

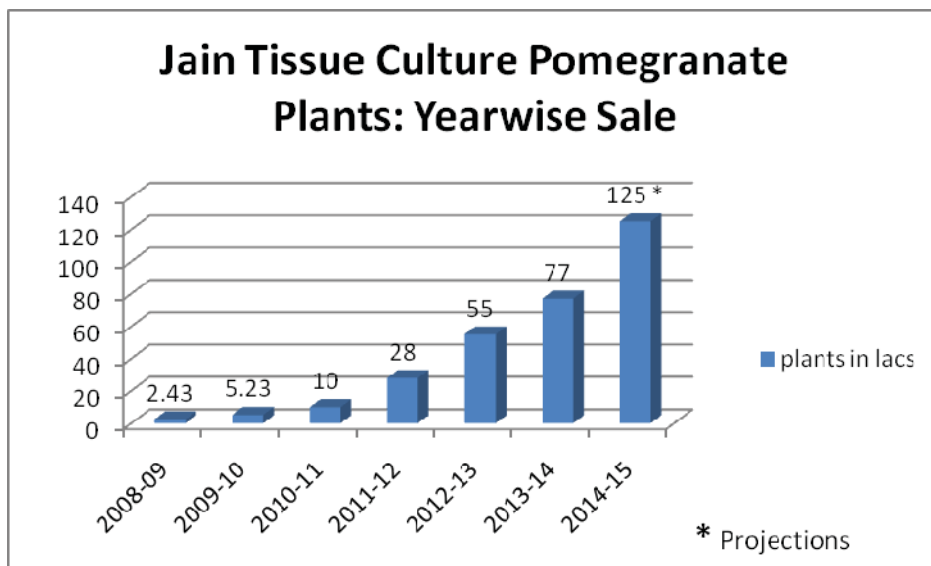
Jain Tissue Culture Pomegranate planting material

SCOPE AND FUTURE:

India is the largest pomegranate growing country in the world. Total area under pomegranate cultivation in India is more than 1.0 lac hectare, where Maharashtra is the leading pomegranate growing state. However, pomegranate is being cultivated extensively in recent years in other states like, Karnataka, Gujarat, Andhra Pradesh, and Madhya Pradesh. Area under pomegranate is being growing up very rapidly because of its huge fruit demand for domestic as well as export market.

PLANTING MATERIAL:

Quality planting material plays an important role in production, productivity and quality in all crops including pomegranate. There are number of disease and pest reported on pomegranate that reduces productivity from 10-90%. In general, vegetative propagated plants have more risk in carrying disease and pest along with the planting material if it is propagated conventionally than seed propagated saplings since the mother plant is exposed to the open environment for many years where there is a high risk of infecting the source plants. Conventional methods of propagation have their own limitations to produce clean and disease free planting material on mass scale. Tissue culture is a hi-tech propagation systems that allows producing clean, disease free, healthy, vigorous and genetically pure planting material on large scale within a short time. The technology offers an advantage of producing large planting material from few mother plants. Considering these advantages of tissue culture, Jain Irrigation has started commercial propagation of pomegranate plants variety Bhagwa and Mrudula through tissue culture from year 2008. Farmers from Maharashtra, Karnataka, Gujrat, Andhra Pradesh, and Madhya Pradesh are some of the leading states where Jain Tissue Culture Pomegranate plants have been planted over thousands acre of area. Year wise sale of Jain Tissue Culture Pomegranate plants is presented below to realize the response received from the pomegranate grower for the technology.



CLIAMATE:

Light, temperature, humidity and rain fall are considered to be important factors for pomegranate cultivation. Pomegranate plants flourish under bright sun light and dry climate. Pomegranate plant can survive under extreme low (0° C) and very high (50° C) temperature, however, 15-40° C is considered to be an ideal for vigorous growth of the plant. Pomegranate crop is recommended in a region that receives moderate rainfall of 500-800 mm per year. Pomegranate crop can not be recommended in a region where rainfall reaches to 1000 mm or above per year since disease and pest management and flowering treatment becomes difficult if pomegranate is cultivated under these conditions.

SOIL: Good soil: Deep loamy or alluvial, well drain soil is highly recommended for pomegranate cultivation. Soil depth minimum 1.5 meter, pH 6.0-8.0, reach in organic carbon is considered to be an ideal soil for pomegranate cultivation. However, pomegranate can be grown on soils which are considered to be unsuitable for most of other fruit trees. Plant can tolerate soils which are limy and slightly alkaline too.

Bad soil: Ill drain soil having water logging properties are not at all recommended for pomegranate cultivation. In these soils the incidence of diseases, pest becomes severe, un-uniform growth of plants occurs and defoliation and flowering treatment to the plants becomes difficult.

PLANTING SEASON: Planting season for any crop is determined on the basis of favorable conditions for the growth of the plant. In the case of pomegranate, there are differences of opinions over the planting season of this crop. In conventional methods most of the farmers use to plant pomegranate during rainy season considering that it is an ideal season for pomegranate. However, looking to the physiology of the plant; it grows more vigorously under bright sun light rather than cloudy weather. Pomegranate plant grows well during dry conditions rather than humid. Therefore pomegranate plantation is highly recommended after completion of rainy season.

LAND PREPARATION AND METHOD OF PLANTATION: Land should be ploughed 2-4 times, rotavator and leveled and allowed for solarization for 2-4 weeks. 8-10 tractor trolleys of Farm Yard Manure (FYM) must be added and spread over the field uniformly. Now field become ready for carrying out further process of planting. Depending on the soil quality planting may be performed either on pits or raise bed. Pit planting is recommended for highly drained, sandy, soft rocky soil while raise bed planting is recommended for deep loamy, alluvial soil.

Pit size: Pit size is depends on drainage quality of the soil. 3'x3'x3' pit is recommended for sandy, soft rocky very high drain soils while 2'x2'x2' pit is recommended for moderate drain soil whereas 1'x1'x1' pit is recommended for well drain soils.

Bed size: Bed should be enough wide for spread of the roots and high to remove excess water from the bed that help for the growth of the white roots. The ideal size of the bed is 3' wide and 2' high. 1'x1'x1' pit must be dig out at the planting place over a bed.

Composition of potting media is very important for initial establishment and further growth of the plant. The components and quantity of potting media per pit are given below.

2 part soil + 1 part FYM (maximum 20 kg per plant) + 1 Kg Neem Cake + 250 gms Super Phosphate + 250 gms Potash + 25 gms Furadon + 5 gms bavistin + 5 gms Bleaching powder Components must be mixed thoroughly before putting it in the pit. Quantity of the potting media for filling up the pit depends on size of the pit and accordingly total quantity should be prepared. After filling the potting media, pit should be water to dissolve components added in the potting media.

CROP GEOMETRY: Traditionally fruit orchards had been planted at wide distance. In recent years, a concept of dense plantation has been evolved in many crops including pomegranate. The idea of increasing plant population per acre was to reduce fruit load per tree, enhance productivity, and ease plant treatment and harvesting. However, pomegranate plantation can not be recommended at high density or ultra high density as is recommended in other fruit crops since pomegranate plant requires more sun light for vegetative and reproductive growth and good air circulation in the orchard to reduce disease incidences.

In pomegranate some factors need to be considered while designing crop geometry that includes soil type, average rain fall, per cent humidity and available sun light. Low dense plantation is recommended in high rain fall, humid climate, ill drain soil and low light intensity areas; where as moderate dense plantation is recommended in low rail fall, dry climate, well drain soil, and high light intensity areas. Considering all above factors, below crop geometry has been recommended for Jain Tissue Culture pomegranate cultivation for both the varieties.

Type of crop geometry	Distance (in feet)	No. of plants/acre
Low dense	15 x 10	290
	14 x 10	311
Moderate dense	12 x 10	363
	13 x 9	372

Crop geometry model

X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X

SELECTION OF VARIETY: Selection of variety is very important step while planning pomegranate cultivation. In India, there are two varieties namely, Bhagwa and Mrudula that are very popular for commercial cultivation. Many times farmers get confused while selecting the varieties. To make them easy, below criteria may be used for selecting the variety.

- ❖ Potential for yield
- ❖ Period of maturity
- ❖ Disease susceptibility/tolerance
- ❖ Keeping quality
- ❖ Market demand

Bhagwa/ Keshar:

- Used as table variety and have high demand for export
- Fruits are big (200-400 gms)
- Rind is red to saffron in color
- Arils are big, red, sweet in taste
- More shelf life than Mrudula
- Takes 180-190 days for maturity from the date of flowering

Mrudula:

- Used as table variety as well as for processing, less demand for export
- Fruits are medium in size (150-250 gm)
- Rind is dark red
- Arils are big, dark red, sweet and little acidic in taste
- Less self life than Bhagwa
- Takes 140-150 days for maturity from the date of flowering

WATER MANAGEMENT: Irrigation at timely intervals, desired quantity and at appropriate place is very important for pomegranate. Irrigation must be done as small amount but frequently. Over irrigation creates huge losses in pomegranate. The roots become inactive and increase the incidences of fungal diseases. Irrigation may be carried out by two methods:

1. **Conventional method:** Flood irrigation comes under conventional method of irrigation. This method consumes more water than the requirement of the plant since large quantity of water is required to irrigate soil rather than plant. The water requirement is highly depends of porosity of soil. In this method, plant suffers from either by water stress or over water.
2. **Drip Irrigation:** Drip irrigation is an advanced method of irrigation where water is provided at timely intervals, desired quantity and at appropriate place. By that way drip irrigation is the only method that fulfills the water requirement and avoids losses.

- **Selection of Drip system for Jain Tissue Culture Pomegranate plants:**

- **Type:** Online drip system is recommended for low density plantation, however either inline or online drip system is recommended for high density plantation.
- **Discharge:** 4 L/Hrs
- **No of laterals:** Double lateral
- **No. of drippers/plant:** 6-8
- **Distance between two drippers:** 60 cms

Irrigation schedule for Jain Tissue Culture Pomegranate

Period	Age of plant (years)				
	1	2	3	4	5
October	2.0	7.0	21.0	28.0	35.0
November	2.0	7.0	21.0	28.0	35.0
December	2.0	7.0	21.0	28.0	35.0
January	3.0	10.0	30.0	40.0	45.0
February	3.0	10.0	30.0	40.0	50.0
March	3.0	10.0	30.0	40.0	50.0
April	4.0	13.0	40.0	50.0	60.0
May	4.0	13.0	40.0	50.0	60.0
June	3.0	7.0	21.0	40.0	50.0
July	2.0	6.0	18.0	25.0	30.0
August	2.0	6.0	18.0	25.0	30.0
September	2.0	6.0	18.0	25.0	30.0

Note: Water requirement mentioned above is as a guide line. It may vary according to the soil type & climate.

FERTILIZER MANAGEMENT:

Jain Tissue Culture pomegranate plant takes 18 months from the date of plantation to complete its vegetative phase and becomes capable for reproductive growth. Total fertilizer requirement of mature pomegranate plant is 625 gms N, 250 gms P and 250 gms P per plant per year. However, fertilizer requirement for first 18 months is lesser than the total fertilizer requirement of the plant. Phase-wise fertilizer requirement and its distribution are tabulated below for easy understanding.

Fertigation schedule for first 18 months (till first flowering) for Variety Bhagawa & Mrudula										
1-18 months (October-March)	Duration (Days)	N =375 g/tree	Urea g/tree	Schedule Urea g/week/tree	P= 187.5 g/tree	Phosphoric Acid g/tree	Schedule Phosphoric acid (52% P) g/wk/tree	K= 166.2 g/tree	White MOP g/tree	Schedule MOP g/wk/tree
1-90 days	90	42	91.3	7.1	20.8	40	3.1	20.5	34.7	2.7
91- 180	90	42	91.3	7.1	20.8	40	3.1	20.5	34.7	2.7
181-270	90	83	180.4	14	42	80.8	6.3	31.3	52.2	4.1
271-365	90	83	180.4	14	42	80.8	6.3	31.3	52.2	4.1
366-456	90	62.5	136	10.6	31.3	60.2	4.7	31.3	52.2	4.1
457-546	90	62.5	136	10.6	31.3	60.2	4.7	31.3	52.2	4.1
Fertigation schedule for 19-24 months (till first harvest) for Variety Bhagawa										
19-24 months (April-September)	Duration	N = 63 g/tree	Urea g/tree	Schedule Urea g/week/tree	P= 62.5 g/tree	Phosphoric Acid g/tree	Schedule Phosphoric acid (52 % P) g/wk/tree	K= 146.3 g/tree	White MOP g/tree	Schedule MOP g/wk/tree
546-591 days	45	21	35	5.5	31.5	60.6	9.43	31	51.7	8.1
592-636	45	21	35	5.5	31	59.6	9.3	31.3	52.2	8.2
637-681	45	21	35	5.5	0	0	0	42	70	10.9

682-726	45	0	0	0	0	0	0	42	70	10.9
Fertigation schedule for 19-22 months (till first harvest) for Variety Mrudula										
19-22 months (April- July)	Duration	N = 63 g/tree	Urea g/tree	Schedule Urea g/week/tree	P= 62.5 g/tree	Phosphoric Acid g/tree	Schedule Phosphoric acid (52 % P) g/wk/tree	K= 146.3 g/tree	White MOP g/tree	Schedule MOP g/wk/tree
546-576 days	30	21	35	8.75	31.5	60.6	15.15	31	51.7	12.9
577-607	30	21	35	8.75	31	59.6	14.9	31.3	52.2	13.1
608-638	30	21	35	8.75	0	0	0	42	70	17.5
639-669	30	0	0	0	0	0	0	42	70	17.5
Fertigation schedule for 25-36 months (based on flower/Bahar treatment)** BHAGWA										
25-36 month	Duration (days)	N = 625 g/tree	Urea g/tree	Schedule Urea g/week/tree	P= 250 g/tree	Phosphoric Acid g/tree	Schedule Phosphoric acid (52 % P) g/wk/tree	K= 250 g/tree	White MOP g/tree	Schedule MOP g/wk/tree
October - November 15	45	187.5	407.6	63.7	100	192.3	30.0	25	41.7	6.5
Nov 16-Dec 31	45	STRESS PERIOD for inducing Flower								
Jan 1- Feb	58	187.5	407.6	49.1	75	144.2	17.4	50	83.3	10.0
March-May	90	187.5	407.6	31.8	75	144.2	11.3	75	125.0	9.8
June- July	90	62.5	135.9	10.6	0	0	0	75	125	9.8
Aug -Sept	60	0	0	0	0	0	0	25	41.7	5.2
Fertigation schedule for 25-36 months (based on Bahar treatment)** MRUDULA										
23-36 month	Duration (days)	N = 625 g/tree	Urea g/tree	Schedule Urea g/week/tree	P= 250 g/tree	Phosphoric Acid g/tree	Schedule Phosphoric acid (52 % P) g/wk/tree	K= 250 g/tree	White MOP g/tree	Schedule MOP g/wk/tree
August-September	60 days	NO fertigation								
October - November 15	45	187.5	407.6	63.7	100	192.3	30.0	25	41.7	6.5
Nov 16- Dec 31	45	STRESS PERIOD for inducing Flower								
Jan 1- Feb	58	187.5	407.6	49.1	75	144.2	17.4	50	83.3	10.0
March- May	90	187.5	407.6	31.8	75	144.2	11.3	75	125.0	9.8
June- July	90	62.5	135.9	10.6	0	0	0	75	125	9.8
Aug -Sept	60	0	0	0	0	0	0	25	41.7	5.2

Note: Application of 10-20 Kg FYM after every three months from the date of plantation is highly recommended. The FYM must be spread over the bed parallel to the laterals and must be covered with soil.

Flower & Fruit Management (Bahar Treatment): Flowering and fruit treatment is decided on below factors:

1. Favorable period for exposing tree to the stress.
2. Availability of water
3. Disease and pest management
4. Harvesting period

Pomegranate tree flowers round the year; therefore selection of flowering period becomes easy in for this crop. However, there are three main seasons popular for flower and fruit treatment, these are, Mrig Bahar (June-July), Hasta Bahar (September-October) and Amebye Bahar (Dec-Jan).

There are two methods used to expose tree against the stress, first by water reduced stress while second is the chemical induced stress.

In first method irrigation is completely or partially stopped for 4-6 weeks depending on the soil type and environmental conditions. In second method, ethephone the precursors of ethylene is used to spray at 2-5 ml/l concentration over the foliage of the tree. In first method, 50-70% leaf defoliation is expected and considered to be an ideal stage of stress while in second method 90-100% leaf defoliation is observed.

One may follow below steps for exposing plants against stress for flower and fruit treatment:

Water reduced Stress:

Day 1: Prune tree and stop irrigation completely or partially

Day 28- 42: Start irrigation partially and increase it as per the schedule

Chemical use stress:

Day 1: Prune tree and stop irrigation completely or partly

Day 2: Spray Ethephone @ 2-5 ml/l Day 28- 42: Start irrigation partially and increase it as per the schedule

Mrig Bahar (June/July treatment):

In this treatment, flowering is allowed at the beginning of monsoon. This treatment is well preferred by farmers from arid to semi-arid region where there are limited water resources available. This treatment has some advantages like exposure of tree to water stress becomes easy since plants are exposed to hot summer naturally minimum for 45-60 days where plant can receive required water stress. However, disease and pest management becomes very critical in this treatment because of favorable conditions for the growth of micro-organism, insect and pest. Fungal diseases are predominant because of high humidity.

Hasta Bahahr (September/October treatment):

This treatment is followed just after completion of rainy season i.e. during September to October. It has been observed that flower management during Hasta Bahar is very difficult because of unsuitable conditions for giving water stress to the plant. Due to the earlier rainy season, plant accumulates more nitrogen and soil retains some moisture that does not allow plant to receive water stress required to induce flowering. Well drain soils may be considered to be suitable for managing this treatment. This treatment is popular because it gives assured price and high demand for the fruits in the market.

Ambey Bahahar (December/February treatment):

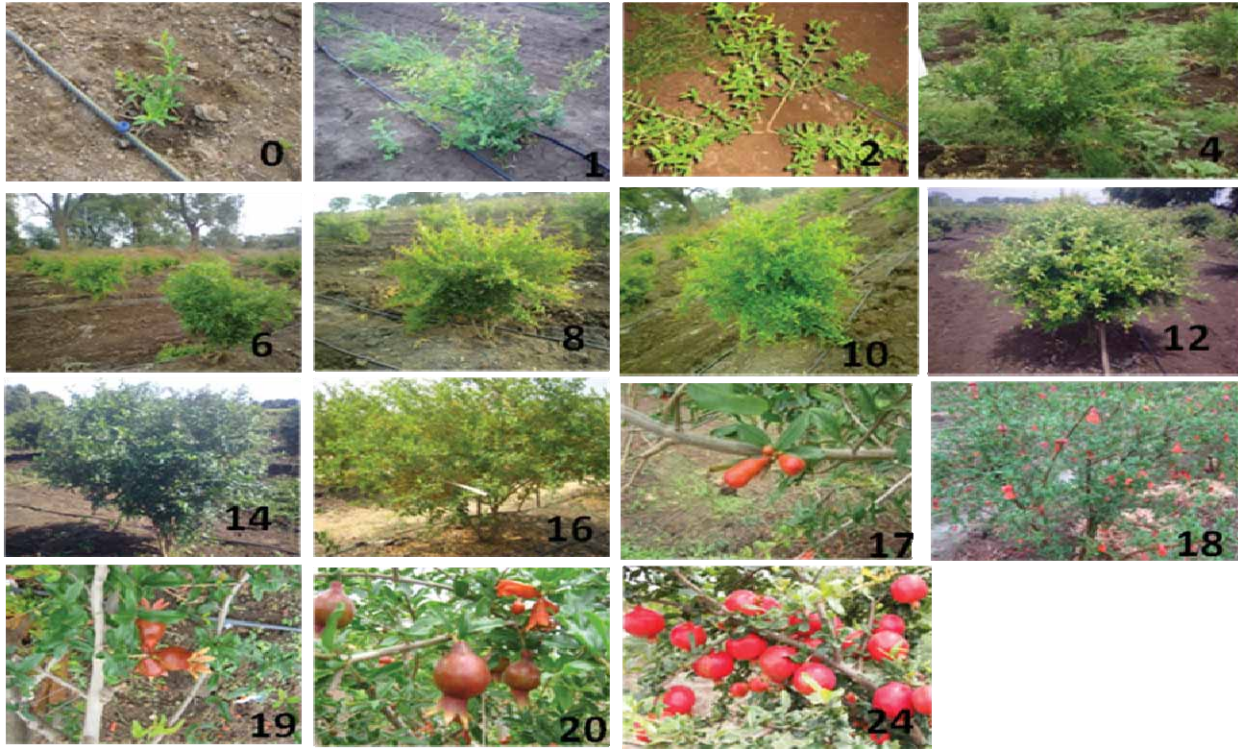
Plants are exposed to water stress during December to February depending on variety. This treatment is practiced by the growers who grow their orchards under heavy clay soil. Special attention is required to control sun burn and cracking to the fruit in this treatment.

SPECIAL OPERATIONS:

1. PRUNNING:

Pruning is an art of cutting away a portion of plant to improve vegetative growth of the plant and the quality of the product; the parts commonly removed are branches. Pruning is very essential in crop like pomegranate that does not have a tendency to produce branches at specific internodes. Pruning help to reduce water shoots, maintain a low tree profile (dwarf), properly trained and pruned trees yields high quality fruit much earlier in their life cycle and live significantly longer. Pruning is essential in both young and old trees.

A. PRUNNING YOUNG TREES: Newly planted young trees require pruning at right stage and regular intervals to develop desired size and shape of canopy. First pruning must be taken place after 30-60 days after planting while rest of the pruning must be carried out after every 2-3 months interval. There must be 5-7 pruning carried out from the date of planting to the maturity of the plant i.e. plant ready for switching over to reproductive phase. Ideal stem size for pruning is refill thickness (2-3 mm) while ideal length of prune stem is around 12''-15'' long. Pictorial presentation is given below for understanding the pruning techniques easily.



Stage-wise growth: 0- First day after plantation, 1- One month after plantation, 2- First Pruning two months after plantation, 4- Second pruning four months after plantation, 6- Third pruning six months after plantation, 8- Fourth pruning eight months after plantation, 10- Fifth pruning ten months after plantation, 12- Sixth pruning twelve months after plantation, 14- Seventh pruning 14 months after plantation, 16- Stress sixteen months after plantation, 17- Initiation of flower bud one month after stress, 18- Profuse flowering two months after stress, 19- Fruit setting three months after stress, 20- Fruit development four months after stress, 20- Fruit maturity eight months after stress

Along with the pruning, training the tree is also important. Training is a practice in which tree growth is directed into a desired shape and form. Training young fruit trees is essential for proper tree development. It is better to direct tree growth with training than to correct it with pruning. In pomegranate there are three types of canopy patterns can be developed for better productivity and ease for cultural operations. These patterns are decided on the basis of crop geometry.

- i. **Round:** When plant to plant and row to row distance is same and wide
- ii. **Oval:** When plant to plant distance is lesser than row to row distance or even at high density population
- iii. **Wall:** When plant to plant distance is too less

❖ **Tools used for pruning:**



Shoot tip/Pinching

Refill thick

Pencil thick

B. PRUNNING OLD TREES: Excessive pruning should be avoided as it affects the growth of the plant by 'dwarfing' and may induce more of eater suckers (water shoots) and thus affect the bearing potential.

❖ **Precautions required after pruning:**

- Take any systemic fungicide spray after pruning.
- Drench with same fungicide whenever water suckers are removed.
- Do not expose plant against water stress (except for flower/bahar treatment).

2. REMOVAL OF WATER SHOOT:

Pomegranate tree tend to produce water shoots during its whole life cycle. Water shoots are produced more extensively during first eighteen months i.e. during vegetative phase. One should be very particular after planting pomegranate plant in the field, since during first two months there are more chances of producing water shoots at this stage. If does not remove at appropriate time it stops growth of normal shoots. Pruning enhances rate of water shoot production. Water shoots are produced at two major locations, first at the bottom of the tree while second is from the stem of the canopy. Identification and removal of water shoot is very important. Water shoots grow straight and long without producing branches, stem is green at early stage. It should be removed by pulling the shoot from the base.



PROPPING:

Pomegranate wood is brittle that can not sustain heavy weight load of the fruit that bears to the plant. It requires propping 2-3 months prior to maturity of the fruits. Cost of propping increases over the trees that have long branches. Propping can be of two types, first temporary and second, permanent. In temporary propping, threads are used to hold the loaded branches while in permanent propping, either bamboos or steel rods/pipes/angels are used to establish permanent support to the tree.

DISEASE AND PEST MANAGEMENT: There are number of insect, pest, bacterial, fungal diseases occur on pomegranate. Some of the devastating diseases, insect and pest are addressed below with their control measures.

1. **Bacterial Blight Disease:** This is the most devastating disease on pomegranate caused by bacterial species *Xanthomonas oxinipodis* pv. *Puniceae*. It is a non-systemic disease that infects leaf, flower, fruit and stem.

Symptoms on leaves: The disease is characterized by the appearance of small irregular water soaked spots on leaves. Spots vary from 2 to 5 mm in diameter with necrotic centre of pinhead size. Spots are translucent against light. These spots turn light brown to dark brown and are surrounded by prominent water soaked margins. Numerous spots may coalesce to form large patches. Severe infestation leads to leaves shedding.



Symptoms on stem: The stem start forming brown to black spots around the nodes. In advanced stages girdling and cracking of node occurs which finally lead to breakdown of the branches.

Symptoms on fruit: Brown to black spots appears on the pericarp with 'L' or 'Y' shaped cracks on fruits.

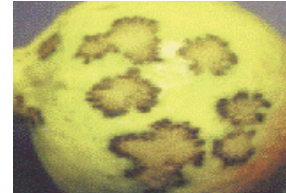
Control measures: No suitable control measures are available till date, however, to reduce the disease, clean planting material and orchard sanitation are heavily recommended. The infected branches should be pasted with Bordeaux paste. Spray of copper oxychloride (0.3%) has also been recommended to control leaf and fruit infections. Streptocycline @ 50-250 ppm (0.05 - 0.25 gms per liter of water depending on disease severity) is recommended to spray to reduce its further spread and severity. After the use of streptocycline, a spray containing 1 gm ZnSo4 + 1 gm MgSo4 + 1 gm CuSo4 per liter of water must be performed.

2. **Fungal Wilts/ Rots:** This disease is caused by fungal organism *Fusarium oxysporum*, *Rhizoctonia solani*, *Ceratocystis fimbriata*. Common symptoms of this disease are yellowing of leaves in single branch, sudden wilting of leaves and drying plant, vertical stem cracking and brown discoloration of the internal root tissue and pith of stem.

Control measures: Maintain proper drainage of water, Soil drenching with carbendazim (0.2%) or Propiconazole (0.15%). Use of biocontrol agent like *Trichoderma* culture also found effective.

3. **Alternaria fruit spot :**

This disease is caused by fungal organism *Alternaria alternata* and affects mostly on fruits. Common symptoms of this disease are small reddish brown circular spots appear on the fruits. As the disease advances, these spots coalesce to form larger patches and the fruits start rotting. The arils get affected which become pale and become unfit for consumption.



Control measures: All the affected fruits should be collected and destroyed. Spraying Mancozeb 0.25 % effectively controls this disease.

Insect and pest:

1. **Thrips:** It infests fruits as well as leaves by scraping of tissues & sucks the cell sap. Fruit cracking is also observed as one of the reason because of thrips infestation on fruit. Heavy infestation may cause flower shading. Leaves curl and dry due to its infestation.



Control measures: Spray Systemic insecticides Dimethoate -0.06%, or Imidacloprid 0.03% prior to flowering. Use of bio-pesticide spray like Neem oil @ 0.5% has also found to be effective.

2. **Aphids:** It infests tender shoots, flowers, leaves and tender fruits by sucking cell sap. Excrete large quantity of honeydew on which black sooty mould develops.



Control measures: Spray Systemic insecticides like Dimethoate @ 0.06%, or Imidacloprid 0.03%. Use of bio-pesticide spray like Neem oil 0.5% has also found to be effective.

3. **Mealybugs:** There are about 20 species of Mealybugs have been recorded on Pomegranate in India. Nymph & adult suck the cell sap from leaves, twigs, flowers and fruits. It secretes honeydew that encourages sooty mould development.



Control measures: Sticky banding around stem above 1 ft level help to control the mealybugs movement from plant to plant. Prune & destroy the affected parts of the plant. Spray of Chloropyrifos @ 0.06% + Dichlorvos 0.05% after pruning.

4. **Whitefly:** These are also found on the leaves and also cause sooty mold. Nymph & adult suck the cell sap from leaves, twigs, flowers and fruits. More incidences occur during the February.

Control measures: This can be controlled by Acetamipride 0.3 gm/liter or Acephate 1 gm/ liter.

