



Integrated Disease and Insect Pest Management in Pomegranate



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Introduction

Eradication of most plant pathogens especially bacterial pathogens is just impractical; however, we can manage these pathogens to minimize losses. Failure of eradication campaigns of citrus canker caused by *Xanthomonas axonopodis* pv. *citri*, taken up by the government of Florida (USA) twice in 1933 and 1994 is well known to the plant pathologists. In spite of eradicating the citrus grooves (total 16,523,176 trees eradicated) to get rid of the canker pathogen, the disease appeared again in 1995. In 2006, the Florida government was forced to withdraw the eradication campaign and shift to management programme. The citrus canker continues to exist and the Florida farmers still grow citrus following health response programmes based on change of season, sanitation, cultural practices, development of resistant/transgenic varieties and spray schedules comprising streptocycline and copper molecules. This keeps the bacterial inoculum load below threshold level to take economic yields. With this background we wish to bring to the knowledge of our researchers as well as growers that it is not possible to eradicate the pomegranate bacterial blight but one can manage it, as has been confirmed through multi-location demonstration of Orchard Health Management (OHM) Schedules during 2008 - 2010 in Maharashtra, Karnataka and Andhra Pradesh. This is indicated by increase in pomegranate area and production in India from 109.21ha in 2008-09 to 125.16 ha during 2009-10, returning the dwindling pomegranate cultivation particularly in Maharashtra having maximum area (82 thousand ha in 2008-09 to 98.9 thousand ha in 2009-10) under pomegranate- on strong footing. Many growers are now convinced that they can take economic yields by following OHM Schedule.

The OHM schedule was successfully demonstrated at different locations in the three states from 2008-2010. On an average 67.49 per cent reduction in bacterial blight severity was achieved in the first year after adoption and 73.97 per cent in the second year, with an average productivity of 7.94t/ha in the first year and 9.28t/ha in the second year. The average benefit in the demonstration orchards was 1:2.36 in the first year of adoption and 1:4.31 in the succeeding year. These demonstrations convincingly proved that the schedule if followed for 3-4 years will definitely check bacterial blight and put back stumbling pomegranate industry on right track.

Recent years have witnessed diseases and insect pests that were of little economic importance in the past, but have now emerged as new threats for the grower in some localities. *Ceratocystis* wilt, some fungal fruit rots and spots, shot hole borer, nematodes and fruit sucking moth are some such diseases and other pests. Developing resistant varieties or transgenic lines are the only long term solutions for most of the diseases. In the absence of resistant germplasm in the country for especially wilt and bacterial blight, it is necessary to follow integrated management practices to keep the pathogen inoculum load

in the orchard low, so that the disease does not spread and remains manageable. Looking into the importance of pomegranate crop and heavy losses (quantitative and qualitative) caused by several diseases and insect pests, The existing orchard health management schedule has been modified at a joint meeting of pomegranate researchers from all the states on Nov. 17-18, 2010 at NRC on Pomegranate, Solapur under the Chairmanship of Dr. JH Kulkarni, former Vice Chancellor, UAS, Dharwad and a panel of experts. The modified schedule known as Integrated Disease and Insect Pest Management (IDIPM) Schedule is a complete package taking care of all aspects of pomegranate cultivation.

Nursery Raising and Preparation of Planting Material

1. The selected mother plants should be maintained by the NRCP, Solapur and relevant genetic/molecular markers should be established for maintaining their varietal identity and purity.
2. The progeny orchards should be established from mother plants in different areas free from bacterial blight. This should be regularly monitored by team of experts from ICAR and SAUs of respective regions.
3. Approved/certified nurseries must obtain standard planting material (air layers /hard wood cuttings/tissue culture saplings) from the respective progeny orchards (see Annexure I for details).
4. New planting should be done with certified disease free planting material or tissue culture saplings.
5. Suspected propagating material have to be tested through diagnostic symptoms, ooze tests, microscopy and also isolation. For the presence of latent infection testing through molecular technique like PCR is essential.
6. The soil used for nursery raising needs to be sterilized through solarisation. Soil solarisation can be done by covering moist soil with 25-75 μ m thick linear low density transparent polyethylene (LLDPE) sheets for 6 weeks during hot summer months.
7. To prepare approximately 100kg of potting material mix 50 kg soil and 50 kg compost along with consortium having 1 kg each of local isolates of *Trichoderma viride* or *T. harzianum*, *Azospirillum*, PSB & *Pseudomonas fluorescens* having cfu 10^9 /g and 5 kg of neem cake. Also incorporate 200g of VAM culture. Planting should be done after 8 days of mixing the above ingredients.
8. Apply Bordeaux paste (10%) to the cut ends of the mother plant and air layered cuttings.
9. Treat the roots of air layered cuttings with copper oxychloride (COC) @3g/l to protect against soil borne diseases at the seedling stage and plant them in the standard size polyethylene bags filled with above potting mixture.
10. Place planting material under 50% shade net. Monthly sprays of streptocycline (0.5 g/l) + COC (2.5 g/l) altered with bronopol(0.5 g/l) + COC (2.5 g/l) in bacterial blight affected areas and only COC in disease free areas should be taken on priority.
11. If fungal leaf spots appear use the combi-product like 'Companion' having mancozeb 63%WP+carbendazim 12%WP @ 2g/l or chlorothalonil 75WP (2.0g/l). Repeat at 15 days interval if required.
12. For sucking pests specially thrips which are a problem in nursery plants spray thiamethoxam 25WG @ 0.3g/l. Repeat the same at 15 days interval or as and when required. Alternate with acetamiprid 20SP@ 0.3g/l or imidacloprid 17.8SL @0.3ml/l to avoid resistance development.

Planting and Care of New Orchard

A) Planting a new orchard

1. Select site having light-medium soil for establishing the orchard.
2. Make pits 1m deep at row to row spacing of 4.5m and plant to plant spacing of 3.0 m. Keep proper spacing and follow proper pruning and training to develop optimum canopy and to avoid contact of branches with neighbouring plants. This is to ensure proper aeration and interception of solar radiation, which helps in better fruit development and also to reduce the incidence of diseases.
3. Pits should be dug at least a month prior to planting and kept open to disinfect the pits by intense solar radiation during the day. Just before filling pits drench the bottom and sides of the pit with 4-5 litres of 0.4% (4ml/l) chlorpyrifos 20EC solution.
4. Dust the pits with bleaching powder (a.i.33% Cl) @ 100g/pit before filling.
5. Fill the pits with soil having, sand/*murrum*, silt and clay in equal proportions.
6. In each pit mix the following in the top soil (30-50 cm):

FYM	10kg
Vermicompost	1 kg
Neem cake	0.5 kg
<i>Trichoderma</i> formulation	25g
Phosphate Solubilising Bacteria (PSB)	25g
<i>Pseudomonas fluorescens</i>	25g
<i>Azotobacter</i> formulation	25g
<i>Azospirillum</i> formulation	25g

7. Before taking the planting material to the main field spray the plants with COC (2.5g/l) + Streptocycline (0.25g/l).
8. Plant two rows of wind breaks like *Casuarina* (Saru), *Grevillea robusta* (Silver oak), *Sesbania grandiflora* etc around the orchard .

B) Care of a pre-bearing orchard

(up to first two years of planting)

1. One month after planting spray with streptocycline (0.5g/l) + COC (2.5g/l) in epidemic areas and only COC in disease free areas. Take alternate sprays of Bordeaux mixture (1%). Alternately, COC + streptocycline sprays have to be replaced with 2-bromo-2-nitropropane-1, 3-diol (bronopol) @ 0.5g/l + captan @ 3g/l.
2. Spray interval should be one month in disease free orchards. In orchards where blight incidence is observed spray schedule should be 15 days during dry periods and 7-10 days during rainy days.

3. In orchards having blight, one spray of streptocycline (0.5g/l) + COC (2.5 g/l) after the rains stop is mandatory.
4. If fungal leaf spots appear spray the combi-product like Companion having mancozeb 63%WP+carbendazim 12%WP @ 2g/l or chlorothalonil 75WP (2.0g/l) or hexaconazole 5EC @ 1ml/l. Repeat the same at 15 days interval if required.
5. For sucking pests particularly thrips which attack new flush growth, spray thiamethoxam 25WG @ 0.3g/l. Repeat at 15 days interval or as and when needed. Alternate with acetamiprid 20SP@ 0.3g/l or imidacloprid 17.8SL @0.3ml/l to avoid resistance development.
6. For mite infestation during dry spell spray fenazaquin10EC @2ml/l or dicofol 50WSP@1g/l or 18.5 EC @2.5ml/l or wettable sulphur 80 WP @3g/l in rotation.
7. For leaf eating caterpillars malathion 50EC@ 2ml/l has to be sprayed.
8. Follow recommended training and pruning procedures to manage optimum canopy. Three stem based training system should be followed, as it facilitates better microclimate around the trees.
9. Monitor regularly for blight symptoms. In case of observance of foliar symptoms, recommended sprays have to be commenced. If blight symptoms are observed on stems, prune and remove infected twigs as and when the symptom is noticed.
10. Prune about 2" below the infected area. Bordeaux paste (10%) is applied to the cut ends after pruning. Oil based pastes (COC paint or Chaubatia paste) should be preferred for pasting the cut ends in the rainy season.
11. Any severely infected plant has to be removed, burnt and replaced with new disease free plant.
12. All sanitation measures (Annexure II) are required to be followed strictly.
13. Apply recommended fertilizer doses as mentioned in Table 1 under the sub heading 'Nutrient Management,' depending on age of the plant. NPK application should be based on soil test and leaf analysis values.
14. Nitrogen is recommended to be applied preferably as urea in black soils and calcium ammonium nitrate (CAN) in red soils, phosphorous as single super phosphate (SSP) and potash through muriate of potash (MOP). At least 1/3rd fertilizers required should preferably be applied through organics, 1/3rd through inorganics and remaining 1/3rd through fertigation.
15. During the first year of planting, apply recommended fertilizers in split doses at monthly intervals, preferably dissolved in water or just before irrigation. In the second year the basal dose of FYM besides recommended NPK fertilizers need to be applied in 3 split doses coinciding with growth flushes.
16. Follow the recommended irrigation schedules as furnished in Table 2 under the sub heading 'Water Management'. Drip irrigation with four drippers placed in four directions should be practiced.
17. The orchard must not be allowed to bear fruits for initial two years to improve the growth cum vigour of plants and better canopy development.

Care of an Established Orchard

Established Orchard

(After Second Year)

1. In bacterial blight prone areas only *hasta bahar* or late *hasta bahar* crop must be regulated. In bacterial blight free areas, growers may take *bahar* convenient to them.
2. Only one crop in a year is recommended.

(a) Rest Period

1. A rest period of four months is recommended for better plant health, vigour and reduction of pathogen inoculum load if any.
2. As the rest period falls during rainy season (for *hasta*/late *hasta bahar* crop) sprays at 15 days interval of Bordeaux mixture 1% alternated with sprays of streptocycline (0.5g/l) + COC (2.5g/l) or 2-bromo-2-nitropropane-1,3-diol (bronopol) @ 0.5g/l + captan @ 3g/l in epidemic areas need to be practiced.
3. No manures and inorganic fertilizers are recommended. Minimum irrigation is preferable.
4. Remove the water shoots regularly.

(b) Pruning and *Bahar* Regulation

1. In orchards where severe bacterial blight infection is noticed, go for heavy pruning immediately after harvest and remove as far as possible all stems with fresh blight infection.
2. Prune about 2" below the infected area. Cankers, if any should be scooped out, till normal wood appears and then pasted/painted. Apply Bordeaux paste (10%) to the cut ends after pruning and to scooped cankers. Oil based pastes [COC paint made by mixing 500g COC + 1 l linseed oil or Chaubatia paste prepared by mixing 1kg red lead(non setting grade) + 1kg copper carbonate + 1.25 l linseed oil] are preferred for pasting during rainy seasons.
3. Any severely infected plant must be uprooted burnt and replaced with new disease free plant or cut from base 2-3 inches above ground level. New well growing sprouts have to be trained for new disease free plant.
4. In disease free orchards, practice need based pruning after rest period.
5. Spray Bordeaux mixture (1%) immediately after pruning.
6. After the rest period defoliate the trees with Ethrel 39% SC 2-2.5ml/l depending on soil moisture conditions. Mix suitable recommended insecticide if some insect attack is observed at the time of defoliation.

7. Do light pruning after leaf fall and spray Bordeaux mixture (1%) immediately after pruning.
8. Collect all fallen leaves and burn for good orchard sanitation.
9. Dust the ground below canopy with bleaching powder @100-150g/plant or drench with bleaching powder 25kg/1000 l water/ha and follow all sanitation measures (Annexure II) strictly.

(c) Nutrient Management

1. About a week after defoliation when all or 85-90% leaves fall down, apply FYM and NPK as detailed below, depending on the age of plant. Remember to adjust the total NPK dose based on soil and leaf tissue analysis values and NPK dose to be applied through fertigation as mentioned at serial number 6 to 8 below.

Table 1: Recommended fertilizer dose/plant

Age of Plant (Years)	FYM (kg)	Nitrogen (g)	Phosphorus (g)	Potash (g)
1	10	250	125	125
2	20	250	125	125
3	30	500	125	125
4	40	500	125	250
5 and above	50	625	250	250

2. Apply N and K in 3 split doses, starting at the time of first irrigation after *bahar* treatment and next at 3-4 weeks interval. Full dose of P should be applied as single dose with first irrigation. Apply fertilizers in shallow circular trenches, 30-45cms away from main stems below tree canopy, up to 8-10cm depth and cover with top soil and irrigate immediately.
3. Nitrogen needs to be applied preferably through urea in black soils and calcium ammonium nitrate (CAN) in red soils, phosphorous as single super phosphate (SSP) and potash through muriate of potash (MOP). At least 1/3rd fertilizers required should be applied as organics, 1/3rd through inorganics and remaining 1/3rd through fertigation. NPK application should be based on soil test and leaf tissue analysis values.
4. Micronutrients (zinc, iron, manganese and boron each 25 g per plant or based on plant or soil analysis) should be supplied along with FYM, preferably through slurry. Apply vermicompost @1 kg/plant, neem cake @500g/plant. and phorate @20g/plant for controlling nematodes.
5. When flowering starts schedule 15 drip applications of fertilizer N:P:K::12:61:00 @ 8kg/ha/application on alternate days. This provides 19.46g of N and 98.92g of P₂O₅ per plant.

6. When fruit setting is observed, schedule 15 drip applications of fertilizer N:P:K::19:19:19 @8 kg/ha/application, on alternate days. This provides 30.80g of each of the nutrients N, P₂O₅ and K₂O per plant.
7. At 100 per cent fruit set starts, again schedule 15 drip applications of fertilizer N:P:K::0:52:34 or mono-potassium phosphate @ 2.5 kg/ha/application, on alternate days for a month. This provides 26.35g of P₂O₅ and 17.23g of K₂O per plant.
8. One month before harvesting, schedule 2 drip applications of calcium nitrate 12.5 kg/ha/application at 15 days interval.

(d) Water Management

1. Avoid excess irrigation. Drip irrigation with four drippers placed in four directions need to be employed.
2. Irrigate the crop immediately after fertilizer application in the case of soil application with light irrigation initially and then irrigate at regular intervals.
3. Irrigate the plants depending on water requirement of the plant in different seasons as detailed below:

Table 2: Water requirement of pomegranate plant

Cropping season	Month	Water Requirement (litres/day/plant)
<i>Ambe</i>	January	17
	February	18
	March	31
	April	40
	May	44
<i>Mrig</i>	June	30
	July	22
	August	20
<i>Hasta</i>	September	20
	October	19
	November	17
	December	16
* Will vary with growth stage of plant		

(e) Management of Bacterial Blight and other Diseases, Disorders and Insect Pests

1. The plant protection schedule given in Table 3 for the management of bacterial blight, fungal leaf/fruit spots and rots and most common insect pests during the *bahar* period is to be followed.

Table 3: Plant protection spray schedule from pruning till harvesting period

Spray schedule	Time of spray	Plant protection chemicals to be sprayed
1 st	Immediately after pruning	Bordeaux mixture (1%)
2 nd	Seven days after 1 st spray	<i>Pseudomonas fluorescens</i> talc based formulation @ 2.0g/l with continuous agitation (optional)
3 rd	Eight days after 2 nd spray (New flush stage)	Copper oxychloride 50WP (2.5g/l) + bronopol (0.5g/l) along with suitable spreader sticker. Also spray thiamethoxam 25WG @ 0.3g/l for sucking pests
4 th	Fifteen days after 3 rd spray (at flower initiation)	Streptocycline (0.5g/l) + carbendazim 50WP (1g/l) + acetamiprid 20SP @ 0.3g/l for sucking pests + soluble forms of zinc, magnesium, boron and calcium each @ 1g/l for disease control and better flowering and fruit growth.
5 th	Fifteen days after 4 th spray	Captan 50WP(2.5g/l) + bronopol (0.5g/l) + imidacloprid 17.8SL @ 0.3ml/l for sucking pests
6 th	Fifteen days after 5 th spray (fruit setting stage)	Streptocycline (0.5g/l) + thiophanate methyl 70WP (1g/l) + cypermethrin 25%EC (1 ml/l) for fruit borer soluble boron 1 g/lit + commercial micronutrient mixture containing zinc, magnesium, calcium and iron 1g/l + <i>Neem</i> seed kernel extract @50g/l (75g if entire seed is used). Black soils which are rich in magnesium and calcium may not include these elements in micronutrient spray.
7 th	Seven days after 6 th spray	<i>Pseudomonas fluorescens</i> talc based formulation @ 2.0g/l with continuous agitation. (optional)
8 th	Seven days after 7 th spray	Bordeaux mixture (0.5%)
9 th	Fifteen days after 8 th spray (50% fruit set)	Streptocycline (0.5g/l) + carbendazim 50WP (1g/l) + chloropyrifos 20% EC (2 ml /l) + <i>Neem</i> seed kernel extract @50g/l (75g if entire seed is used)
10 th	Fifteen days after 9 th spray (100% fruit set)	Bordeaux mixture (0.5%)
11 th	Fifteen days after 10 th spray	Captan 50WP(2.5g/l) + bronopol (0.5g/l)+ methomyl 40%SP@ 1g/l

12 th	Fifteen days after 11 th spray	Streptocycline (0.5g/l) + thiophanate methyl 70WP + acetamiprid 20SP@ 0.3g/l
13 th	Fifteen days after 12 th spray	Bordeaux mixture (0.5%)
14 th	Fifteen days after 13 th spray	Streptocycline (0.5g/l) + copper hydroxide 77WP (2g/l)+ <i>Neem</i> seed kernel extract @50g/l (75g if entire seed is used) or azadirachtin 1500ppm @ 3ml/l
15 th	Fifteen days after 14 th spray (1 month before harvesting)	<i>Pseudomonas fluorescens</i> talc based formulation @ 2.0g/l with continuous agitation or 0.5% Bordeaux mixture
16 th	15-20 days after 15 th spray (Fruit maturity and harvesting)	Potassium dihydrogen phosphate @5g/l or potassium nitrate@10g/l or 0:0:50 @10g/l

NOTE:

1. Under high disease pressure and congenial weather conditions (Temp. between 25-33°C, humidity > 80% and intermittent rainfall) reduce spray interval to 8-10 days.
2. In orchards having blight one spray of streptocycline or bronopol (0.5g/l) + COC (2.5 g/l) after the rains cease, is mandatory even if scheduled spray has been taken prior to commencement of rains.
3. The above sprays take care of most of the fungal spots, if still **fungal spots** persist spray the combi-product like Companion having mancozeb 63% WP+carbendazim 12%WP @ 2g/l or chlorothalonil 75WP (2.5 g/l) or hexaconazole 5EC or difenconazole 25 EC@ 1ml/l. Repeat the spray at 15 days interval if required.
4. On observing first symptoms of **wilt** in the orchard immediately drench soil with chlorpyrifos 20EC (2.5ml/l to 4.0ml/l) + carbendazim 50WP (2.0g/l) or propiconazole 25EC(2ml/l) use 5-8 l solution/tree. Also drench at least 2-3 healthy plants on all the four sides around the infected plant/s. Repeat the drenching 3-4 times at 20 days interval
 - Uproot the affected dead wilted plants and burn immediately; do not pile them in or around the orchard for firewood. While removing the wilted plants from the orchard for burning, protect the entire root zone with cover, as the spores of the pathogen are present abundantly on the roots and they may spread to other healthy plants.
 - For controlling **shot hole borer** (*Xyleborus* spp.) which is associated with wilt disease, 10 litres preparation containing red soil (4kg) + lindane (25g) + chlorpyrifos 20EC (20ml) + copper oxychloride (25 g) needs to be applied on plant base up to 1-2 ft. from second year onwards.

- For **stem borer** control, inject in the holes on the trunk with DDVP 2-3 ml and plug the holes with mud.
 - Where **nematodes** are a problem apply phorate 10G @10- 20g/plant or carbofuran 3G @ 20-40g/plant, in the plant basin, in a ring near root zone and cover it with soil.
 - Plant *Tagetes erecta* (African marigold) between plant to plant space in a row, or in a ring, on the border of plant basin, these help as a trap crop in reducing nematode population. For effective results these should be grown for more than 4-5 month.
5. For **fruit cracking** avoid long dry spells, maintain required soil moisture through regular irrigation of plants during fruit development stage. Boron sprays recommended above also help in minimizing fruit cracking.
 6. Maturity indices should be monitored. Delay in harvesting often results in **internal break down of arils** hence, harvest the fruit as soon as they reach optimum maturity to avoid internal break down of arils.
 7. To avoid **sun scald**, maintain suitable crop canopy through proper pruning to ensure that fruits facing the noon sun are not directly exposed to rays. Spray anti-transparent like kaolin (5.0%) 2-3 times during the fruit development stage. Covering the fruits, particularly those receiving direct sun light, with paper (preferably butter paper) bags also reduces sunburn.
 8. For **mite infestation** during dry spell spray fenazaquin 10EC @2ml/l or dicofol 50WSP @1g/l or dicofol 18.5 EC @2.5ml/l or wettable sulphur 80 WP @3g/l in rotation when required.
 9. For **leaf eating caterpillars** spray malathion 50 EC@1.5ml/l when observed.
 10. For **mealy bugs** spray chloropyriphos 20% EC (2 ml /l) or monochrotophos 36EC @1.5g/l when observed

Precautions for Spraying

1. All pesticide concentrations recommended are for high volume sprays (1000 litre water/ha).
2. Use good quality non-ionic spreader sticker with every spray except with Bordeaux mixture. it improves efficacy of the spray chemical .
3. Bordeaux mixture (should have CuSO₄ with 26.6% Cu).
4. Bordeaux mixture should always be prepared fresh and used on the same day.
5. All sprays should be done at recommended doses only, lower doses are ineffective and help in disease development.
6. Take only need based sprays, as all sprays without a bactericide may help in the development of bacterial blight and aggravate its incidence.
7. People handling diseased plants/orchards should avoid entering/touching disease free orchards/ plants without changing clothes and washing.
8. All pesticides including weedicides should be used judiciously as indiscriminate use may lead to other physiological problems.
9. Pesticides should be used in rotation to avoid resistance development in the pests.
10. Cheaper brands of *neem* cake have impurities, test its quality before purchasing.
11. In order to keep pesticide residues below recommended MRL spray keep in mind the recommended dose and pre harvest interval (Annexure III)

Annexure I

PRODUCTION OF CERTIFIED PLANTING MATERIAL

I. Foundation planting material

(i) **Source of plant material:** Identify true to type, disease free mother plants/progeny orchards established in the disease free areas, for the production of foundation plant material. Certify these orchards/mother plants for the absence of other diseases/insect pests and nematodes. This should be supervised periodically at 3-4 months interval by the technical team of experts.

(ii) **Type of planting material :** In general pomegranate is being propagated through air layers, hardwood cuttings and tissue culture plants. The ideal features for each type are given below.

- **Air layers:** Thickness at collar level 10-15 mm, height 45-50 cm with minimum of 2 side shoots along with active growing tips.
- **Hardwood cuttings:** lignified /matured past season shoots (6-7 month old) should be selected from the bottom/middle portion of the shoot, having thickness of 8-10 mm at the bottom and height of 18-20 cm with minimum of 4 nodes.
- **Tissue Culture plants:** Shoot tips, axillary/nodal buds and meristems from the mother plants can be used as explants, avoid too many sub cultures prefer only up to 5th subculture). These plants initially raised in trays of 3" pots with appropriate growing medium (1:1::sterile soil:cocopeat) and then shifted to 6" pots and sufficiently hardened for 6 months before planting. It takes nearly 18 months from initial culture to get hardened plants of 12-14" height with 3-4 branchlets, required for planting in the field.

II. **Issue of phyto-sanitary certificate (Mandatory):** Periodical (3-4 months interval) inspection of the specified/nurseries should be mandatory for presence of any disease/insect or other pests before the planting material is lifted. This may be supervised by the certifying authorities in collaboration with experts from ICAR institutes/SAU's in the region before issuing phytosanitary certificate.

Annexure II

ORCHARD SANITATION

1. Do not leave infected plant parts (leaves, flowers, fruits & twigs) in orchards nor dump near orchard, nor throw in irrigation channels. The orchard should be swept clean to collect all fallen plant parts and burnt.
2. Dust bleaching powder (a.i.33% Cl) every 3 months @ 100-150g/plant or drench @ 25 Kg/1000 l water/ha on ground below the canopy in the basin of the tree. This will reduce the bacterial inoculum on left over plant debris if any in the orchard.
3. Pruning tools secateurs etc should be sterilized after handling each infected tree with sodium hypochlorite (2.5%).
4. Keep orchard free from weeds, which may be latent carriers or multiplication ground for several diseases including bacterial blight pathogens and insect pests.

Annexure III

PESTICIDES RECOMMENDED FOR THE CONTROL OF VARIOUS DISEASES AND INSECT PESTS OF POMEGRANATE FOR EXPORT TO THE EUROPEAN UNION

Sr. No.	Pesticide recommended for major disease and pest	Nature of pesticide	Dose on formulation basis	EU MRL (mg/kg)	Pre-harvest Interval (PHI in days)
Diseases:					
A Bacterial Blight (<i>Xanthomonas axonopodis</i> pv. <i>punicae</i>)					
1	Bordeaux mixture	NS	0.5-1.0%	50.00	42
2	Copper oxychloride 50% WP	NS	2.5 g/l	50.00	42
B Wilt (Fungal complex <i>Ceratocystis fimbriata</i>, <i>Fusarium oxysporum</i>)					
3	Propiconazole 25% EC	S	1.50 ml/l (drenching)	00.05	20
4	Carbendazim 50%WP	S	2.00 g/l (drenching)	00.30	50
5	Tridemorph 80%EC	S	1.00 ml/l (drenching)	00.05	40
C. Leaf and Fruit Spots (<i>Alternaria alternata</i>, <i>Cercospora punicae</i>, <i>Colletotrichum</i> sp., <i>Drechslera</i> sp.)					
2a	Copper oxychloride 50%WP	NS	2.5 g/l	50.00	42
6	Mancozeb 75%WP	NS	2.0 g/l	05.00	35
7	Propineb 70%WP	NS	3.0 g/l	01.00	40
8	Ziram 80%WP	NS	2.0 g/l	00.05	90
9	Copper hydroxide 77%WP	NS	2.0 g/l	50.00	42
10	Captan 50%WP	NS	2.5 g/l	00.02	35
11	Chlorothalonil 75%WP	NS	2.0 g/l	01.00	60
12	Difenoconazole 25%EC	S	0.5 ml/l	00.50	45
13	Hexaconazole 05EC	S	1.0 ml/l	00.10	38
14	Myclobutanil 10WP	S	0.4g/l	01.00	30
15	Triadimefon 25% WP	S	0.5-1.0 g/l	02.00	45
16	Sulphur 80%WP	NS	2.5 g/l	MRL not applicable	-
4a	Carbendazim 50% WP	S	1.0 g/l	00.30	50
17	Thiophanate Methyl 70%WP	S	1.0 g/l	00.10	50
D Fungal Blight (<i>Phytophthora</i> sp)					
6a	Mancozeb 75%WP	NS	2.0 g/l	05.00	35

9a	Copper hydroxide 77%WP	NS	2.0 g/l	50.00	42
2b	Copper oxychloride 50%WP	NS	2.5 g/l	50.00	42
18	Metalaxyl 8% + Mancozeb 64% (Metalaxyl MZ 2%WP)	S	2.5 g/l	2.0 + 5.0	66
19	Cymoxanil 8% + Mancozeb 64% (Curzate M8)	S	2.0 g/l	0.2 + 5.0	66
20	FosetylAI 80%WP	S	2.0 g/l	100.0	07
21	Dimethomorph 9%WP + Mancozeb 60% WP (Acrobat MZ)	S	1.5g/l	3.0 +5.0	66
Insect Pests					
A Fruit Borer (<i>Deudorix isocrates</i>)					
22	Indoxacarb 14.5%SC	NS	0.5 ml/l	0.02	30
23	Spinosad 45 %SC	NS	0.5 ml/l	0.02	28
24	Cypermethrin 25%EC	NS	1.0 ml/l	0.05	40
B Stem Borer (<i>Celosterna spinator</i>)					
25	Chlorpyrifos 20%EC	NS	2.0 ml/l	0.05	40
22a	Indoxacarb 14.5%SC	NS	0.5 ml/l	0.02	30
23a	Spinosad 45 %SC	NS	0.5 ml/l	0.02	28
24a	Cypermethrin 25%EC	NS	1.0 ml/l	0.05	40
C Shot Hole Borer (<i>Xyleborus fericatus</i>)					
25a	Chlorpyrifos 20% EC	NS	2.0 ml/l	0.05	40
22b	Indoxacarb 14.5%SC	NS	0.5 ml/l	0.02	30
23b	Spinosad 45 %SC	NS	0.5 ml/l	0.02	28
24b	Cypermethrin 25%EC	NS	1.0 ml/l	0.05	40
D Leaf Eating Caterpillar (<i>Achaea janata</i>)					
25b	Chlorpyrifos 20%EC	NS	2.0 ml/l	0.05	40
22c	Indoxacarb 14.5%SC	NS	0.5 ml/l	0.02	30
23c	Spinosad 45 %SC	NS	0.5 ml/l	0.02	28
24c	Cypermethrin 25%EC	NS	1.0 ml/l	0.05	40
E Mealy Bug (<i>Ferrisia virgata</i>)					
25c	Chlorpyrifos 20%EC	NS	2.0 ml/l	0.05	40
26	Dimethoate 30 %EC	S	1.0 ml/l	0.02	100
27	Imidacloprid 17.8% SL	S	0.3 ml/l	0.05	60
28	Thiamethoxam 25% WG	S	0.25 g/l	0.05	40
F Thrips/Aphids/Jassids/White flies					
26a	Dimethoate 30 %EC	S	1.0 ml/l	0.02	100
27a	Imidacloprid 17.8% SL	S	0.3 ml/l	0.05	60

28a	Thiamethoxam 25% WG	S	0.25 g/l	0.05	40
29	Lambda + Cyhalothrin 05EC/CS	NS	0.50ml/l	0.20	30
G	Mites				
30	Propargite 57%EC	NS	1.0 ml/l	0.01	15
31	Abamectin 1.9%EC	S	0.5 ml/l	0.01	30
32	Azadirachtin 1% (Neem based formulation)	NS	2.0 ml/l	0.01	3
H	Nematodes				
32a	Azadirachtin 1%	NS	2.0 ml/l	0.01	3

NS= Non systemic, S= Systemic

Note:

- Recommendations of pesticides for the management of various insect pests and diseases along with their dose, PHI and MRL values are of advisory nature for the Good Agriculture Practices and based on the recommendations by SAUs, ICAR Institutes & research literature therefore, not covered under any legal scrutiny.
- All the doses mentioned above are for high volume sprayers, where normal spray volume is 1000 l/ha. Spray volume can however be changed as per the efficiency of sprayers used. However, the amount of each pesticide (active ingredient) recommended for 1 ha on the basis of 1000 litre spray solution should be strictly maintained to minimize pesticide residues.

Annexure IV

KEY SIGNS /SYMPTOMS FOR DIFFERENT DISEASES, DISORDERS AND INSECT PESTS TO BE OBSERVED IN THE ORCHARD

A number of bacterial, fungal, insect, mite and nematode pests and some disorders are known to cause quantitative as well as qualitative losses in pomegranate. Some of the most common pests observed in the orchard, with most characteristic symptoms that can help in the correct identification of the disease are given below.

Bacterial Blight

- On leaves water soaked spots on undersurface of leaf which, later turn blackish brown
- Irregular spots of different size on leaves, with a clear regular chlorotic halo against light.
- On fruits spots of water soaked appearance or brownish black spots with cracks or split fruits.
- The bacterial ooze if it comes out after rains/spray, feels sticky to hands and after drying gives white shiny encrustation on the surface of blight lesion.
- On stems water soaked grey/black lesions on nodes or brown cankers with/without stem cracking.

Wilt

- Plants with yellowing/drooping/drying of leaves in some of the branches or entire plant.
- Observe the roots and split open the roots and lower portion of the stems, if you observe:
 - brown/gray/black discolouration of wood it is a fungus *Ceratocytis fimbriata*
 - only xylem is brown it is *Fusarium sp.*
 - pin holes it is shot hole borer
 - knots on fine roots it is nematode infestation.

FRUIT SPOTS

Cercospora Fruit Spots: Dark black discrete spots of various sizes without cracks and no stickiness.

Fruit Scab: Rough raised brown spots giving russet appearance to fruit skin

Anthraxnose (on Fruit): Hard dark black to brownish black spots of no proper shape or size, sometimes spots with light centre and dark brown black edges

FRUIT ROTS

Colletotrichum Fruit Rot: Dark brown fast spreading dry rot generally starting from calyx end and spreading towards stem end of fruit, with rusty appearance below skin.

Phytophthora Fruit Rot: Light brown tan colour rot, neither hard nor very soft, generally first in fruits near ground level, spreads rapidly with white sporulation in humid conditions

DISORDERS

Sun Scald: Surface skin of fruits facing afternoon sun turns brownish black due to scorching, underneath skin is normal.

Internal Breakdown (Arl Browning): Randomly open some of the fruits and observe soft arils of brown colour in a fruit looking healthy from outside, more common in dry condition with intense heat.

Abiotic Fruit Cracking: Healthy Fruits split open all though they do not have any scar/spot on the fruit surface, generally when rains come or irrigation is given after a long dry spell.

INSECT AND MITE PESTS

Fruit borer: Look for fruits showing holes with blackish brown excreta of larva coming out continuously. Cut open the damage fruit to see the larva of fruit borer hiding inside.

Thrips: Thrips, if present can be seen by tapping the tender shoots on white paper. Affected leaves curl upwards and downwards. The tip of the tender growth gets dried. Scrapping marks on buds and fruits can be noticed easily.

White Flies: White appearance of lower surface of leaf, and insets seen flying on disturbing the twig. Affected parts distort and dry.

Aphids: Whitish green aphids can be noticed on tender foliage, buds, flowers and fruits, which might be accompanied with black exuviae. Sticky honey like semisolid also found on upper surface of leaves on which sooty mold grows.

Mealy Bugs: White waxy cottony appearance on tender foliage buds and fruit is seen; if infestation is severe it looks as if white lime is sprinkled on plant parts.

Hairy Caterpillar: Bored sepals of buds, eaten sepals of flowers and nibbled rind of fruits and bark of soft stems can be noticed. Black and brown hairy caterpillar can be seen at affected sites.

Semilooper: Leaf lamina eaten by caterpillar hence only midribs seen on the entire leaves of the branches; milky brown caterpillars are seen around affected areas.

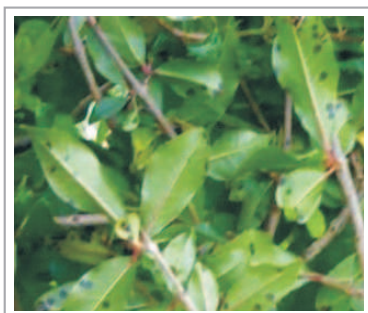
Stem Borer: A single bored hole on the middle or a lower portion of tree trunk can be noticed from which wood dust comes out.

Bark Eating Caterpillar: Wood dust and faecal matter hangs in the form of a web around the joints of branches with main stem or on the main stem directly.

Fruit Sucking Moth: Needle size punctured holes can be noticed on fruits from which blackish brown rotten fruit juice oozes out.

Mites: Shiny white/brown patches can be seen on the undersurface of affected leaves which may further curl and fall. Leaf may get reddish look due to heavy build up of mite population; if you press thumb against the surface of infested leaves thumb turns red.

Various Symptoms of Bacterial Blight



Water soaked lesions on under surface of leaves



Necrotic spots with yellow halo



Water soaked spots on fruit



Necrotic spots with small cracks on fruit



Splitting of fruit at necrotic spot



White shiny encrustation of bacterial ooze on infected fruit



Water soaked lesions on stem nodes turning brown black

Symptoms due to Different Wilt causing Agents



Yellowing/drooping /drying of leaves in 1-2 branches of a plant



Plants with yellowing/drooping/drying of leaves and dried fruits attached



Drying and death of several neighbouring plants in a row due to *Ceratocystis* wilt



Brown/gray/black discolouration of xylem and surrounding wood due to *Ceratocystis* wilt



Browning of xylem due to *Fusarium* wilt



Pin holes in lower part of stems due to shot hole borer attack along with *C. fimbriata*



Knots on fine roots of wilted plant due to nematode infestation

Fruit Spots



Cercospora spots

Dark black discrete spots of various size without cracks and no stickiness



Anthracnose

Hard dark black to brownish black, corky spots of no proper shape or size, covering small or large surfaces



Fruit Scab

Rough raised brown spots of various shapes and sizes giving russet appearance to fruit skin

Fruit Rots



Light brown tan colour rot with white sporulation



Tan colour rot turns darker in later stages

Phytophthora fruit rot



Colletotrichum fruit rot

Dark brown dry rot from calyx end and spreading towards stem end of fruit



Brownish soft rot



Blackish sporulation of the fungus seen in later stages.

Aspergillus Rot

Disorders



Sun Scald

Surface skin of fruits facing afternoon sun turns blackish brown due to scorching



Internal Break Down

Soft arils of brown colour in a fruit looking healthy from outside



Abiotic Fruit Cracking

Fruits split open without any disease, generally when rains come or irrigation is given after a long dry spell

Insect Pests



Fruit showing blackish brown excreta of larva coming out from live holes



Bored holes from which adult borer has escaped



Rotting from bored holes in later stages

Fruit borer



Dried tips of the tender growth



Affected leaves curl upwards and downwards



Scrapping marks on buds and fruits noticed as rough light greenish-brown patches



Thrips

Insect Pests



White appearance in patches on lower surface of leaf in initial stages of infestation



White wash like appearance on lower surface of leaf in severe attack



Distorting and drying of affected parts

White fly infestation



Whitish green aphids on tender foliages, accompanied with white skin remains



Black sooty mold fungus grows on sticky honeydew—a semisolid excretion of aphids on upper surface of leaves

Aphid Damage

Insect Pests



White waxy cottony appearance on fruit



White waxy cottony infestation covering entire fruit in severe cases

Mealy bug infestation



Hairy caterpillar
Nibbled rind of fruits.



Semilooper
Eaten Leaf lamina by caterpillar hence only midribs seen; milky brown caterpillars are seen around affected areas.

Insect and Mite Pests



Stem borer

Single bored hole on the middle or lower portion of tree trunk from which wood dust is coming out



Bark eating caterpillar

Scrapped bark of the plant and web with wood dust and faecal matter around the joints of branches with main stem or on the main stem directly



Fruit sucking moth

Needle size punctured holes on fruits, from which blackish brown rot starts and fruit juice oozes out



Mites

Shiny white/brown patches on undersurface of leaves, heavy build up of mite population gives reddish look to leaves

Annexure V

Do's and Don'ts for a Healthy Pomegranate Orchard



Keep recommended plant to plant and row to row spacing and follow proper pruning and training. Close spacing provides favourable microclimate for disease development and also results in contact of branches and roots with neighboring plants, which may transmit disease from infected to healthy plants



Always keep the orchards clean and weed free as orchard sanitation plays important role in disease and insect pest management. Weeds play important role in disease development as these may be latent carriers or multiplication ground for several diseases and insect pests



Do not keep plants with many stems, prune and remove excessive stems, keeping only 2-3 stems, apply Bordeaux paste to cut ends



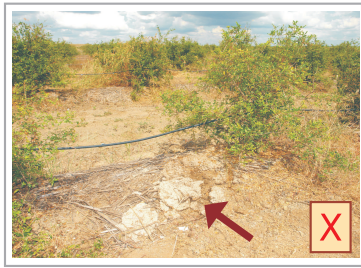
Disinfect secateurs after pruning each plant, collect plant debris, dump them outside the orchard and burn them. Never dump plant debris in or near the orchard



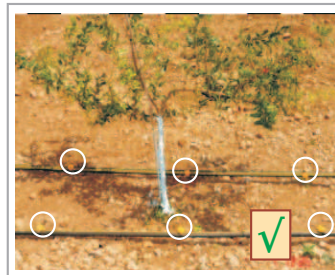
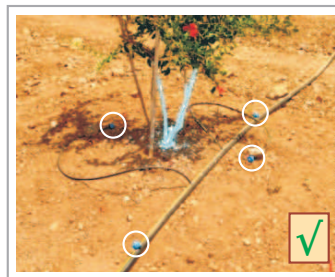
Do not allow water sprouts to grow, remove them and do not allow side shoots to grow up to 2 ft. from base, also paint it with Bordeaux paint or oil based paint



Severely blight infected plant should be cut from base and 2-3 developing new shoots be trained for new plant



Apply fertilizer in a ring and not below drippers at one place



Irrigate the crop using drippers in a ring or place 4-6 drippers around the plant instead of two drippers



Stake the branches to avoid them touching the ground at fruiting stage this helps in proper aeration, light distribution, disease and insect pest management and proper fruit development



Remove extra fruits from cluster to reduce disease and insect pest incidence and also to allow each fruit to attain proper size and colour



Harvest the fruits at proper maturity to get good quality fruit, overripe fruits may deteriorate aril quality