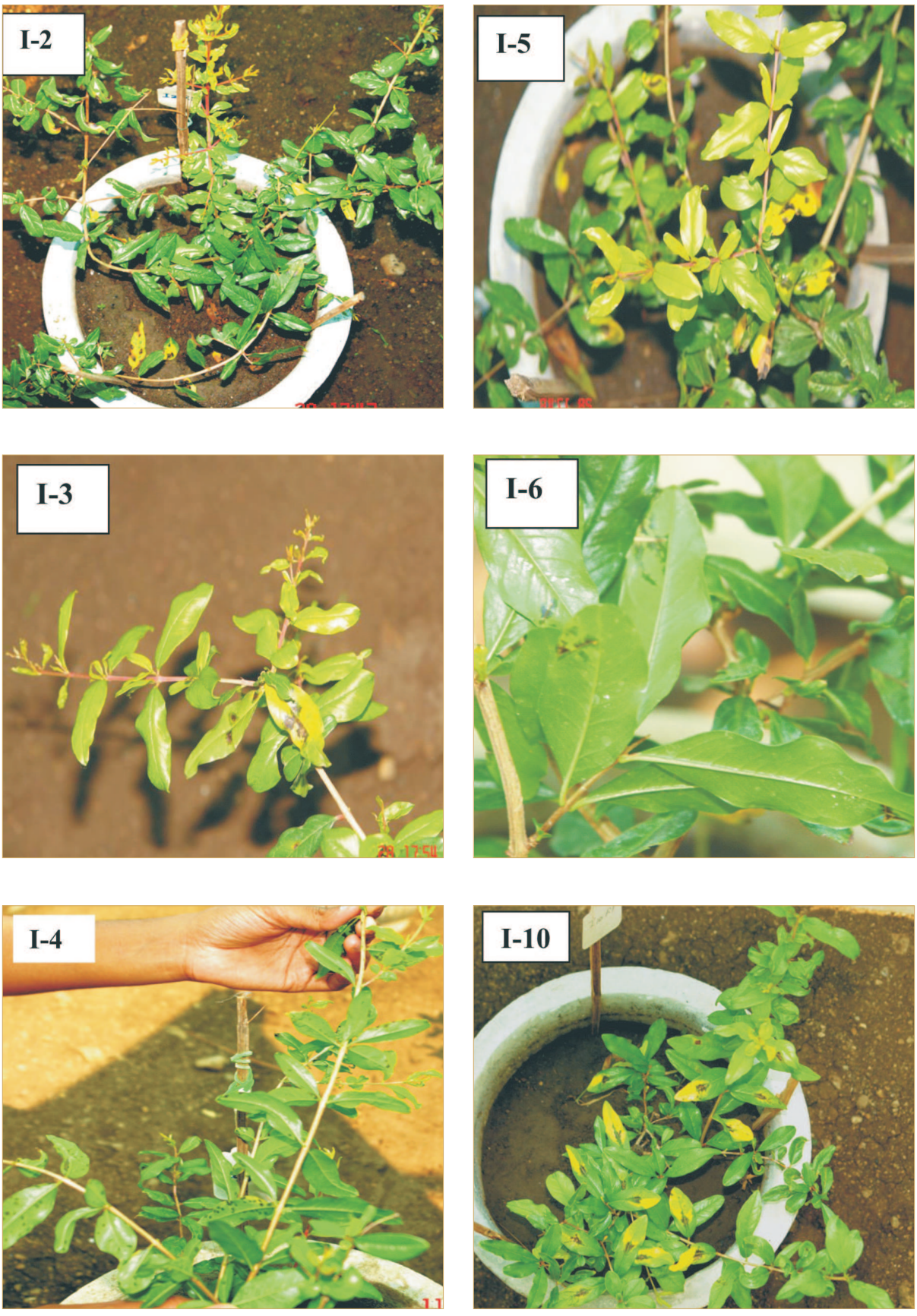


Fig. 28 : Bacterial blight symptoms produced by different methods of inoculation

Transmission

Through propagating material

Plants which were inoculated during January 2007 produced severe blight symptoms on all above ground parts of the plant and have been maintained to observe progress of symptoms. The infected plants were pruned removing old and infected twigs. The apparently healthy stems of these plants were also used for propagation. The fresh leaves which appeared after defoliation have till date (March 2008) not produced any symptoms. The foliage of hard wood stem cuttings found disease free till date and they will be monitored further.

Epidemiology

Bacterial blight development during different seasons

Ambe bahar

Data reveal that blight severity was only 5.5% in the last week of May and by the end of July disease severity reached upto 100.0% (Fig.29), thereby, destroying the entire fruit crop. Area under disease progress curve during *Ambe bahar* was 3285.1. During the season blight spread at brisk rate as evident from the apparent infection rate 'r' =0.2/unit/day (Table 15).

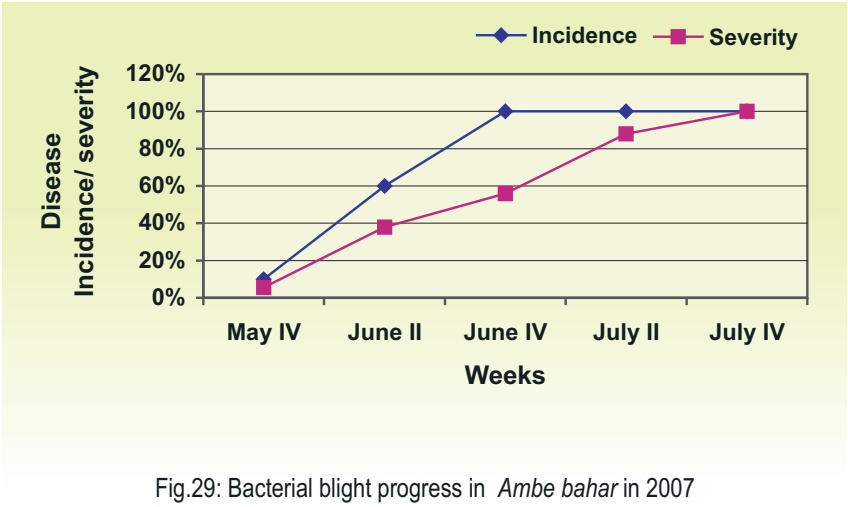


Fig.29: Bacterial blight progress in *Ambe bahar* in 2007

Table 15 : Area under disease progress curve and apparent infection rate in *Ambe bahar* and *Hastha bahar* during 2007-08

Crop season	Observation period	Area under disease progress curve (AUDPC)	Apparent infection rate 'r'/Unit/day
Ambe bahar	May. IV to July IV	3285.1	0.21
Hasth bahar (Unsprayed)	Jan. IV to March IV	885.1	0.08
Hasth bahar (Sprayed)	Jan. IV to March IV	316.7	0.04

Hastha bahar

Blight progressed at a slow pace during the season as disease severity was only 5.5% during last week of January and by the last week of March disease severity increased to 38.0%. However, blight incidence at the same point of time was 100.0% on cv. Bhagwa (Fig.30). AUDPC was 885.5 and apparent infection rate 'r' was 0.08/unit/day.

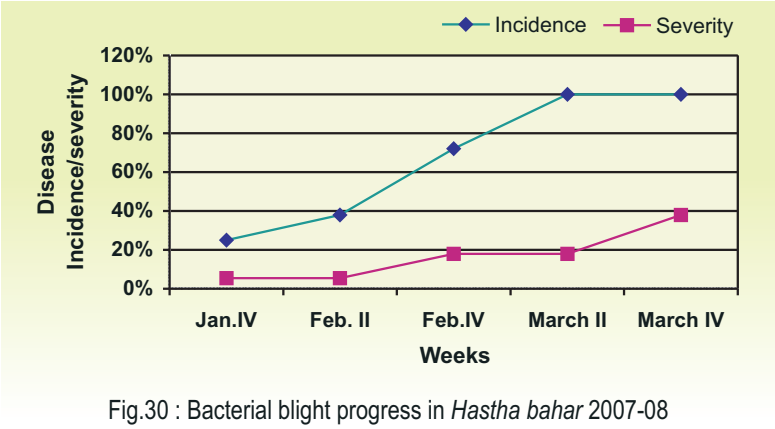


Fig.30 : Bacterial blight progress in *Hastha bahar* 2007-08

The blight severity was more during the *Ambe bahar* (100.0%) as compared to *Hastha bahar* where maximum severity was 38.0%, though incidence was 100.0% (Fig.31). Severe nature of blight in *Ambe bahar* is reflected from the fact that AUDPC values in *Ambe bahar* and *Hastha* bahar were 3285.1 and 885.5, respectively, where as apparent infection rate 'r' was 0.2/unit/day and 0.08/unit/day in *Ambe* and *Hastha bahar* crops, respectively (Table 15).

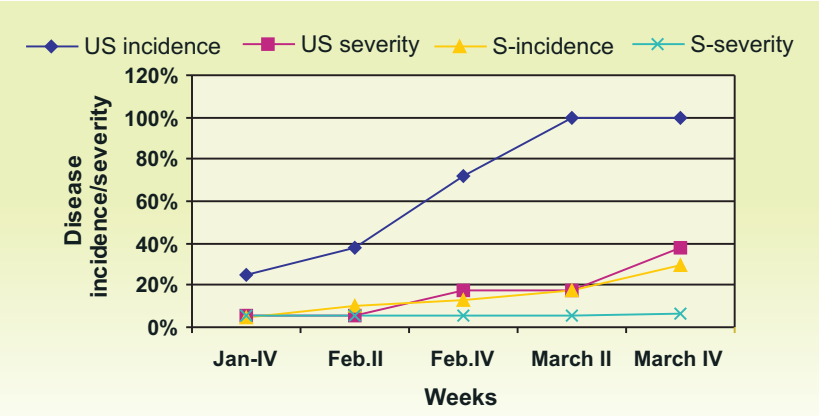


Fig.31 : Bacterial blight progress in unsprayed (US) and sprayed(S) *hastha bahar* (2007-08)

Blight severity on different cultivars

Blight incidence and severity on different cultivars as recorded on February 21, 2008 are presented in Fig.32. Cultivars Bhagwa and Arakta showed higher disease (72.0 %) incidence as compared to cv. Ganesh (41.0%). Disease severity was 18.0 and 16.88% on cvs. Arakta and Bhagwa, respectively and on cv. Ganesh severity was only 6.1%. The blight was more severe on cvs. Bhagwa and Arakta (Fig.32).

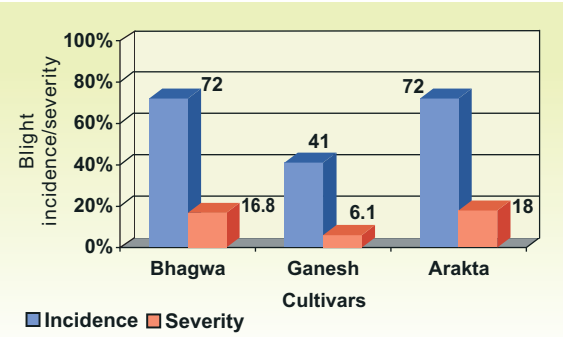


Fig.32: Bacterial blight incidence /severity in different pomegranate cultivars in *hastha bahar* crop in Feb. 2008.

Mode of bacterial blight development during *hastha bahar*

Efforts were made to study the mode of infection in fruits, whether the infection initiated from the pedicel/stem end or calyx end or fresh lesions were formed on fruits itself. Critical examination of diseased fruits revealed infection from the stem (pedicel) end in 37.6% of the fruits and from the calyx end in only 11.59%. In 20% of the fruits infection was traced to both pedicel and calyx end and in another 20.0% fruits, mode of infection could not be ascertained due to coalesced lesions and complete drying of the fruits. Only 1.4% of the fruits revealed fresh lesions with no indication of spread from either pedicel or calyx end.

Studies on survivability of blight pathogen

Survivability of *X. axonopodis* pv.*punicae* was studied in infected leaves during 2007-08. The infected leaves were incubated under laboratory conditions and examined periodically for presence of bacterium and also used for isolating the blight pathogen on media. The bacterial survivability in infected leaves noticed even at the end of 9 months. However, some reduction in bacterial inoculum was observed after 3 months of incubation.

Studies on streptocycline resistance

The sensitivity of *X. axonopodis* pv.*punicae* was studied against streptocycline by employing poisoned food technique. Two out of four isolates of the bacterium had developed resistance at lower concentration (10ppm). However, no growth of bacterium was observed at higher concentrations (25-250 ppm).

Screening of chemicals and bio-agents for the control of bacterial blight *In vitro* screening of chemicals and antibiotics

Thirteen antibiotics were tested at 2 different concentrations (200 and 400 ppm) *in vitro* using inhibition zone technique. Five were significantly more effective than streptocycline,2 less effective and 5 ineffective (Table 16).

Treatment	Concentration (ppm)	
	200	400
T1	17.00	19.00
T2 (Streptocyline)	19.00	20.33
T3	23.00	26.00
T4	0.00	0.00
T5	10.0	11.0
T6	20.00	21.67
T7	0.00	0.00
T8	22.67	27.00
T9	0.00	0.00
T10	20.00	22.0
T11	0.00	0.00
T12	20.33	28.00
T13	0.00	0.00
CD (P= 0.05%)	**0.49**	

Table 16 : Sensitivity of *X. axonopodis punicae* to chemicals and antibiotics Inhibition zone- well method)

Among 33 antibiotics (including streptocycline) tested using sensitivity discs method, 13 were significantly superior to streptocycline, 8 were at par and 11 less effective (Table17).

Table 17: Sensitivity of *X. axonopodis pv punicae* to different antibiotics (Sensitivity discs)

Treatment	Concentration (mcg)	Mean
A1	17/10	32.00
A2	30	30.67
A3	100/10	28.00
A4	10	26.67
A5	25	26.33
A6	30	26.00
A7	30	25.67
A8	30	25.67
A9	5	25.00
A10	5	24.67
A11	5	23.33
A12	30	23.00
A13	30	22.33
A14	30	22.33
A15	30	22.00
A16	30	20.33
A17	30	20.33
A18	75	20.00
A19	20*	20.00
A20	100	19.67
A21	30	18.33
A22	75	17.67
A23	100	17.00
A24	30	16.67
A25	25	16.00
A26	300	15.00
A27	10	14.33
A28	30	14.33
A29	10	13.33
A30	30	13.00
A31	10	11.67
A32	10/10	10.33
A33	10	10.00
	CD (P=0.5)	**2.38**
	CD (P=0.1)	**3.16**

***** Streptocycline disc 20mcg was prepared by impregnating 50µl of 400ppm solution on 5mm filter paper disc

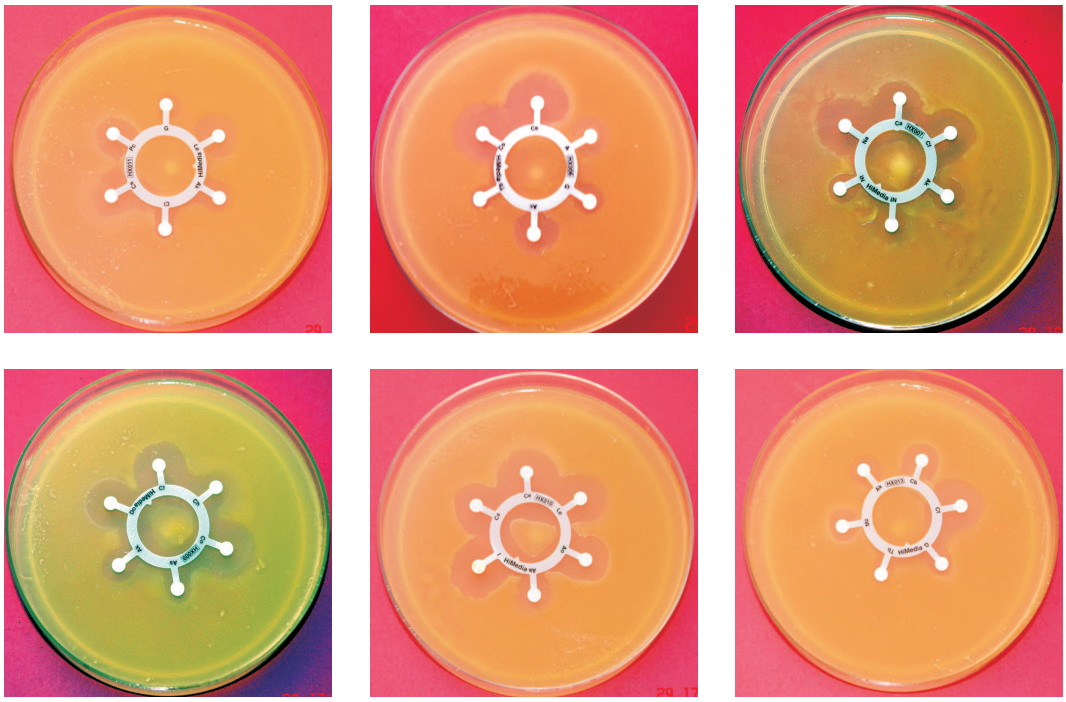


Fig 33a: Inhibition zones produced by different antibiotic sensitivity discs

Inhibition of *X. axonopodis pv punicae* at different concentrations of selected antibiotics

Five antibiotics were tested at 12 different concentrations ranging from 0.001 to 240 mcg. All antibiotics except Neomycin, inhibited the pathogen even at low concentrations between 0.1 -2 mcg, however, between 2-8 mcg, chloramphenicol was most effective followed by ceftriaxone, tetracycline, kanamycin and neomycin. Beyond this concentration, neomycin was as good as or better than tetracycline and kanamycin (Fig. 33a and b).

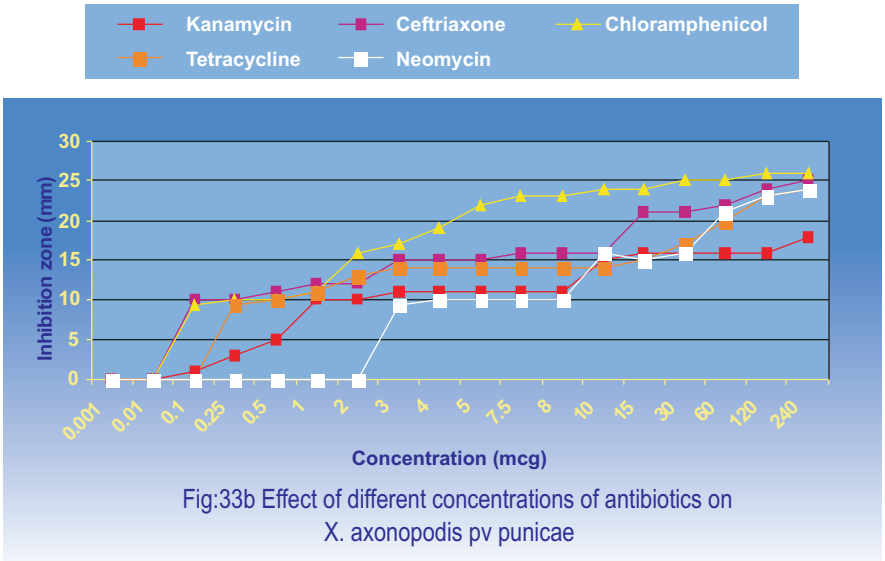


Fig:33b Effect of different concentrations of antibiotics on *X. axonopodis pv punicae*

In vivo screening of chemicals/antibiotics and bio-agents

Fourteen chemicals and antibiotics, 10 bio-agent including 5 isolates of PPFM, 3 of *Pseudomonas fluorescence*, one each of *Trichoderma harzianum,* algae and commercial formulation were evaluated in replicated field trials. The disease level in the control, at the time of reporting was too low to draw any conclusion, hence, final observations would be taken later at harvest and conclusions would be drawn accordingly.

Bacterial blight management

Bacterial blight management under field conditions

Field trials were conducted during 2007-08 in *hastha bahar* on cv. Bhagwa to study the efficacy of streptocycline (500ppm) +carbendazim (0.15%) sprays on blight management. Blight severity in unsprayed crop was 38.0% (Fig. 31) as compared to sprayed one (6.5%). However, the disease incidence in unsprayed and sprayed crops was 100.0% and 30.0%, respectively. Sprays of streptocycline (500ppm) at 15 days interval resulted in 82.2% disease control during the late *hastha bahar* (October 2007-May 2008).

Post infection activity of antibiotics against *X. axonopodis pv.punicae*

Activity of different antibiotics namely pronopal, bactronol, bactrinashak, streptocycline and cephalosporin was studied through series of laboratory experiments on reduction of blight inoculum using naturally blight infected foliage and twigs collected from infected plants. The infected foliage and fruits were dipped in antibiotic solutions of different concentrations and examined after different incubation intervals for bacterial production under the microscope. However, no consistent and convincing results were obtained on reduction of bacterial growth and thus experiment remained inconclusive.

Rejuvenation of severely blight affected/ adopted orchard at Solapur

NRCP adopted a severely blight affected orchard (cv. Bhagwa, 6 years old) having an area of 3 acres at Hiraj village in Solapur district for rejuvenation in May 2007. Bacterial blight was prevalent in severe form in May-June 2007 at Hiraj farm at the time of adopting the orchard (Fig.34). Orchard health management schedule which included the following measures was followed for the effective management of bacterial blight (*X. axonopodis* pv. *punicae)* and obtaining quality produce.

Fig. 34 : Severely blight affected orchard at Hiraj before adoption in May 2007

Fig.35 : Bacterial blight free and healthy *hastha bahar* crop in adopted orchard at Hiraj in 2008

- Severe pruning of diseased and dead branches followed by immediate sprays of streptocycline (500ppm) + fungicides like carbendazim (0.15%)/ copper oxychloride (0.25%). These sprays were continued at 15 days interval throughout the season till fruit maturity (June 2007 to April 2008).
- Applied Bordeaux paste (10%) to main stem 2 feet above the ground level and to cut ends of branches and twigs.
- Sanitation measures strictly followed including collection and destruction of diseased plant parts and dusting the orchard particularly the area under crop canopy with copper dust 4 % @ 20 Kg/ha in June and November.
- Provided rest period of 4 months from June to September 2007.
- Prior to flower regulation, defoliation was done in the first week of October for flower regulation in late *Hastha bahar* (October November 2007).
- Applied bio-fertilizer consortium consisiting of *Trichoderma viride*, *T. harzianum*, *seudomonas fluorescence*, *P.striata*, *Azotobacter*, *Acetobacter* and PPFM @ 250g/plant in October immediately after defoliation. Also applied recommended fertilizer dozes of N (625g/plant, half doze in November and rest half in January), P_2O_5 (250g), K_2O (250g/plant) in November.
- Sprayed insecticides namely monocrotophos (0.15%) and chloropyriphos (0.1%) for the management of fruit borer, sucking pests and leaf eating caterpillar, respectively, in the months of September, November 2007 and February 2008.
- Manual fruit thinning done in February 2008 to maintain 80-100 fruits/tree.

After following the above mentioned Good management practices, the adopted orchard revealed 82.2% bacterial blight control and produced healthy fruits of better quality (Fig.35) as compared to adjacent non-adopted orchard. Besides, there was complete control of other leaf and fruit spots and insect-pests which otherwise were prevalent in non-adopted orchard. Crop was harvested in the first week of May 2008 and fruit yield recorded was 16t/ha.

Leaf and fruit spots and fruit rots

Surveillance

During surveys conducted in August 2007, majority of the orchards in Ahmednagar (70.0%) and Nashik (47.8%) districts revealed leaf and fruit spots in moderate proportion (Table 18). Remaining orchards in Ahmednagar (30%) and Nashik (52.16%) districts revealed spots in traces to severe form. In Solapur, however, spots were observed in traces. Surveys of Bagalkot, Gadag, Koppal and Bijapur districts during February 2008 revealed spots prevalence in traces (28.57%), moderate form (37.14%) and severe form (2.87%).

Fruit rot prevalence was 60.0% in Ahmednagar and 30.0% in Nashik districts. In Karnataka, fruit rots were prevalent in moderate form in 5.71% orchards (Table 19). Isolations from leaf and fruit spots samples on PDA media revealed association of different spots causing pathogens like *Cercospora punicae, Colletotrichum* spp., *Dreschlera rostrata, Alternaria alternata*. However, *Colletotrichum gloeosporioides* and *Aspergillus* sp. were isolated from fruit rot affected samples. Forty nine isolates of fungal fruits spots (*Cercospora, Colletotrichum, Alternaria, Dreschlera spp.*), 25 of fungal leaf spots (*Cercospora, Colletotrichum, Alternaria spp.*) and 15 isolates of fruit rots (*Colletotrichum, Penicillium, Aspergillus Spp.*), have been maintained in pure culture.

Table 18 : Survey of pomegranate orchards for assessing prevalence and severity of leaf and fruit spots in Maharashtra and Karnataka during 2007- 08

State	District (No. of Orchards surveyed)	Month/ Date of Survey	Disease prevalence (%)	Orchards affected with leaf and fruit spots(%)			
				Severity grades			
				Severe	Moderate	Mild	Free
Maharashtra	Nashik (23)	August 16-18, 2007	100.0	43.47	47.82	8.69	0.00
	Ahmednagar (10)	August 16-18,2007	100.00	10.00	70.00	20.00	0.00
	Total (A) (33)		**100.00**	**33.33**	**54.54**	**12.12**	**0.00**
Karnataka	Bagalkot (15)	February 3-6,2008	66.66	6.66	60.00	0.00	33.33
	Koppal (11)	February 3-6,2008	54.54	0.00	27.27	27.27	45.45
	Bijapur (9)	February 3-6,2008	88.88	0.00	11.11	77.77	11.11
	Total (B) (35)		**68.58**	**2.87**	**37.14**	**28.57**	**31.42**
	Total(A+B) (68)		83.80	17.64	45.58	20.58	16.17

Table 19 : Survey of pomegranate orchards for assessing prevalence and severity of fruit rots in Maharashtra and Karnataka during 2007-08

State	District (No. of orchards)	Month/Date of Survey	Disease prevalence (%)	Orchards affected with fruit rots (%)			
				Severity grades			
				Severe	Moderate	Mild	Free
Maharashtra	Nashik (23)	August 16-18, 2007	30.42	4.34	8.69	7.39	69.56
	Ahmednagar (10)	August 16-18,2007	60.00	0.00	30.00	30.00	40.00
	Total (A) (33)		**39.39**	**3.03**	**15.15**	**21.21**	**60.60**
Karnataka	Bagalkot (15)	February 3-6,2008	6.66	0.0	6.66	0.0	93.33
	Koppal (11)	February 3-6,2008	0.00	0.0	0.0	0.0	100.0
	Bijapur (9)	February 3-6,2008	11.11	0.0	11.11	0.0	88.88
	Total (B) (35)		**5.71**	**0.0**	**5.71**	**0.0**	**94.28**
	Total (A+B) 68)		22.05	1.47	10.29	10.29	77.94

Epidemiology

Cercospora and *Colletotrichum* spots were severe during the humid conditions in the months of July to September. However, *Cercospora* spots were also observed in Koppal district of Karnataka during February. On the other hand, *Alternaria* spots were observed throughout the year. Scab symptoms were more common in February during surveys of Karnataka and also observed in August in Ahmednagar district.

Though fruit rots were observed throughout the year, incidence of rots was more common during rainy conditions as observed in the month of August in Ahmednagar district of Maharashtra.

Management of fruit spots and fruit rots

Leaf and fruit spots caused by different fungal pathogens were effectively managed by the sprays of carbendazim (0.2%), mancozeb (0.2%) and copper oxychloride (0.25%) under field conditions.

Wilt

Surveillance

Pomegranate orchards in Maharashtra and Karnataka were surveyed for assessing wilt incidence during 2007-08. Survey carried out during August 2007 revealed high wilt prevalence (78.0%) in Nashik district followed by Solapur (40.0%) and Ahmednagar (30.0%) (Table 20). In Sangamner and Akola talukas of Ahmednagar district, wilt prevalence was 16.6 and 50%, respectively (Fig.36). In Nashik district, out of 4 talukas surveyed, wilt was more prevalent in Malegaon (100% prevalence) followed by Satana (78%) and Deola (71%). In Malegaon and Satana talukas wilt was recorded in moderate proportion (11-40% severity) in 60% and 55.5% orchards, respectively (Fig.37). In Solapur district (Pandharpur, Malsirus and South Solapur talukas), wilt was observed in mild form (1-10%) where as in North Solapur taluka, disease was prevalent in moderate form (25%) (Fig.38). In Maharashtra, wilt was not present in severe form in any of the orchards and was observed in traces to moderate proportion in 33.9% and 20.75% orchards, respectively. In general, wilt prevalence in Maharashtra was 54.71%.

Survey conducted during February 2008 in Karnataka revealed wilt prevalence in 59.9% orchards from traces to severe form (Table 20). Wilt was prevalent in 80% orchards in Bagalkot, 63.6% in Koppal and 22.2% in Bijapur districts. Barring Koppal district, disease was prevalent in traces (42%) to moderate (11.42%) form in different orchards of Karnataka. In Koppal district, however, wilt was observed in severe form in 18.1% orchards.

Table 20 : Survey of pomegranate orchards in Maharashtra and Karnataka for assessing wilt prevalence and severity during 2007-08

State	District (No of Orchards)	Month/ Date of survey	Wilt prevalence (%)	Orchards revealing wilt (%)			
				Severe (>40%)	Moderate (11-40%)	Mild (1-10%)	Free
Maharashtra	Nashik (23)	August 1-6 18, 2007	78.25	0.0	34.7	43.47	21.73
	Ahmednagar (10)	August 1-6 18,2007	30.00	0.00	10.00	20.00	70.00
	Solapur (20)	May-2007 March 08	40.00	0.00	10.00	30.00	60.00
	Total (A) (53)		**54.71**	**0.00**	**20.75**	**33.96**	**45.28**
Karnataka	Bagalkot (15)	February-3 6,2008	80.00	0.00	20.00	60.00	20.00
	Koppal (11)	February-3 6,2008	63.63	18.18	9.09	36.36	36.36
	Bijapur (9)	February-3 6,2008	27.22	0.00	0.00	22.22	77.77
	Total (B) (35)		**59.98**	**5.71**	**11.42**	**42.85**	**40.00**
	Total (A+B) (88)		**56.81**	**2.27**	**17.04**	**37.50**	**43.18**

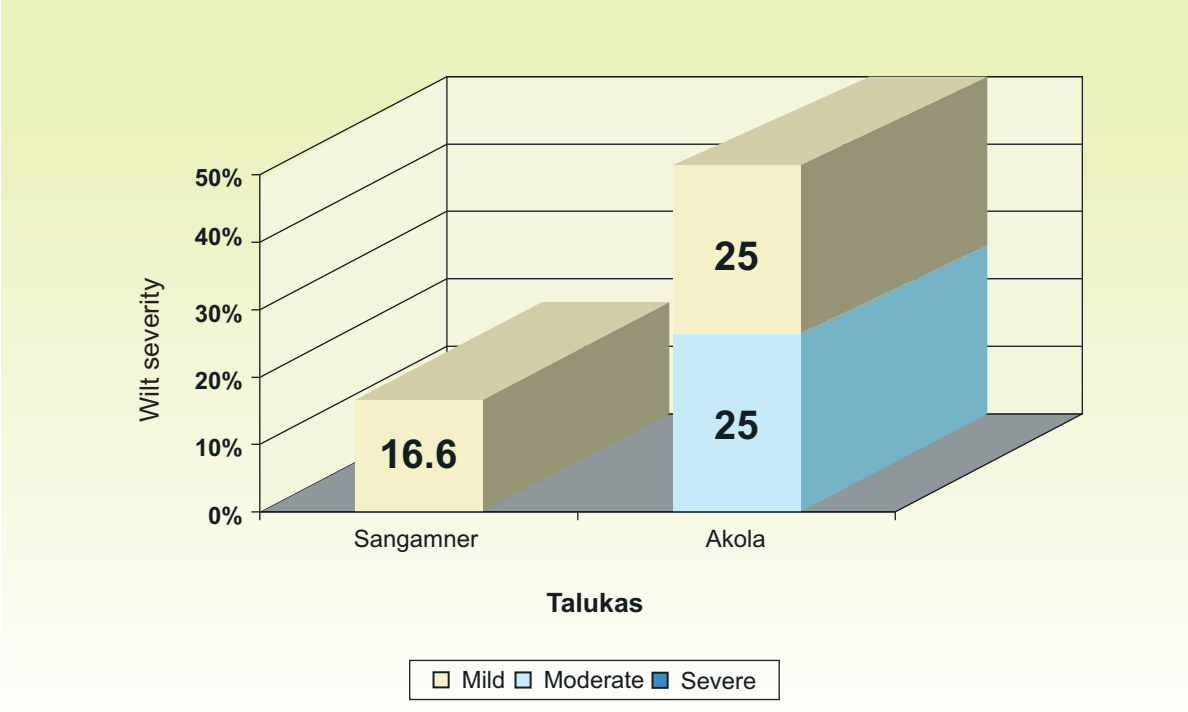


Fig.36: Wilt prevalence and severity in Ahmednagar.

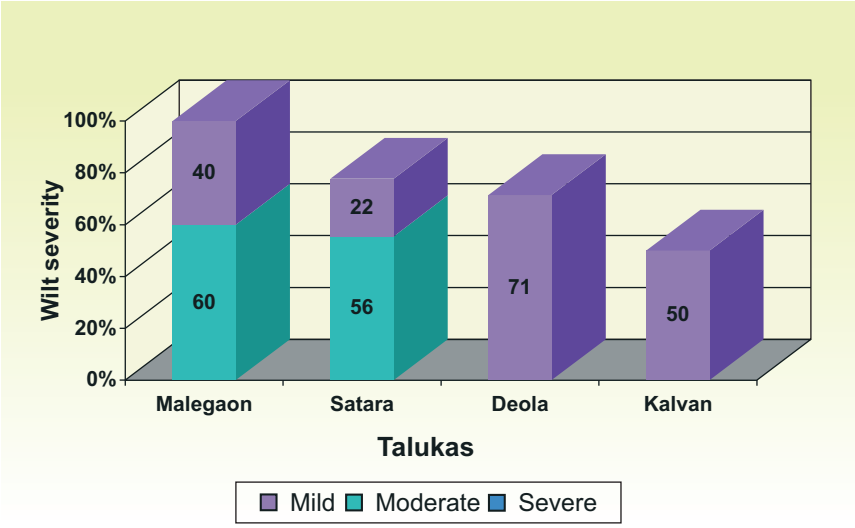


Fig.37 : Wilt prevalence and severity in Nashik

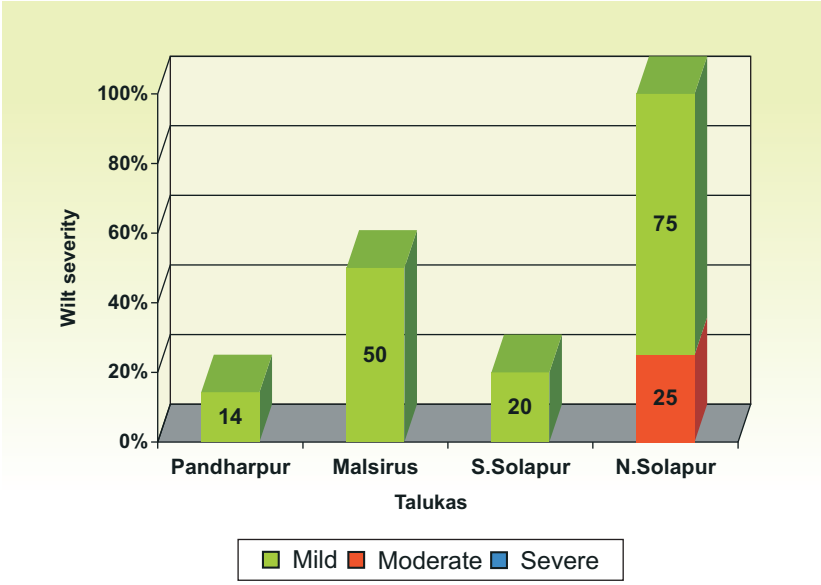


Fig. 38 : Wilt prevalence and severity in Solapur

Symptomatology

Initial disease symptoms were observed as yellowing of foliage of one or a few branches of a tree followed by yellowing and drooping of foliage of the entire tree (Fig39a). At times only one or two stems of the tree showed wilting and it took a few weeks to some months for the entire tree to completely wilt (Fig.39b). Occasionally on some plants wilt symptoms were observed as drooping of entire tree's foliage all of a sudden. It is important to mention that wilt infected plants often revealed dried foliage and fruits intact for many months (Fig.40).

Fig. 39: Wilt symptoms (a) partly wilted tree (b) completely wilted in Hiraj (Solapur)

Fig.40: Severely wilt infected orchard in Bagalkot district of Karnataka

Etiology

In order to ascertain the etiology of wilt, diseased plants were observed critically. Isolations were made from diseased plant parts particularly affected stems and roots and rhizosphere soil on different media. *C. fimbriata* was obtained in 77% of the isolations made on media and carrot slices from samples collected from Nashik, Beed, and Solapur districts of Maharashtra and Bagalkot and Koppal districts of Karnataka. Roots and stems of wilt affected plants often revealed greyish discolouration of vascular and adjoining tissues (Fig.41). Microscopic examination of sections of affected stem and root portion and seldom of leaf tissue revealed conidia of *C. fimbriata*.

Fig 41: C. *fimbriata* affected plant showing discolouration of cortex and adjoining stem tissues

Occasionally, isolations from roots and underground stems of wilt affected plants also revealed association of *Macrophomina phaseolina, Fusarium spp. Rhizoctonia solani, Pythium and Phytophthora spp.* Most of these pathogens were associated with root/stem rot portions of some wilt affected plants.

Some insects like stem borer (*Coelosterna* sp.), shot hole borer (*Xyleborus* sp.), bark eating caterpillar (*Inderbela* sp.) and nematodes were also found associated with wilt infections. In Bagalkot district of Karnataka, a few isolated plants revealing stem borer infestations resulted in wilting. However, in Dhodi village (South Solapur) a few wilt affected plants of cv. Ganesh

Fig. 42: Shot hole borer infested stem of wilt infected pomegranate plant

Fig. 43: Nematode attached to the ascospore mass of *C.fimbriata*. x 100

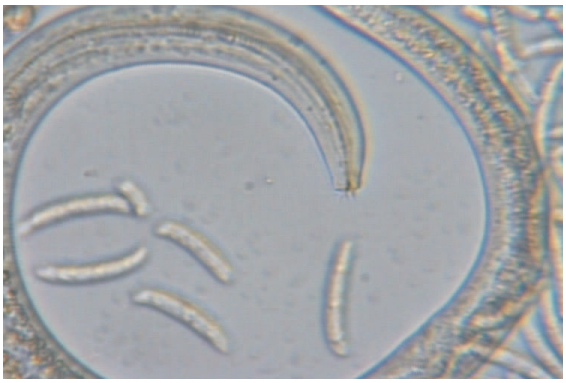


Fig.44 : Nematode along with *Fusarium* spores in wilt culture x 400

revealed *C .fimbriata* in association with shot hole borer infestation (Fig.42) in March 2008. Similarly many wilt infected soil samples from Maharashtra and Karnataka and their cultures showed nematodes in association with *C. fimbriata* (Fig.43) and *Fusarium spp*. (Fig 44). Wilt infections from a few orchards showed symptoms of root knots which on examination showed presence of nematodes and their eggs. Association of insects like shot hole borer, stem borer and nematodes (*Meloidogyne* sp.) with wilt infections is an indicator of their probable role in spread of wilt pathogen, *C. fimbriata,* and also in isolated wilt infections due to their ability to weaken and kill the plant under severe infestations.

Pathogenicity of *C. fimbriata*

Pathogenicity of *Ceratocystis fimbriata* was studied on one and half year old potted plants of cv. Ganesh under net house conditions. Spore suspension of one month old culture of *C.fimbriata* was prepared in distilled sterilised water for inoculation purpose. Inoculations were performed by three different methods I) Injuring the roots by simply scratching with razor and then mixing the inoculum in the rhizosphere soil ii) Mixing the inoculum in the rhizosphere by exposing the roots but not injuring and iii) Inoculating the main roots and underground stem with pathogen's culture growth. In a separate experiment, foliage of potted plants was inoculated by spraying spore suspension with atomizer. Wilt symptoms appeared after 25 days of inoculation in a few plants (Fig.45) and continued to develop on others with progress of time, and resulted in complete wilting (Fig.46).

Fig. 45: Wilt symptoms in potted plants inoculated with *C.fimbriata* culture (a) initial, (b) advance stage

Fig.46: Severe wilt infections in inoculated plants in pathogenicity tests

Fig. 47 : Healthy plants in un-inoculated pots(Control) during pathogenicity tests

During pathogenicity tests, wilt symptoms initiated as yellowing of a few leaves or all leaves of the plant resulting in complete drooping. In some plants wilt symptoms were conspicuous by sudden drooping of leaves of the entire plant through loss of turgor pressure. However, in a few plants wilt symptoms were initially observed on one branch only and it took some incubation period for the other branch of the same plant to develop wilt symptoms. No wilt symptoms were observed in control (Fig. 47) and such plants remained healthy throughout the experiment. Development of wilt symptoms in plants without root injury revealed that *C. fimbriata* was capable to infect and cause infections in plants on its own. However, inoculated plants with injured roots developed symptoms at faster pace as compared to plants with uninjured roots. Treatment where fungal culture was directly inoculated into main root/underground stem by giving slight incision resulted in wilt infections after longer incubation period as compared to soil inoculations. Sections of wilt affected stems/roots of inoculated plants during the pathogenicity tests, indicated presence of aleurioconidia of *C.fimbriata* (Fig.48).

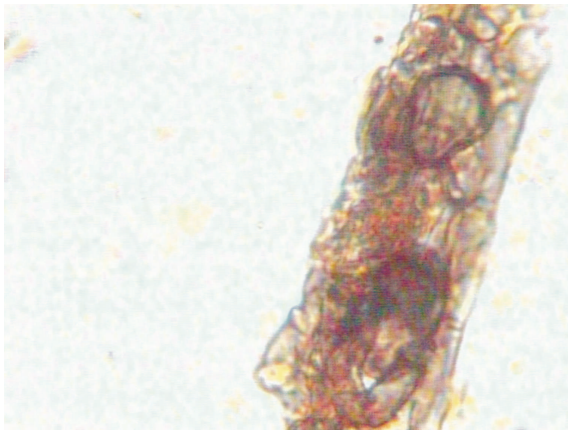


Fig. 48: Aleurioconidia of *C.fimbriata* in root tissue of wilt infected plant obtained through inoculation during pathogenicity tests.

C.fimbriata was reisolated on PDA medium from infected root and stem portion of the wilt affected plants during pathogenicity tests. Inoculations done on foliage also revealed someinfections in the form of characteristic yellowing of leaves and sections of such leaves showed conidia of *C.fimbriata*. However, there was no further development of disease on other foliage of the plant there by indicating that aerial spread of the pathogen was rare in nature. These results also get support from the fact that in wilt infected plants where only one branch was infected spread of the pathogen to adjacent branch/branches was not immediately observed despite leaves of two branches were being in contact with one another. Based on disease symptoms, microscopic examination, isolations of the pathogen on media and pathogenicity tests, the causal organism of wilt disease was identified as *C. fimbriata* Ellis and Halsted. *C. fimbriata* belongs to Phylum: Ascomycota; Class: Pyrenomycetes; Order: Microascales; Family: Ceratocystidaceae. Chalara is considered as anamorph stage of *C.fimbriata*. Results of pathogenicity tests of *Fusarium* sp.and *Macrophomina phaseolina* were not convincing and were inconclusive.

Biology of *C. fimbriata*

The pathogen was isolated from diseased plant parts and rhizosphere soil and cultured on carrot slices, PDA and Carrot agar media. Isolations of the pathogen on PDA medium at 26.0°C revealed greenish black fungal growth with hyaline septate mycelium in the beginning producing abundant endoconidia. Endoconidia were hyaline, cylindrical (Fig.49) and formed endogenously in hyphae (Fig.50) and their size varied between 10.24-42.11 x 2.35-4.57µ with average size 19.83 x 3.30µ. Aleurioconidia were ellipsoidal, pyriform or obpyriform, truncate at the base, golden brown, thick walled. They were borne singly (Fig.51) or in chains (Fig.52) and were intercalary or lateral or terminal on hyphae. Since aleurioconidia were more frequent in more than two months old cultures, had thick walls, their function appeared to be similar to chlamydospores in survival of the pathogen. Their size varied between 7.55-35.61 x 6.08-16.33 µ with av. size of 16.48 x 10.90 µ. Perithecia were blackish to brown blackish in colour, globose to subglobose and measured 137.14-286.98 x 130.36 x 263.42 µ with average size 197.90 x 181.40 µ with characteristic long necks measuring 109.72-713.14µ with average size 470.09µ (Fig.53) and releasing ascospores through ostioler hyphae towards the end of neck (Fig.55). During the course of studies, at times, ascospores were found discharged through dissolved perithecial wall also. Ascospores were hyaline, spherical to galeate and measured.3.03-5.58 x 2.59 -3.64 µ with average size of 4.18 x 3.25 µ (Fig.56). Out of 48 *C. fimbriata* isolates examined, 47 isolates were observed to be self-fertile producing abundant perithecia. One isolate NW4 was, however, self-sterile (Fig.54) as it did not produce mature perithecia in cultures even after long incubation period. The culture revealed immature perithecia and only endoconidia and aleurioconidia characteristic of genus *Chalara* considered as anamorph of *C. fimbriata.*

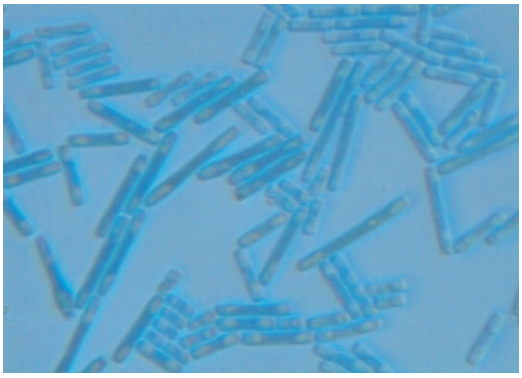


Fig.49: Endoconidia of *C.fimbriata* in culture x1000

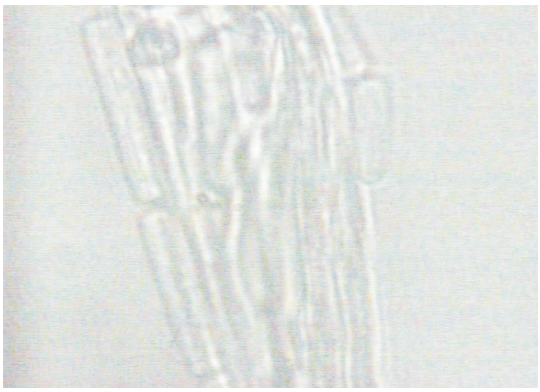
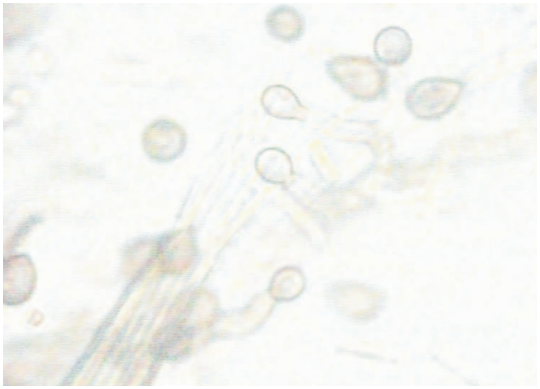


Fig 50: Endoconidia produced endogenously in hyphae in *C.fimbriata* culture x1000.



Fg.51: Aleurioconidia in *C.fimbriata* culture x400

Fg.52: Chain of Aleurioconidia in *C .fimbriata* culture x1000.

Fig. 53: Perithecia in self-fertile culture of *C.fimbriata* x 40.

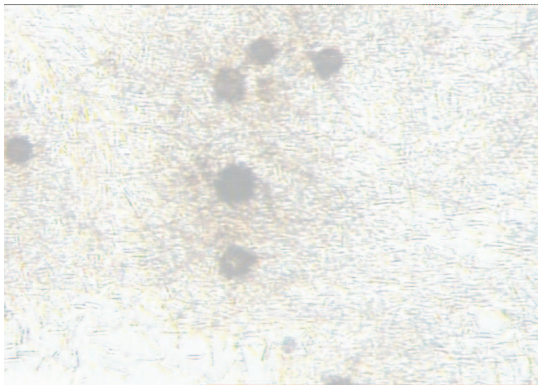


Fig. 54: Self-sterile culture of *C.fimbriata* revealing immature perithecia x40

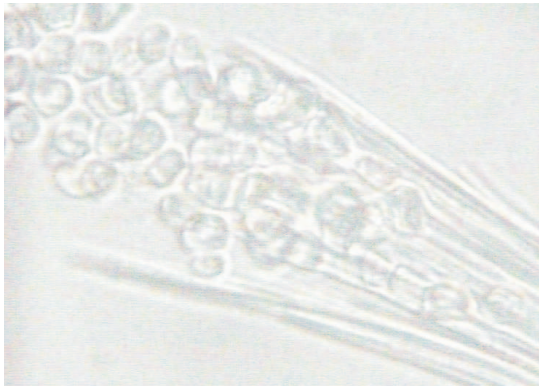


Fig. 55: Ascospores releasing through perithecial neck in *C.fimbriata* culture x 1000

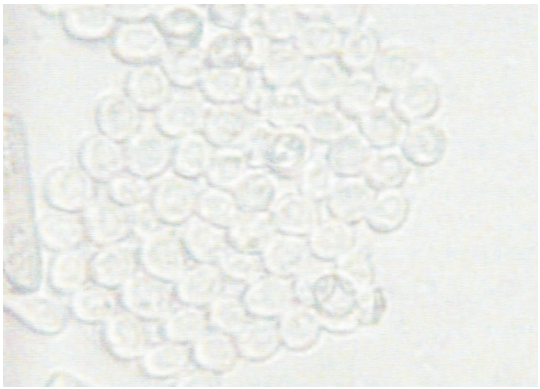


Fig. 56*: C.fimbriata* culture revealing ascospores x1000

Epidemiology

Wilt infections were evident in orchards of all ages from 2 years and above, and in all cultivars grown in the region. Similarly, wilt affected plants were prevalent in all soil types ranging from light sandy to deep clay soils. However, shallow to deep clay soils with poor drainage revealed more wilt infections.

Even sloppy lands with sandy to sandy loams in some areas of Bagalkot and Koppal districts of Karnataka and Pandharpur taluka of Solapur district in Maharashtra also revealed severe wilt infections.

Wilt disease caused by *C. fimbriata* was mainly observed to be soil borne in nature and symptoms also observed in vascular and adjoining cortex tissues of roots, underground stem and above ground stem upto 4 feet height. The pathogen was found spreading from tree to tree in and around orchards probably through movement of water and insects like shot hole borer and nematodes. Although conidia of *C. fimbriata* observed on foliage of affected plants both in nature and on artificial inoculations, wilt infections remained confined and did not spread to adjacent plants any further thereby indicating that in nature aerial spread of the pathogen was remote.

Studies on management of wilt

In vitro efficacy of different fungicides was studied against *C. fimbriata* by employing poisoned food technique. In all 9 fungicides at two different concentrations (Table 21) were evaluated against the wilt pathogen. Results revealed that 8 out of 9 fungicides (Hexaconazole, propiconazole, tricyclazole, myclobutanil, carbendazim (1000 and 1500 ppm), mancozeb, zineb, captan (1500 and 2000ppm) resulted in 100 per cent growth inhibition of *C. fimbriata* after 7 days of incubation at 26.0°C. However, copper oxychloride at 2000 and 2500 ppm provided 65.8% and 68.2% growth inhibition, respectively after 7 days of incubation.

Table 21 : *In vitro* efficacy of different fungicides against *C. fimbriata*

S.No	Fungicide	Concentration (ppm)	Fungal growth Colony diameter (cm) after days		Per cent growth inhibition after days	
			7	14	7	14
1	Hexaconazole 5%EC	1000 1500	No growth	No growth	100.0	100.0
2	Propiconazole 25%EC					
3	Tricyclazole 75%WP					
4	Myclobutanil 10% WP					
5	Carbendazim 50%WP					
6	Mancozeb 75%WP	1500 2000	No growth	No growth	100.0	100.0
7	Zineb 75%WP					
8	Captan 50%WP					
9	Copper oxychloride 50%WP	2000	1.5 x 1.3	2.1 x 1.9	65.8	64.2
		2500	1.4 x 1..2	2.02 x 1.97	68.2	64.4
10	Control	No growth	4.2 x 4.0	56 x 5.6	No growth	No growth

Farmer's visit

Pomegranate growers from different districts of Maharashtra and Karnataka visited experimental fields and enriched their knowledge in production and plant protection by interacting with the scientists. The major concern of the farmers was related to the devastating disease like bacterial blight and wilt. However, in some parts of Maharashtra fruit borer was also a major problem.

Field day

A bacterial blight affected pomegranate orchard (Cv. Bhagwa) was adopted to mitigate the disease during *hastha bahar* (Fig. 57). About 82.2% disease control was recorded. After successful completion of the trial, a field day was organized during 2007-08. The DDG (Horticulture) presided over the function and addressed the gathering of pomegranate growers. The DDG expressed his happiness and thanked the farmers for their keen interest. He told that growers should adopt the package to minimize the spread of such a devastating disease in Maharashtra and its adjoining states. More than 500 farmers participated in the field day. And they also visited the orchard and interacted with the scientists (Fig. 58).

Fig. 57: Field day organized at an adopted pomegranate orchard in Solapur

Fig. 58 : On the eve of the field day, Dr. H.P. Singh, DDG (Hort.) interacted with farmers and Maharashtra State Agricultural Officers

Kisan gosthi

On the eve of centre's establishment day, one day *Kisan Gosthi* was organized (Fig. 59) at Kegaon farm. Dr. Vedaprakash Patil, Ex.-Vice Chancellor, MPKV, Rahuri was the chief guest. The function was presided over by Dr. K.H. Govindraj, Collector, Solapur. The programme was organized by Dr. V.T. Jadhav, Director, NRCP, Solapur. More than 300 farmers, scientists from MPKV Centre, KVK, CRS (NRCS), Solapur officials from State Govt. of Maharashtra etc. attended the function.

Lectures on various aspects of pomegranate cultivation and protection were delivered for quality production followed by interface discussion with scientists and farmers. Folders on bacterial blight and wilt management and technical bulletin were distributed to the farmers.

Fig. 59 : Dignitaries (upper) and pomegranate growers (lower) at a *Kisan gosthi*

On farm visits

Scientists of the centre made visits to different pomegranate orchards in Maharashtra and Karnataka during the year to assess and solve the problems of the pomegranate growers. 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. 60, 61 and 62).

Fig. 60: Scientists visit an orchard in Bagalkot (Karnataka)

Fig. 61: Meeting of scientists from NRCP, Solapur with progressive pomegranate growers of Karnataka during their visits to bacterial blight affected orchards at Kustgi

Fig.62. Scientists visit to promote pomegranate cultivation in nontraditional area (Jhabua, M.P.)

High level meeting on bacterial blight of pomegranate

A high level meeting was held on November 4, 2007 at Pune to discuss the devastating situation created by bacterial blight disease in pomegranate. It was Chaired by Shri Sharadchandra Pawar, Hon'ble Union Minister of Agriculture, Consumer Affairs, Food and Public Distribution. The meeting

was attended by Shri Vinay Kore, Hon'ble Minister of Hort., Govt. of Maharashtra, Pune, Dr. Mangala Rai, DG, ICAR and Secretary DARE, GOI, Shri Vijay Kolte, Vice President, MCAER, Pune, Dr. H. P. Singh, DDG (Hort.), ICAR, Dr. S. M. Desalphine, Add. Secretary, GOI, Dr. N. B. Patil, Principal Secretary (Agri. and Hort.), Govt. of Maharashtra, Dr. R. B. Deshmukh, Vice Chancellor, MPKV, Rahuri, Dr. S.S. Kadam, Vice Chancellor, MAU, Parbhani, other officers from ICAR, Ministry of Agriculture, GOI and State Government of Maharashtra, Karnataka and Andhra Pradesh, NGOs. Scientists from ICAR Institutes and SAUs and progressive growers of pomegranate from Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu (Fig. 63 and 64).

Dr. Mangala Rai informed that though bacterial blight was known since 1952, it became epidemic in the recent years. Initiative taken by the ICAR has resulted in removing the confusion on blight of pathogen and formulation of a management strategy to minimize the losses. Dr.H.P. Singh emphasized the importance of bacterial blight in the country and said that the purpose of the meeting was to take stock of current situation of bacterial blight, assess the impact of 'Orchard Health Management Package' formulated in February, 2007 and develop short term and long term strategies for effective management of the disease of pomegranate (Fig. 65). Dr. V.T. Jadhav, Director, NRC on Pomegranate, Solapur presented the current scenario of bacterial blight in the country and management strategies (Fig. 66). He told that its etiology was confirmed in 1959 and first major outbreak of the disease was reported in 1987 from Karnataka, however, it took epidemic proportions in 2004 in Karnataka and Maharashtra. A management schedule was finalized by ICAR in February, 2007 for the management of the disease and NRC on Pomegranate has adopted grower's orchards for demonstrating the impact of this package. He also informed that the package has worked well wherever adopted. Dr. S.H. Jalikop, Principal Scientist, IIHR, Bangalore provided a brief account of breeding work done for developing resistant varieties to overcome bacterial blight disease in pomegranate. He said that sources of resistance are available in varieties like Daru and Nana which have to be incorporated in commercial cultivars. Shri. Feroz N. Masani, Consultant, National Horticulture Mission informed that the package has given excellent results at farmer's field in Karnataka and Maharashtra. The present package must be applied on community basis since disease moves from one plot to another.

The Hon'ble minister wanted to know the experiences and achievements from the pomegranate growers who implemented the package of practices. A large number of farmers appreciated the package for its effectiveness but requested for support to adopt the package. The Hon'ble Union Minister observed that Scientists are doing their best to give good management practices and desired that breeding work should be upscaled.

Dr.Mangala Rai also emphasized on development of resistant varieties, use of botanicals and bio-agents and collective discussions among scientists working in different institutions. He asked all Institutes and Universities to give uniform package to farmers for adoption and also to work on Integrated Nutrient Management.

Fig. 63 : Shri. Sharadchandra Pawar, Hon'ble Union Minister of Agriculture at a high level meeting on bacterial blight held at Pune

Fig. 64 : Shri. Sharadchandra Pawar, Hon'ble Union Minister of Agriculture and Dr. Mangala Rai, DG, ICAR interacting each other to announce package for bacterial blight affected orchards

Fig. 65 : Dr. H. P. Singh, DDG (Horticulture), ICAR interacting with the Director, NRCP and Maharashtra State Govt. Officials to solve the bacterial blight problems

Fig. 66 : Dr. V.T. Jadhav, Director, NRCP gives the actual scenario of bacterial blight of pomegranate in India

Transfer of technology through media

To promote pomegranate cultivation in traditional and non-traditional areas, proper media coverage on different aspects of its cultivation was regularly given through local newspapers, television channels and magazines.

Publications

Papers presented in symposia, conferences, etc

Sharma Jyotsana, Kumar P and Jadhav VT. 2007. *Manav Swasthya Evam Kalyan Mein Anar ki Bhoomika. In: Smarika Paddap Vigyan Dwara Swasth wa Samridha Samaj* held from November 29-30, 2007 at CIMAP, Lucknow. pp: 34-35(Hindi).

Sharma KK, Sharma Jyotsana, Jadhav VT and Chandra R. 2008. Bacterial blight of pomegranate and its management. In: *Plant disease scenario in organic agriculture for eco-friendly sustainability* held from January 10-12, 2008 at MPKV Regional Wheat Rust Research Station, Mahabaleshwar. Pp: 128-129.

Sharma KK, Sharma Jyotsana and Jadhav VT. 2008. Prevalence and Etiology of wilt of pomegranate. *In : National Symposium on Plant Disease Scenario in organic agriculture for Eco- Friendly Sustainability* held from January 10-12, 2008 at MPKV Regional Wheat Rust Research Station, Mahabaleshwar. Pp: 127-128.

Chandra R, Kumar P, Babu KD, Marathe RA and Jadhav VT. 2008. Effect of gamma irradiation on seed germination and survival of seedlings in pomegranate (*Punica granatum* L.). In: *National Seminar on Opportunities and Challenges of Arid Horticulture for Nutrition and Livelihood* held from March 8-9, 2008 at CIAH, Bikaner. p:91.

Bulletins and Pamphlets

Sharma Jyotsana, Sharma KK and Marathe RA. 2007. *Dalimbavaril* "Bacterial Blight" *Rogache Akalan Wa Prabandhan*. *Tech. Bull*. 2. Publ. NRCP, Solapur, 16 pages (Marathi).

Sharma KK, Jadhav VT and Sharma Jyotsana 2007. Management of Diseases and Insect Pests of Pomegranate. *Ext. Bull.*1. Publ. NRCP, Solapur, 16 pages (English).

Jadhav VT, Sharma KK, Sharma Jyotsana and Marathe RA. 2007. *Rogmukta Dalimb Bag Vyavasthapan. Ext. folder* 5. Publ. NRCP, Solapur, 6 pages (Marathi).

Books and Chapters

Jadhav VT, Sharma KK and Sharma Jyotsana 2008. Bacterial Blight (Oily Spot) of Pomegranate. *In: 'Crop Diseases - Identification and Management Colour Handbook'* (Eds. Gangawane LV and Khilare VC). Daya Publ. House, Delhi, pp: 143-145.

Sharma KK, Sharma Jyotsana and Jadhav VT. 2008. Wilt of Pomegranate. *In: 'Crop Diseases - Identification and Management Colour Handbook'* (Eds. Gangawane LV and Khilare VC). Daya Publ. House, Delhi, pp: 146-147.

Sharma Jyotsana, Sharma KK and Jadhav VT. 2008. Cercospora leaf and fruit spots of pomegranate. *In: 'Crop Diseases - Identification and Management Colour Handbook'* (Eds. Gangawane LV and Khilare VC). Daya Publ. House, Delhi, pp: 148-149.

Sharma Jyotsana, Sharma KK and Jadhav VT. 2008. Anthracnose of pomegranate. *In: 'Crop Diseases - Identification and Management Colour Handbook'* (Eds. Gangawane LV and Khilare VC). Daya Publ. House, Delhi, p: 150.

Jadhav VT, Sharma KK and Sharma Jyotsana 2008. Sun Scald of pomegranate. *In: 'Crop Diseases - Identification and Management Colour Handbook'* (Eds. Gangawane LV and Khilare VC). Daya Publ. House, Delhi, p: 151.

Jadhav VT, Sharma KK and Sharma Jyotsana 2008. Abiotic fruit cracking of pomegranate. *In: 'Crop Diseases-identification and Management Colour Handbook* (Eds. Gangawane L.V and Khilare V.C). Daya Publ. House, Delhi, p: 152.

Popular articles

Chandra R, Jadhav VT, Marathe RA and Kumar P. 2007. Wedge grafting A successful method for pomegranate propagation. *ICAR News,* 13(4): 3.

Jadhav, VT and Sharma Jyotsana 2007. Pomegranate cultivation is very promising. *Indian Horticulture*, 52(4): 30-31.

Sharma Jyotsana, Jadhav VT, Sharma KK and Marathe RA. 2007. *Telya Rokhnyasathi Samuhik Preyatnachi Garaj. Shetimitra Vigyan Yugach*, 1(9):14-16 (Marathi).

Jadhav VT, Jyotsana Sharma and Marathe RA. 2008. *Dalimbache ann wa Aushdhiya Mahatva* In: *Dalimbvrith Smarnika*, Publ. Akhil Maharashtra Dalimb Utpadak Sansodhan Sangh, Pune, pp 21-23 (Marathi).

Marathe RA and Jadhav VT. 2008. *Matitil Annadrawya Parikshan. Dalimbwrutta Smaranika*. In: *Dalimbvrith Smarnika*, Publ. Akhil Maharashtra Dalimb Utpadak Sansodhan Sangh, Pune, pp: 83-86.

Chandra R, Sharma Jyotsana and Marathe RA. 2008. *Prakriyayukt Padarthachaya Nirmitidwarae Dalimbamadhaye Mulyavridhi*. In: *Dalimbvrith Smarnika*. Publ. Akhil Maharashtra Dalimb Utpadak Sansodhan Sangh, Pune, pp: 113-114 (Marathi).

Chandra R, Jadhav VT, Kumar P and Babu KD. 2008. Biodiversity of pomegranate (*Punica granatum* L.) In: Souvenir, Biodiversity and Agriculture, Lucknow, pp: 63-69.

Research Programmes and Projects

S. No	Project Title	Project Investigator (PI) and Associates
1.	Survey, collection, evaluation, propagation and improvement of pomegranate	Dr. Ram Chandra (PI) Dr. R. A Marathe Dr. (Mrs.) Jyotsana Sharma Dr. P. Kumar (transferred) Mr. D.T Meshram Dr. W.L. Barwad Dr. K. Dhinesh Babu
2.	Identification of suitable soils for sustained production and productivity of pomegranate	Dr. R.A. Marathe(PI) Dr. Ram Chandra Dr. V.T. Jadhav
3.	Etiology, epidemiology and management of wilt of pomegranate	Dr. K.K. Sharma (PI) Dr. (Mrs.) Jyotsana Sharma Dr. V.T. Jadhav
4.	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
5.	Exploitation of Bio-agents in Pomegranate Productivity	Dr. V.T. Jadhav, (PI) Dr. (Mrs.) Jyotsana Sharma, Dr. R.A. Marathe Dr. Ram Chandra
6.	Nutrient Management in Pomegranate	Dr. R.A. Marathe, (PI) Dr. Ram Chandra Dr. V.T. Jadhav
7.	Biology of pomegranate butterfly *(Deudorix isocrates F.)* and its management	Dr. W.L. Barwad (PI) Dr. K.K. Sharma

IMC AND SRC Decisions

Management committee (MC) meeting

The third management committee meeting of NRCP was held on October 18, 2007 under the Chairmanship of Dr. V.T. Jadhav, Director, NRCP, Solapur. Dr. M.S. Raut, Head, CSR (NRCS), Solapur, Dr. V. J. Shivankar, Pr. Sci., NRC for Citrus, Nagpur, Dr. S.D. Sawant, Sr. Sci., NRC for Grapes, Pune, Shri. Prabhakar Chandane and Shri. Vishwasrao Kachare, progressive farmers, Solapur, and Dr. P. Kumar, Pr. Sci., Dr. Ram Chandra, Pr. Sci., Dr. R.A. Marathe, Sr. Sci. and Sh. K.S. Sharma, AAO, NRCP, Solapur were present in the meeting.

Various issues pertaining to the centre were discussed thoroughly. Proceedings of second IMC meeting was approved. Dr. V.T. Jadhav gave a brief account on research and physical infrastructure facilities developed at the centre. He informed that rejuvenation programme on bacterial blight at farmer's field was adopted and there was encouraging result in controlling the disease. Research need on wilt was also emphasized looking into the importance of this disease. Besides, research done at the centre particularly in the germplasm collection, organic farming using bio-agents and nursery studies, plant nutrition and disease management were discussed. XIth five year plan document (EFC), annual plan 2007-08, RE 2007-08 and BE 2008-09 were also discussed.

Management Committee

Chairman

Dr. V.T. Jadhav, Director, 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

Co -Members

Dr. P. Kumar, Pr. Scientist, NRC on Pomegranate

Dr. R.A. Marathe, Sr. Scientist, NRC on Pomegranate

Member Secretary

Shri. K.S. Sharma, AAO, NRCP, Solapur

Fig. 67 : Management committee meeting held at NRCP, Solapur

The centre is facing problem of vehicle and AFAO post. Looking into these problems, the committee had strongly recommended for purchase of vehicle and creation of AFAO post in XIth plan. Besides, some other issues of the centre were also highlighted (Fig. 67 and Fig. 68).

Staff research council (SRC)

The Second SRC meeting was held on May 24, 2007 at NRCP, Solapur to finalize research projects, review work done by the scientists and the technical programmes for the ensuing year 2007-08. Dr. V.T. Jadhav, Chairman informed that the pomegranate industry in Maharashtra, Karnataka and Andhra Pradesh is suffering due to a devastating bacterial blight disease. He emphasized that scientists should solve such problem on priority basis. In addition, his requests were also made to the scientists to bring some external funded projects to solve major problems of pomegranate in India. Altogether five new project proposals (RPF-I) were approved and the progress of five ongoing projects were reviewed.

Chairman
Dr. V.T. Jadhav, Director
Member
All scientist
Member Secretary
Dr.Ram Chandra, Pr. Scientist (Horticulture)

Fig. 68 : Management committee visited various experiments at NRCP, Solapur

Meetings, Conferences, Seminars, Etc.

S. No.	Name of meeting /conference /Seminar etc.	Venue and date	Name of participant/s
1	MAU 16th Convocation	MAU, Parbhani on January 28, 2007	Dr. V.T Jadhav
2	Agricultural Exhibition - *Kesar Matti*	S.B.I., Pandharpur from April 10-15, 2007	Drs. Ram Chandra, K.K. Sharma, Jyotsana Sharma, R.A. Marathe, W.L. Barwad and Mr. D.T. Meshram
3	RRC Meeting	MAU, Parbhani on April 18, 2007	Dr. V.T. Jadhav
4	Training Workshop on Pomegranate Bacterial Blight Management	Lokmangal Biotechnology Wadala (Shriram Pratisthan) North Solapur on April 24, 2007	Drs.V.T. Jadhav and K.K. Sharma
5	National Conference on Horticulture-2007 and Director's/ Project Coordinator's Meeting	NASC Complex, New Delhi from April 27-28, 2007	Dr. V.T. Jadhav
6	Breeding Strategies for Pomegranate	CIRT, Pune on May 12, 2007	Drs. V.T. Jadhav, P. Kumar, Ram Chandra and K.K. Sharma
7	Meeting on Management of Mealy Bugs of Pomegranate	NRC on Grapes, Pune, on June 20, 2007	Dr. V.T. Jadhav
8	Mega Seed Project	CISH, Lucknow from June 29-30, 2007	Dr. Ram Chandra
9	Director's Conference	NASC, New Delhi from July 15-18, 2007	Dr. V.T. Jadhav
10	District Level Pomegranate Workshop	Department of Agriculture, Jhabua on July 17, 2007	Drs. Ram Chandra and R.A. Marathe
11	Assessment Committee Meeting	ASRB, New Delhi from July 30 - August 1, 2007	Dr. V.T. Jadhav
12	Assessment Committee Meeting	ASRB, New Delhi from August 7-8, 2007	Dr. V.T. Jadhav
13	Foreign Aided Project	IIHR, Bangalore from August 16-18, 2007	Dr. Ram Chandra
14	Intelligent Reporting System	NAARM, Hyderabad from August 30-31, 2007	Dr. K. Dhinesh Babu
15	Meeting on Bacterial Blight of Pomegranate	ADR, Solapur on September 24, 2007	Drs.V.T. Jadhav and K.K. Sharma
16	Bacterial Blight Disease of Pomegranate	Office of Principal Secretary, Ministry of Agriculture and Horticulture Maharashtra, Mumbai on October 9, 2007	Dr. K.K. Sharma
17	Special Interactive Workshop on Administrative and Financial Matters	NIANP, Bangalore on October 26, 2007	Dr.K.K. Sharma

18	8th *Rashtriya Kisan Mela* on Citrus	NRC for Citrus, Nagpur on October 31, 2007	Drs. Ram Chandra and W.L. Barwad
19	Management of Bacterial Blight Disease in Pomegranate	Sakhar Sankul, Pune on November 4, 2007	Drs. V.T. Jadhav, P. Kumar, Ram Chandra, K.K. Sharma, Jyotsana Sharma and R.A. Marathe
20	Pomegranate Growers Workshop	Baramati on November 7, 2007	Drs. Ram Chandra and K.K. Sharma
21	Management of Bacterial B light of Pomegranate.	Sakhar Sankul, Pune on November 15, 2007	Dr. V.T. Jadhav
22	Role of Information and Media	MPKV, Rahuri on November 30, 2007	Dr. V.T. Jadhav
23	Horticultural Biotechnology Present Status and Future Action Plan	IIHR, Bangalore on December 8, 2007	Drs. V.T. Jadhav, K. Dhinesh Babu and Ram Chandra
24	Development of Pomegranate Variety Tolerant to Bacterial Blight	IIHR, Bangalore on December 8, 2007	Drs. V.T. Jadh av and Ram Chandra
25	Control of Oily S pot and Wilt of Pomegranate	Sakhar Sankul, Pune on December 13, 2007	Drs. V.T. Jadhav and K.K. Sharma
26	Pesticides Residue Monitoring Programme and Sampling of Pomegranate for Export	APEDA, Mumbai on December 14, 2007	Drs. V.T. Jadhav and K.K. Sharma
27	Residue Monitoring Programme	Sakhar Sankul, Pune on December 19, 2007	Drs. V.T. Jadhav and K.K. Sharma
28	Interactive Meeting	Sangola on December 19, 2007	Drs. Ram Chandra and Jyotsana Sharma
29	Improvement of the Package for Oily Spot of Pomegranate	Sakhar Sankul, Pune on January 5, 2008	Dr. V.T Jadhav
30	National Seminar on Plant Disease Scenario in Organic Agriculture for Eco-Friendly Sustainability	MPKV Regional Wheat Research Station, Mahabaleshwa from January 10-12, 2008	Drs. Ra m Chandra and K.K. Sharma
31	Mitigating the Bacterial Blight Diseases	Krishi Bhavan, Ministry of Agriculture, New Delhi on January 16, 2008	Dr. V.T. Jadhav
32	Tools and Machinery for Development of Horticulture	CISH, Lucknow on January 18, 2008	Dr. Ram Chandra
33	Intellectual Property Protection and Technology Licensing in Agriculture	KAU, Thrissur, Kerala February 17-20, 2008	Dr. K. Dhinesh Babu
34	XXth Regional Committee meeting	CICR, Nagpur from February 29 - March 1, 2008	Dr. V.T. Jadhav
35	National Seminar on Pomegranate Present and Future' in Solapur	Market Yard , Solapur from February 10-12, 2008	Drs. V.T. Jadhav, Ram Chandra, K.K. Sharma, Jyotsana Sharma and R.A Marathe
36	Seed and Planting Material Testing Manual	CISH, Lucknow from March 11-12, 2008	Dr. Ram Chandra
37	National Seminar on "Opportunities and Challenges of Arid Horticulture for Nutrition and Livelihood"	CIAH, Bikaner from March 8-9, 2008	Dr. K. Dhinesh Babu
38	Seminar on Importance of Agrochemicals in Quality Horticulture Production	MCCIA, Pune, on May 15, 2007	Dr. K.K. Sharma

Fig. 69 : Dr. H.P. Singh, DDG (Hort.) sees plan of water harvesting Pond at Hiraj, Solapur

Fig. 70 : Dr. S.N. Pandey, ADG (Hort.) and Dr. V.T. Jadhav visit adopted pomegranate orchard at Hiraj, Solapur

Fig.71 : Dr. H.P. Singh, DDG (Hort.) visited Field Gene Bank of pomegranate at Kegaon , Solapur

Fig. 72 : Dr. S.N. Pandey, ADG (Hort.) in Field Gene Bank of pomegranate at Kegaon, Solapur

Fig. 73 : Dr. H.P. Singh, DDG (Hort.) gives interview to media people about strategies to control bacterial blight

Fig. 74 : Dr. S.N. Pandey, ADG (Hort.) showed interest in pot culture trials on wilt etiology.

Fig. 75 : Shri. Ratnakar Mahajan visited Field Gene Bank of pomegranate on 28.01.2008

Fig. 76 : Shri. Ratnakar Mahajan showed interest in results of bio-agents in pomegranate

Fig. 77 : Inauguration of Agricultural Meteorology by Dy. Collector, Solapur

Fig. 78 : Dr. V.T. Jadhav addressed on the occasion of Hindi week celebration at NRCP, Solapur

Fig. 79 : Farewell to Shri. T. Ashok Kumar, AAO on his promotion and transfer to Bangalore

Fig. 80 : Dr. V.T. Jadhav and his wife greet Dr. P. Kumar, Pr. Scientist on his transfer to Lucknow

Personnel

RMP

Dr. V.T. Jadhav :	Director

Scientific Staff

Dr. Ram Chandra	Principal Scientist (Horticulture)
Dr. W.L. Barwad	Senior Scientist (Entomology)
Dr. K.K. Sharma	Senior Scientist (Plant Pathology)
Dr. (Mrs.) Jyotsana Sharma	Senior Scientist (Plant Pathology)
Dr. R.A. Marathe	Senior Scientist (Soil Science)
Mr. D.T. Meshram	Scientist (Soil and Water Conservation Agricultural Engineering)
Dr. K. Dhinesh Babu	Scientist (Fruit Science)

Technical Staff

Shri. Dinkar Chaudhari	T-3 (Field Technician)
Shri. Mahadev Gogaon	T-1 (Field Technician)

Administrative Staff

Shri. K.S. Sharma	Assistant Administrative Officer
Shri. Amolkumar Rathod	Lower Division Clerk

Supporting Staff

Shri. Shailendrasing Shivpalsing Bayas	SSG – I
Shri. Vishal Shankar Gangane	SSG – I

Promotions/Transfers

Promotions

Scientist

1. Dr. Ram Chandra, Senior Scientist to Principal Scientist w.e.f. 27.07.2006
2. Dr. R.A. Marathe, Scientist (SS) to Senior Scientist w.e.f. 01.08.2005

Administrative

1. Sh. K.S. Sharma, Superintendent to Assistant Administrative Officer w.e.f 22.09.2007

Transfers

1. Dr. P. Kumar, Principal Scientist transferred from NRCP to IISR, Lucknow w.e.f 19.03.2008
2. Sh. T. Ashok Kumar, Assistant administrative officer transferred from NRCP to NDRI (SC), Bangalore. w.e.f 21.09.2007.

Meteorological data

Meteorological data of the year 2007-08 at NRC on Pomegranate, Kegaon, Solapur

Month	Temperature (⁰C)		Relative humidity (%)		Average sunshine per day (hrs.)	Total rain fall (mm)
	Max.	Min.	Max.	Min.		
July	NR*	12.16	50.61	35.29	4.60	82.0
August	NR	18.65	53.10	37.06	3.13	216.0
September	30.10	21.78	59.03	42.13	4.10	183.0
October	33.18	20.24	46.68	17.29	6.71	0.0
November	31.89	16.87	47.03	20.13	9.22	5.4
December	30.61	16.52	57.35	36.42	8.41	0.0
January	30.82	14.88	52.10	33.61	9.34	0.0
February	32.43	17.74	46.93	33.38	8.85	0.0
March	35.15	20.59	56.90	35.0	8.28	77.0

*NR : Not recorded

Double Flower Ornamental Pomegranate

National Research Centre on Pomegranate
NH - 9 Bypass Road, Shelgi, Solapur - 413 006 (MS), India