9. Canopy Management

There are several operations involved in improving the yield and the quality of mango fruits. Among them, canopy management is one of the most important factors to sustain the yield and quality of fruits in mango. In many fruit crops, increase in production with enhanced fruit quality is achieved by managing canopies. Capturing and conversion of sunlight into the fruit biomass (dry matter content) is an important process in fruit production. In general, compact and small trees capture and convert sunlight into fruit production in a better way than the larger ones. The main controlling factors are the extent of incoming radiation and percentage radiation intercepted by tree canopies. It can be enhanced by proper canopy management practices.

For commercial fruit cultivation, the natural form and shape of fruit trees are to be modified through the practice of pruning to achieve the targeted yield by scientific approach. This is because; it is not always wise to allow a plant to develop naturally, since unwanted portions may develop at the expense of those which are essential. Appropriate pruning practices keep the plant in such shape and condition as to yield fruits of desired quality. Canopy management depends on the nature and growth pattern of plant, number of plants per acre and pruning techniques.

9.1 Canopy Management in Young Trees

The early stages of growth are most important for the initial shaping of the young tree. A well-structured tree will be able to carry a heavy crop, facilitate spraying operations and ensure the fruit is exposed to plenty of light leading to a good blush on the fruit at maturity. Training the plant during juvenile phase is important to get a strong frame. To develop a strong trunk, the trees should be allowed to grow over 1 meter height initially. They are then cut back to a height of 0.6 to 0.7 m. The site of first cut is important for the development of a strong frame. Mangoes grow in flushes; each flush is delineated by a concentrated whorl of leaves on the stem. This is referred to as a “ring of buds”, as a bud capable of forming into a branch which is situated at the base of each leaf. If the cut is made above this “ring of buds” the resulting regrowth will be a feather duster effect of seven or more shoots developing. These would need to be thinned out to three or four if a good tree structure is to be attained.

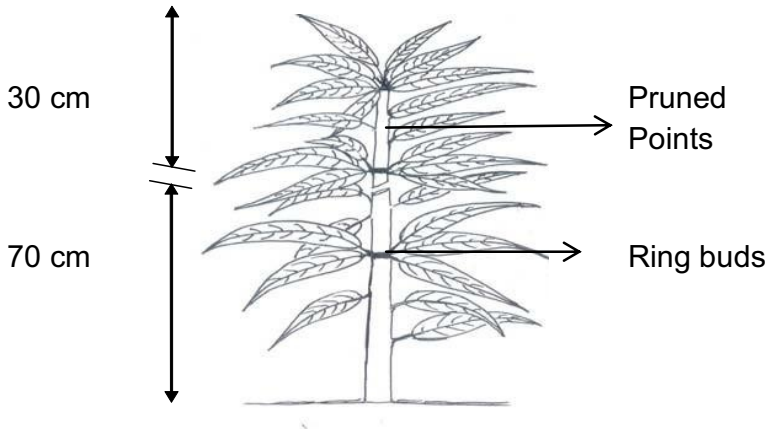




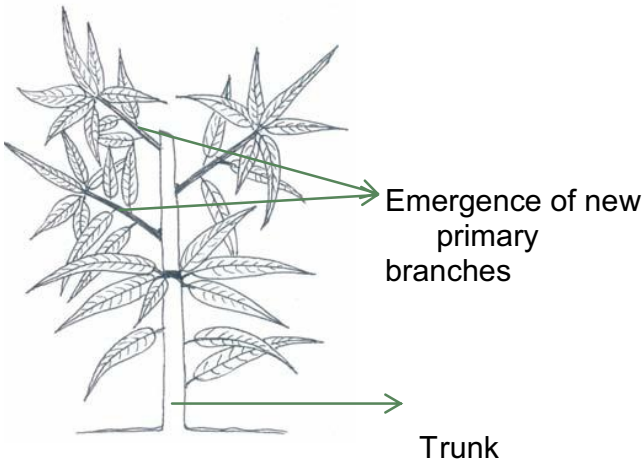




However, cutting above the ring of buds may result in the formation of weak crotches, prone to breaking during storms and heavy bearing. Below the “ring of buds”, the leaves are more spaced out along the trunk. An inch below the ring of buds is the correct point to give a cut.



Young seedling of 1 M height with cut given below ring of buds



Emergence of new shoots below cut end

It will ensure that the branches are well spaced out resulting in a strong frame for future development. After the initial cut, allow 3 or 4 shoots to grow into branches of over one meter long. These are then cut back to about 60-70 cm length, which will give a good strong branch for supporting the growing tree. After this, the trees should start branching by themselves. Young trees can be pruned at any time of the year. The aim should be to develop a spreading tree rather than a tall tree. Downward and inward growing branches or branches that cross over each other should also be removed.

Stepwise Operations

Allow the grafts to grow to a height of one metre from ground (single stem)

↓

Head back the graft at 60-70 cm from the ground during October-November to induce primary branches (make a smooth cut with sharp secateur)

↓

Heading back results in the formation of new primary branches (3-7) during March-April. Prune the excess branches and allow 3 to 4 in all the directions

↓

Prune primary branches at 60-70 cm height to induce new secondary shoots (7-10 month after the first cut preferably during October-November)

↓

Thin the excessive secondary shoots retaining 2-3 shoots per primary branch

↓

Tertiary branches (2 to 3) can be obtained by pruning the secondary branches at 60-70 cm height

9.2 Canopy Management in Bearing Trees

It may not be necessary to prune trees every year. Mango trees normally respond to pruning by sending out a vegetative flush, usually the heavier the pruning the more vigorous and numerous the flushes. Mango trees are terminal bearers, i.e., they flower from the ends of the branches and will only flower on mature wood, i.e., shoots that are six weeks or older. Hence, pruning affects the flowering and yield. It is therefore most important to ensure that the trees do not have enough vegetative flushes with poor yield. There are two periods when pruning can be taken up.

9.2.1 First pruning after harvest

First pruning should be done immediately after harvest and should be completed by the end of July. It includes:

i. **Skirting.** Removal of low hanging branches is known as skirting. It facilitates the operations such as fertilizer application and controlling of weed.

ii. **Opening up**. Removal of branches inside the tree which cross over or clutter up the center of the tree restricting the penetration of sprays. One or two uprightly growing branches from center of tree are to be removed to reduce tree height significantly and to increase the availability of light

inside the canopy for better photosynthesis. During removal of branches, first cut should be given on the lower side of branch, so that a smooth cut is possible which avoids bark splitting. In bearing mango trees, not more than 25 per cent biomass should be removed at a time; otherwise it results in excessive vegetative growth with reduced flowering shoots.

iii. **Hygiene.** It involves the removal of any diseased or dead branches in the tree, which could be a source of infection.However, it is need based and recommended for those trees found to have yield decline.





9.2.2 Second Pruning – pre flowering

Second pruning may be taken up during March. Second pruning should be completed in a short period not exceeding one to two weeks.

I. **Skirting**: Low hanging branches which could cause fruit to drag on the ground are to be removed.

ii. **Opening up**: Twigs and disorderly branches inside the tree are to be removed to have a open canopy. This not only facilitates spray penetration for better insect and disease control but also allows light into the tree, improving fruit color.

iii. **Hygiene:** It is essential to reduce the source of flower and fruit infection. Any diseased or dead branches should be removed. Further, pruning of malformed panicles is also very necessary at this stage as they appear.





9.3 Canopy Management Through Chemicals in Bearing Trees

Mango responds well for growth retardant treatments. Among the several chemicals, paculobutrazol (PBZ) has pronounced effect on flowering in mango.

Pruning the flowered/vegetative shoots 10 cm above the node during July (immediately after harvest) followed by soil drenching with paculobutrazol application of fertilizers 30-40 ml during August -September enhanced flowering, fruit set and quality of fruit in mango under irrigated condition in the regular season.





9.4 Rejuvenating Old Trees

Old trees often produce fruits and difficult to harvest due to their size. Moreover, old trees harbor pest and diseases and it is difficult to reach the whole tree while spraying to control them. It is possible to cut these trees back to a more manageable size, but depending on the severity of the pruning one may lose two to three crops. Rejuvenation improves production, fruit size and quality once trees recover. But, rejuvenation of mango trees under rainfed condition is not recommended since the tree may not recover after pruning. There are two models approaches to take up rejuvenation in mango.

Model 1

In this model, the tall central trunks are cut back to about 3-4 m height from the ground. The actual site to cut back to should be at a point where there are side branches. A chain saw is necessary for the job to make a smooth cut. Here, one half of the tree is cut back and the remaining trunks and leaves will help protect the stump from sunburn. The freshly exposed trunks and branches to the sun should be painted with white water-based paint diluted three or four times. This is to prevent sunburn, which could attract borer on to the damaged bark. In a short time, numerous shoots will develop; select the most vigorous of these, spaced evenly around the stump and if possible at differing heights. Remove all the unwanted shoots. This process should be repeated as often as necessary until the selected shoots begin to dominate and take over. Then the rest of the tree can be cut back and the operations may be repeated. By this method, half the yield will be realized throughout the process till it regains the vigor.





Model 2

Old, unthrifty trees can often be rejuvenated by a moderate to severe pruning. This is in the form of skeletonizing the tree, i.e. cutting back the branches of the tree till only the basic frame is left. Moderate skeletonizing would entail cutting back the large branches to healthy wood, while at the same time maintaining the basic structure of the tree. Particularly large unthrifty trees would benefit from a more severe skeletonizing, where all the main branches are cut back to the main trunk only leaving about a meter or so of branch. The whole trunk and remaining branches should be painted with diluted paint to prevent sunburn and borer attack. In both these cases there will be a proliferation of sucker growth. These should be treated as mentioned previously.

9.5 Pruning Tips

While cutting the larger branches with a saw, always do a cut of 20 to 40 mm into the underside of the branch to be cut before cutting all the way through from the top. This ensures a clean cut and prevents the branch tearing away as the cut reaches the end.

Large upright branches and trunks should be cut on a slight angle to prevent water sitting on the cut surface with the potential to cause rotting.

Large branches and main trunks should be cut off in sections, rather than in one cut where they could fall onto branches below and damage them.

Fungicide spray may be given after pruning to avoid any fungal growth from the cut surfaces. Always preference is given to Copper based fungicides like copper oxychloride, Copper hydroxide or Bordeaux mixture.

Preparation of Bordeaux mixture (0.5 %)

1. Dissolve 50 g of powdered copper sulphate in 5 liters of water in a plastic bucket
2. Prepare milk of lime in another plastic bucket by dissolving 50 g of quick lime in 5 liters of water
3. Pour the copper sulphate solution and the milk of lime above two vessels into a third one by gently stirring the mixture all the while. This will give a final volume of 10 liters of 0.5 % strength

4. The mixture is to be tested before use for the presence of free copper, which is toxic to the plant. Dip a polished knife in the mixture. If the blade shows a reddish color add lime to the mixture till the blade does not show staining on dipping. For 1 % solution adds 100 g Copper sulphate and 100 g lime.

Bordeaux paste:

Dissolve 100 g of Copper sulphate and 100 g quick lime each in 500 ml of water separately. Mix together to make one kg of the paste with the proportion of 1:1:10.

9.6 Tools and Equipments for Canopy Management

Canopy management involves pruning and lopping of branches. Pruning done through manual methods are cumbersome. However, different pruning tools are available to make this operation simple and easy nowadays. Following tools/ equipment scan be used based on the need.

1. **Secateurs**
   They are used to prune small twigs and terminal shoots of mango. Twigs around 1 to 1.5 cm diameter can be cut easily.
2. **Pruning saw**
   Saw is used to prune small branches of 1 to 2 inches diameter.
3. **Tree pruner** (Pruning shears)
   Tree pruner is used to prune 2 to 2 ½ inches diameter branches of mango.
4. **Chain saw:**
   It is a power operated saw used to prune big logs of any diameter.
5. **Hydraulic fruit picking platform**
   It is a self-propelled machine can be moved inside the orchard. It is fitted with chain saw and a cutter. Chain saw can cut branches of any size. However, the cutter could able to cut a branch of 2 to 3 inches thickness. Having the hydraulic attachment, it can reach 25 to 30 feet from the ground.
6. **Tractor trolley mounted hydraulic platform**
   This hydraulic machine can be used to move inside the orchard and reach up to a height of 25 feet from the ground. Pruning can be done using pruning saw, tree pruner and chain saw by standing in the bucket provided.
7. **Ladders/Stools**
   Tripod ladders or stools of various sizes may also be used to meet the task of pruning.

















10. Weed Management

- First 3-4 years after transplanting are crucial for the growth of mango plants.
- Application of organic manure and inorganic fertilizers, irrigation at regular intervals and good sunshine results in the growth of a broad spectrum of grassy and broad leaf weeds in mango orchards.
- The major monocot weeds that occur in mango orchards are *Cynodon dactyion* and *Cyprusrotundus*,and dicot weeds are *Bidens pilosa*, *Tridax procumbens* and *Phyllanthus maderaspatensis*.
- Usually, manual method of weed control is adopted at this time due to young nature of mango plants.
- They use small hand tools (Khurpi) for removing weeds in basins and between rows of plants.
- When the orchard comes of age, i.e., between 8 and 10 years, mechanical method of weeding by using tractor drawn implements like rotavator or weed slasher and tillers with special weeding tool attachments for effective weed control.
- The type and nature of tools used in mechanical method depend upon the row spacing adopted for mango orchards.
- In the cultivation of mango orchards at least twice a year is necessary to keep the weeds under check which otherwise may prove harmful to the growth and productivity of mango trees.
- In closely planted orchards, where ploughing becomes difficult, the cultivation is done by hoeing with the spade.
- In mango orchards, 15 to 20 years old, weed problems still exist and the degree depends upon the variety grown and the row spacing given.
- When trees are young, the sunlight received at the ground level is more and this results in the growth of perennial grassy weeds.
- As the tree grows, the canopy cover increases and shades larger area beneath trees which is suitable for the growth of shade loving weeds.
- In dwarf varieties, more sunshine is received around the trees and this encourages the growth of grassy and broad leaf weeds compared to tall varieties.
- Similarly, infestation of mango orchards by weeds is closely linked with row spacing, showing direct proportion between the two.
- It is concluded that, for an average type of mango orchard, three to four ploughings are enough in a year.
- Cover cropping is another practice followed in mango orchards to suppress the growth of weeds, to bring additional income to the grower until the trees begin to bear and to improve the health of trees if the intercrops grown are of the right type.

- Generally, cover crops are grown in space between the trees taking due care that no crop comes under the spread of the trees so that roots of the intercrops and the trees do not come into competition with each other for drawing nutrients from the soil.
- The recommended intercrops in mango orchards for summer season are bitter gourd, onion, chillies and cowpea etc.
- For winter season, the intercrops suggested are, peas, turnip, cauliflower, carrot and radish etc.

  Herbicides have been using to some extent in mango to control weeds since near past.

  One spray of Glyphosate @ 300-400 ml/20 lit of water with flat fan nozzle as pre-emergent treatment to soil and one spray as post-emergent spray on weeds six months after the soil treatment, to be effective for controlling both monocot and dicot weeds under the canopy of trees even the spaces between rows and plants.
- In the orchards where mango sudden death (MSD) is the problem, eradication of weeds especially under the tree canopy is recommended through scrapping with spade or application of herbicides.

Now a days, rotary tiller has been introduced in Pakistan. Eradication of weeds through this machine is also recommended under the canopy.







Botanical Name *Euphorbia granulate* Forsk
Common Name Garden spurge
Urdu Name Hazar Dani



Botanical Name *Euphorbia heliscopia*
Common Name Sun Sperge, Cats Milk, Wart spurge
Urdu Name Chatri dodhak





Botanical Name *Digera muricata*
Common Name False amaranth
Urdu Name Tandla



Botanical Name *Paspalum distichum*
Common Name Water grass
Urdu Name Naru Ghas





Botanical Name *Cyprus rotundus*
Common Name Common Nut Sedge
Urdu Name Dela



Botanical Name *Cyperus esculentus* (Scripus maritimus)
Common Name Yellow nut sedge
Urdu Name Zarad/ Della





Botanical Name *Portulaca oleracea*
Common Name Common pursalene
Urdu Name Qulfa Loonak



Botanical Name	*Trianthema portuclacastrum*
Common Name	Horse pursalane
Urdu Name	ITSIT



Common Name



Dabb grass



Botanical Name
Common Name



Taraxacum officinale
Dandelion



Common Name



Larna



Botanical Name
Common Name
Urdu Name



Tribulus terrestris
Puncture Clover
Bhakra, Gokhru

11. Physiological Disorders

11.1 Alternate Bearing

Irregular and alternate bearing in mango is a major problem faced by mango growers. This problem causes great economic loss to the growers with the poor yield or failure of crop during ``off year'' and the selling produce at low price during ``on year'' due to fruit glut in the market. Though planting of regular bearing varieties are suggested for getting regular fruits, most of the commercially grown varieties leading one Chaunsa are alternate bearers. In such trees regularity can be achieved by pruning, fertilizer Application flower induction with paclobutrozole, irrigation and pest control after harvest.

Mango normally flowers during February-March and is ready for harvest during June-July. Fruits are borne largely on previous year shoots, so pruning should not be very severe. Light pruning limits the vegetative growth and activates the quiescent fruit bearing buds by redistributing the endogenous hormonal substances and favors flowering, fruiting and improves fruit yield. After harvesting the fruits, troop off branches to open the centre. Also remove dead wood, weaker branches and criss- cross branches to allow sunlight to enter the canopy. Delay in harvesting of fruits may also lead to failure of crop for the next year.

This should be followed by fertilizer application. Though recommended doses of fertilizer differ with locality and variety, in general apply 700-1000 g N, 1000 g P_2 O_5 and 500 g K_2O. B, Zn, Fe & Cu may also be applied through soil or foliar application after leaf analysis. 2nd dose of Nitrogen 300-500 g and 500 g P2O is applied during flowering season of mango. Boron in the form of Boric Acid @ 80-100 g/100 lit may also be sprayed to get good fruit setting.

During September-October months, treat the soil with paclobutrozole (30-40 ml/plant) after getting the new flushes.

The field should be irrigated immediately after treatment to increase efficiency ofpaclobutrozole. It checks Gibberellic Acid biosynthesis, increases cytokinin level, Chlorophyll content, improves mineral uptake and carbohydrate gradient of the entire plant system. This helps in achieving a balance in C:N ratio which induces flowering normally.

If the low temperature prevails and results in late flowering then spray of 1% Potassium Nitrate is done to break the dormancy and to get uniform flowering.

During flowering or after flowering, the attack of diseases like apical necrosis, blossom blight and powdery mildew may occur. Always adopt the proactive approach to combat these diseases with prophylactic sprays. Infestation of inflorescence midge and hopper during flowering may also hamper mango crop. These pests may also be managed with the use of appropriate insecticides.

11.1.1 Flowering Mechanism in Mango

Flowering is the most important phonological stage of mango crop and all the orchard management practices are considered productive if flowering is achieved because it is the final product of the endeavors performed during different phonological stages of mango. So, understanding with flowering mechanism has paramount importance through describing the followings:

1. Florigen Concept

Florigen is a hypothetical hormone responsible for flowering in mango that is produced in fully developed leaves in restage and it is regulated by the cool inductive conditions. There are two types of inductive conditions in mango i.e. cool and warm. Cool inductive conditions (15°/10° day & night) strongly trigger the mechanism of conversion of a mature vegetative shoot into generative (reproductive) shoot but this temperature range may vary from variety to variety. Hence it is a need of era to work on the extent of low temperature that triggers the flowering response in different commercial varieties of mango in Pakistan.

Immature shoot as well as high nitrate contents adhere the signal of transduction even in the cool inductive conditions and may lead to develop vegetative shoot.

The florigen regulates the distal shoot from the donor shoot up to 100cm and transmits the signals into terminal growing tips. This signal would be expressed in four different forms of growth like pure vegetative growth, pure generative (flowering) and two mix shoots in which vegetative and generative possess mix transition growth i.e. strong vegetative with a weak generative or vice versa. The warm inductive conditions (30c°/25c°day & night) are responsible for the induction of vegetative shoot only. Similarly, the inductive signal can be altered from generative to vegetative or vegetative to generative with the change in temperature to which plants are exposed during the early shoot development.

2. Flush Maturity

Mango tree emerges vegetative flushes normally from April to October and their intensity and vigor depend upon the temperature fluctuation, soil moisture content, nitrogen accumulation, tree age, health status and relative humidity etc. Each flush passes through various development stages from its initiation towards maturity as terminal bud swell into pointed shape, bud sprout, leaf initiation, flush elongation, flush expansion, leaf hardening and a rest or cessation. This rest period vary from variety to variety, some varieties respond a short rest period while some respond on long rest. After hardening of the vegetative flush, the rest period may vary from minimum 15-20 days to a maximum >12 months depending upon the prevailing stress conditions. Due to intensive and improved management practices this rest can also be curtailed and possible to convert a vegetative shoot into flowering.

Normally, a mature vegetative shoot passes a rest period of 4-5 months and may become able to induce flowering. Minimum 90 days shoot may be matured by the help of growth inhibitors application.

3. Water Stress

The practice to stop irrigation from 15th October to onward is very important for flowering of mango groves during the upcoming season. The Arial temperature starts to decline from this date and if it is augmented with water stress, the cessation of apparent growth on the tree is achieved. Ultimately newly induced vegetative shoot get maturity and produce flowers.

For making the tri factor concept (Nitrogen, temperature and water) more conspicuous, the nitrogen application should be completed just after harvest in order to complete the vegetative growth before the dormancy. It is to mention that early and mid-seasonal varieties of mango have enough time (100 to 150 days) from harvesting to complete the vegetative growth.

Mango is ever green and tropical nature crop that also dwell in to sub-tropical climate. True dormancy is always present only in deciduous temperate plants that shed their whole leaves. In mango, dormancy is not true, it is pseudo dormancy that is induced in the tree in order to stop the new vegetative growth. This is known as latency or quiescence as well.

4. Dormancy Breaking Chemicals

There are a lot of options for the breakage of dormancy in mango tree for nitrate application and its attachment to the different compounds like potassium, calcium and ammonium may vary the dose and time of application to accomplish the task. The application of nitrate spray may result in ethylene synthesis that reinforces the signal strength to the shoot either it is generative or vegetative. In addition to this it is pretty much sure that nitrate application neither has the capacity to evoke the signal nor alter the signal for a specific job on the mango tree. It is comprehensively explained in the previous topic that cool inductive conditions emerge generative shoot and warm inductive conditions generate vegetative so nitrate application is done only to shorten the span in between the signal transmit and its physical expression.

5. Growth Regulators

Gibberellins are considered indigenous plant growth regulators and exhibit a large array of physiological function in plants including mango. Gibberellins has well documented for suppress of flowering growth. The floral inhibitory effect of gibberellins depends upon its concentration, growth stage and climatic conditions. This hormone is responsible for induction as well as stimulation of vegetative flushes and shoots elongation process during the warm conditions. With the passage of flush maturity the indigenous concentration of gibberellins gradually dissociates and reinstates the process of floral induction in the shoot tip.

There are evidences that induction of flowering in mango depends on the accumulation of higher C:N (Carbohydrate and Nitrogen) ratio. Maturity in terminal shoot and accumulation of Carbohydrate in shoot apex are in linked for the synthesis of floral stimulus. Concentration of gibberellins in sap increased with in buds during 'off' year mechanism and decreased in 'on' year for the erratic flowering.

6. Erratic Flowering

Sometimes mango tree does not follow the true concept of flower emergence and this type of flowering is called as unusual or erratic flowering.

- When the trees have enough carbohydrates reserve in addition with favorable weather conditions than tree emerges direct flower initiation from the main trunk this is leaf less flowering process.
- After harvest of the fruit, its dry panicle rachis lying on the same shoot does not allow this shoot to grow new vegetative growth. Sometimes during warm conditions vegetative buds activate and emerge vegetative flushes form auxiliary buds but in case of cool conditions auxiliary buds activate and emerge flower panicle. Severity of this erratic flowering is variable amongst the mango varieties. The phenomena of this unusual flowering can be hypothesized in a way that fully developed leaves on previously fruited shoots become mature enough that they can easily transmit the generative signal to the auxiliary buds having a tool of a hormone(Florigin) even in the condition that the terminal growth remains in cessation due to the existence of dry pedicel
- The shoot tip pruning may also emerge the same signal to the auxiliary buds to emerge out flowering growth as it is being practiced in tropical mango growing countries to stop the vegetative growth and to make the leaves mature for the production of required hormone so that generative signal could be achieved. This task is completed with the application of Potassium nitrate later on.






11.2 Fruit Drop

The Initial falling of mangoes from stalks is quite common and not due to any insects or other problem. A tree cannot support heavy fruit set. Only a certain percentage of it can mature to full size fruit. Dropping of some mango fruits is a normal thinning process of tree to properly utilize the available nutrients. The immature fruits are all competing for the available food and water and the strongest will survive. There are however, many factors that may be responsible for the tree to shed its fruits. The weather, dry weather or too much rain, pests, insects, diseases, lack of fertilizer, wrong time of fertilization can cause the young fruits to fall off.

Water

Getting right amount of water is an important factor for the growth of a mango trees. Not only scarcity of water but too much water can cause fruit dropping prematurely. Note that a mature mango tree does not require frequent watering. Always do the irrigation at “dry water conditions”.

Temperature

Mango tree grow well in warm tropical climates. However, a mature tree can withstand low temperatures.

Cover the tree to protect it from frost. Do not prune dead branches if the frost continues.

The mango tree fruit may fall if there was a cold weather during bloom and fruit set. The cold damages the developing embryo in the seed, due to which the ethylene gas given off by the damaged embryo causes fruits to drop before maturity.

Cover the area around the tree with weeds to minimize the soil temperature during severe summer days.

Fertilizer

Another reason for premature dropping of mangoes from a tree is improper or over fertilization.

Use balance fertilizers for fruit trees, with correct ratios of nitrogen (N), phosphorous (P), and potassium (K). Fertilize your tree with a fertilizer that has a higher P and K ratio. Too much nitrogen will damage flowers.

You can also give an organic fertilizer to feed the tree.

Regularly add organic compost to the plant.

Spray of 1 percent Urea along with 0.25 Percent Zinc sulphate during mid of April helps to protect from fruit drop.

Diseases

The fruits fall off the tree due to some mango tree problems.

Fungal disease such as anthracnose and powdery mildew can cause premature dropping of mango fruit. Due to anthracnose, the infected mango fruits drop early from the tree and fruit that initially appears unaffected quickly decays upon ripening and also the tree start losing leaves.

As the fallen diseased twigs, leaves and fruits on the ground are a potential source of infection, never allow them to remain on the ground for too long. Prune dead branches and leaves from the tree regularly to avoid further spread of the diseases.

Dispose of all infected parts of the plant in the rubbish or burn them.

Use a fungicide if the fungal problem persists. If the tree is already affected by anthracnose, or powdery mildew infection, it is too late to spray for these now. To avoid these fungal problems in the future, spray trees when they begin to form flower spikes.

How can you use the fallen unripe mangoes?

You may want to use the fallen unripe mangoes. Here are some of the suggestions:-

Use them in coriander-mint chutney.

Peel, chop and use them in salads.

Peel, chop and use them in sweet mango chutney.

Use them in making a mango drink which may be beneficial in summer.

12. Environmental Disorders

12.1 Hails

Hails, when strike, also damage the leaves, twigs, trunk, flowers and fruits. The injured areas are of variable in size, irregular in shape, and may vary with respect to sharp cutting edges. Hail injures small fruits, tears the bark of trunk and twigs of mango up to a depth of about 0.5 to 1.5" lengthwise. Soft tissues receive more wounds and frequently xylem tissue is bleached. Such wounds provide the site for secondary infection by various micro-organisms, which cause further rotting in the tissues.

Control

Wounds should be protected by spraying or pasting of copper oxychloride (0.3%).

12.2 Frost

Frost injury damages the young mango grafts. Such damages are usually considered as „Act of God and are beyond the control of man. The damage occurs mostly at or near ground level where frost settles longer. Canopy of the young tress is badly affected. Young trees are more prone to frost and should be protected during the severe winter for several years after planting.

Symptoms are characterized in the form of splitting of bark, which may not be visible in initial stages but one can only visualize when the plant withers away. Exudation of gum from stem bark, death of new shoots, charred appearance of leaves, burning of growing fruit buds and panicles, complete death of plants, are the symptoms which have been noticed as indicative of frost injury. Mild frost causes water soaking in leaves or temporary leaf curling. Sometimes when frost is not very severe enough to kill the whole leaf, small necrotic spots develop on the leaf blade. Frost damaged trunks, limbs and inflorescence are invaded by secondary microorganisms which promote rot.







Control

To protect the mango plants from the frost, young plants should be thatched with dried grass. The plants are covered on all sides except east to allow penetration of sunlight and air. The polyethylene sheet may also be used to protect the plants from frost but the plant must be covered with sheet up to the ground level with making some holes in the marquee.

Provide adequate soil moisture through irrigation for both old and young mango trees. Overhead irrigation is the best but a fair amount of protection is reported to be obtained by under the tree application during cold spells.

Grove heaters are effective for protecting the tops of both cold and young trees during cold spells.

Affected branches and twigs should be pruned after sprouting so that dried branch could be assessed easily and pasted with fungicide paste if plants have not died completely. Spray of fungicide is also recommended.

12.3 Wind & Rain Storm and Wind

Hurricane storm /wind followed by rains are occasionally experienced in mango growing regions during flowering to maturity. The unusual high velocity wind driven rains affect the fruit set and cause loss due to dropping of mangoes, thus resulting in about 30-40 per cent loss of the crop. Hot dry winds coupled with drought can promote distortion, tattering and desiccation of leaves. Young fruits are easily damaged when leaves, twigs or fruits rub against the rind and get confused with damage from other causes viz., thrips, scab and bacterial canker etc. Wind scar on fruit peel may also present a serious marketing problem.

Wind breaks should be planted to western side of the orchard.

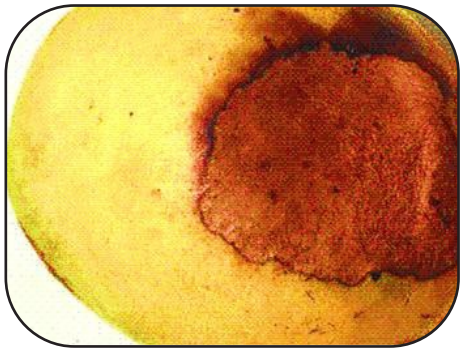


12.4 Sun Burn/Scald

Mango fruit may occasionally suffer major losses from sun burn. Damage generally occurs due to following factors:

1. Very high temperatures that cause sun burn on exposed fruit on the tree.
2. Fruit suddenly being exposed to sunlight when branches are broken.
3. Holding harvested fruit in direct sunlight or left on the ground during summer.

Sun burn produces bleached or yellow patches on the surface of fruit. In severe cases, the skin is leathery, yellow brown to black, hard and slightly depressed.





Control

Avoid any tree damage which may expose fruit to the sun.

Do not leave fruit in direct sunlight or on the ground after harvest.

Protect fruits from scorching sun during dry weather.

12.5 Flood

Flood alters the oxidation reduction status of the soil, reduces the redox potential due to chemical changes and various by products of soil microbes. Flood decrease the pH of alkaline soils and bound nutrient elements such as iron, magnesium & manganese to become more soluble. If the flooding period is prolonged, lack of oxygen in the soil results in a reduction of root and shoots growth, wilting, decreased nutrient up take and eventual death. Root rot causes severe damage under flooded conditions. Flood carries silt andclosed the pore spaces (macro & micro pore spaces). The mechanism of exchange of gases (CO_2 & O_2) collapsed and decline the root and shoot growth.

Treatment of Flood Affected Mango Orchard

Drain out the flood water from mango orchard immediately otherwise oxygen availability to the roots will become insufficient and attack of root rot will take place and plants will start to die. Orchard owner should try to apply tractor pumps to pull out the standing water from the orchard areas.

Harvesting of mango fruits should be completed during flood condition and re-instate the health of mango plant.

Clean the mango stems after flood water and apply Bordeauxe paste (one Kg. lime, one Kg. copper sulfate and 10 liter of water) upto 4 hight to protect the stem from diseases.






Remove all branches, fallen fruits, diseased & dried and burn them or burry into the soil.

Spray the orchard with copper based fungicide @ 250 g/lit of water.

Make 2x1 ft. basin twice at 15 days interval rings around the stems of mango trees and 1x1 foot around the small mango trees.

Under shed areas of mango trees should be ploughed up (shallow depth) or made shallow hoeing with spade to avoid the root damage of trees.

Apply 2 Kg ammonium nitrate/plant and 80-100 Kgs FYM/tree to absorb the extra moisture.

Apply 10 Kg. lime per tree to protect the soil from fungal diseases and release the excess moisture from the soil.

Apply one Kg. copper sulfate in the rootzone of trees to protect the root system from diseases.

After flood inspect the mango trees individually and if gummosis is observed then clean the stem/branches with knife withoutdamaging the skin and apply potassium per magnate (500 gm/100 litter of water) on the damaged area and repeat this action after 10-12 days interval up to recovery.

Stop the irrigation up to 2-3 months followed by dormancy stage.

When soil comes in wattar condition, plough the field with (rotavator/deep plough) 2 inches deep in soils so that mechanism of exchange of gases and root development can take place subject to the condition that there is no reported incidence of sudden death in the orchards. Collect the fallen fruits and burry into the soil and burn it otherwise fallen fruits are source of reproduction of fruit flies and dissemination of disease like anthracnose, die back etc.

Sudden death is the common disease of mango trees observed after flood. The organisms enter damage root, stem and lead to death of the tree.

13 Environment and Mango Crop Pathway

Flowering and fruit set are the most critical events of phenologocal cycle of mango crop. The influence of environment on these stages mainly determines the mango crop pathway. For the understanding of environment, some following terms are needed to interpret.

Atmosphere. It is a layer or a set of layers of gases surrounding the planet (earth)

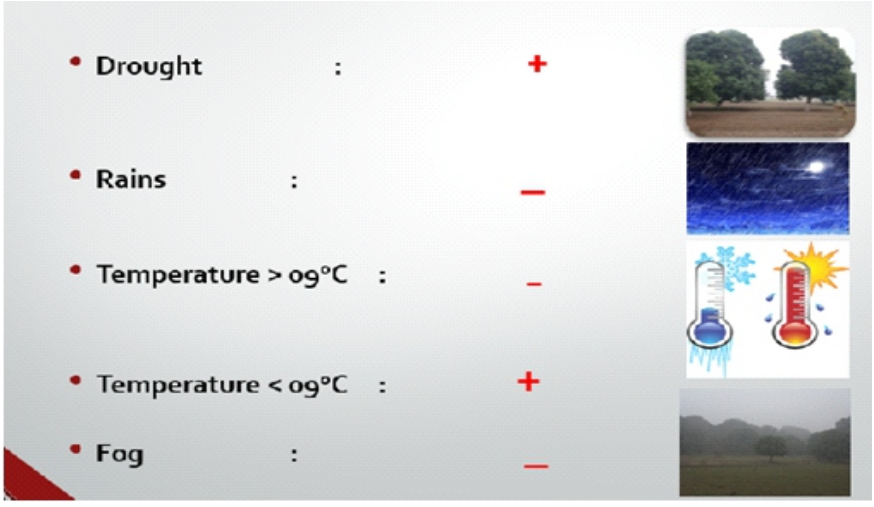
Weather & Climate. Weather refers to day to day temperature and precipitation activity, whereas climate is the term for averaging of weather conditions of a place over longer period of time.

Environment. The surroundings or conditions in which a person, animal or plant lives or operates. Weather and climate contribute a lot to develop the environment.

Induction in mango is the temporary commitment of buds to evoke a particular developmental pathwayi.e. vegetative shoot, generative shoot or mixed shoot. The inductive signal can be shifted from floral to vegetative or vegetative to floral mainly due to the fluctuation in temperature (thermal regime) during early shoot development. There some other factors influencing the induction in mango e.g. age of flush, nitrogen level in leaves, water stress and photoperiod. Generally low temperature less than 10 °C for 25-50 days favors the floral buds for the flushage of 90 days at least and having 1-1.4 percent nitrogen in leaves. Floral bud is caused by photoperiod of 10.5 to 13.5 hrs for 20-35 days. Similarly, water stress imposed for more than 8 weeks on plants during the cool autumn months expedite the floral buds. The behavior of the different mango cultivars towards these factors might be different which is still to be determined variety wise.

The crop model is the only tool to determine the impacts of environmental variables on crop phonological events. Here is some depiction of the influence of environmental variables during the critical stages of mango.

13.1 Effect of environmental variables on floral bud induction



13.2 Effect of environmental variables on flowering & fruit setting

- Temperature decrease< 10 °C
  - \+ (Floral induction)
  - \- (Flower emergence,
- Temperature increase > 15 °C
  - \- (Floral induction)
  - \+ (Flower emergence, Perfect flowers, Pollen viability, fruit set)
- Drought
  - \+ (Floral induction)
  - \- (Flower emergence, Fruit set &Retention)
- Rains
  - \- (Fruit set)
- Light
  - \+ (Floral induction & Flower emergence)



13.3 Effect of environmental variables on fruit growth and quality

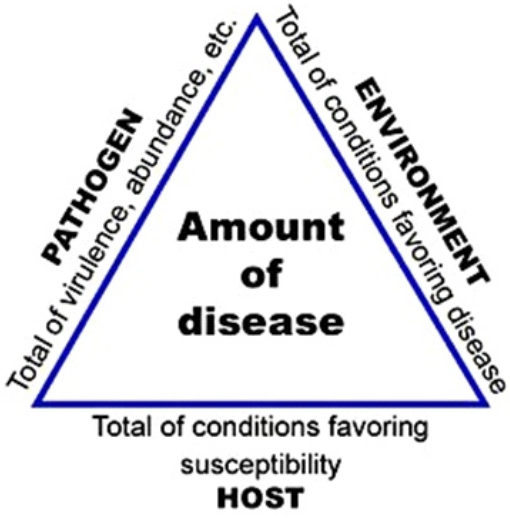
- Temperature increase +/- (Quality)
  - \+ (More Rapid growth)
- Drought
  - \+ (Quality)
  - \- (Size)
- Light
  - \+ (Skin colour, quality & size)



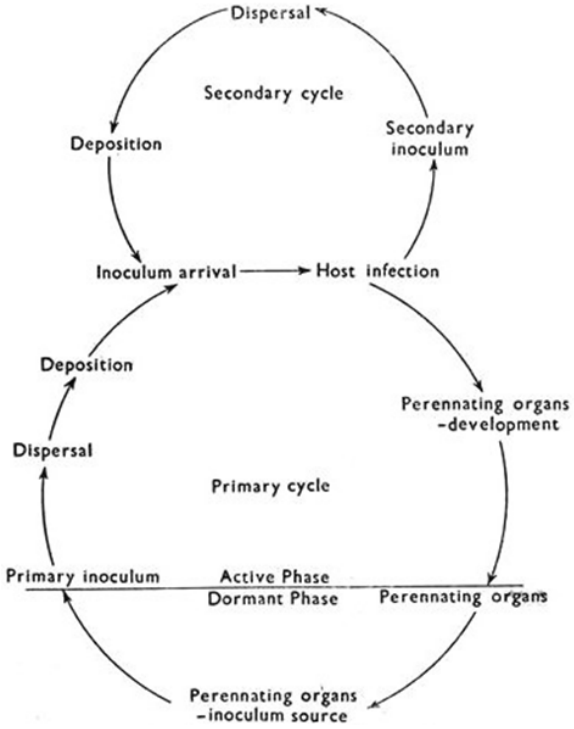
14. Mango Diseases and Their Management

Diseases affect all the tissues and developmental phases of mango. If these diseases are managed, the increase in yield by 28% is quite possible. The integrated disease management (IDM) through the use of resistant varieties, cultural practices, biological and chemical means is the best approach in the holistic disease management program of mango. Before going to the mango diseases it is imperious to understand the mechanism of disease development in plants.

A plant becomes diseased in most cases, when it is attacked by a pathogen or when it is affected by an abiotic agent. Therefore, in the first case, for a plant disease to occur, at least to components (Plant and Pathogen) must come in contact and must interact. If at the time of contact of a pathogen with the plant, or for some time afterward, conditions are too cold, to hot, to dry, or some other extreme, the pathogen may be enable to attack or the plant may be able to resist the attack and therefore, despite the two being in contact, no disease develop apparently than, a third component, namely a set of environmental conditions within a favorable range, must also occur for disease to develop. The interactions of three components of disease have often been visualized as a triangle generally refers to as the disease triangle.



An inoculum that survives dormant in the winter or summer and causes the original infection in the spring or in the autumn is called a primary infection. An inoculum produced from primary infections is called as a secondary inoculum and it, in turn, causes secondary infections. Generally the more abundant the primary inoculum and closer it is to the crop, the most severe the disease and the losses that result.



Diseases above ground are the most important and conspicuous problems on mango. Since many of the pathogens that incite foliar diseases also affect the panicles. There are a few diseases that affect the branches and trunks of mature trees. However, flowers are described firstly.

14.1 Flower diseases

14.1.1 Apical Necrosis

Causal Organism *Pseudomonas syringae* (Bacterium)

Apical necrosis is a disease characterized by a rapid expansion of necrotic lesions on buds and leaves. Disease symptoms include necrosis of vegetative and yellow buds and bud failure. Flower panicles are also affected, which results in severe economic losses due to a decreased fruit set. The necrosis lesions are very much similar as observed after the incidence of frost or cool water.

Epidemiology

This bacterium is supposed to be as weak pathogen which causes disease only when the host is stressed. For example, during tree dormancy and bud break. Cool rainy weather is very conductive for outbreak of symptomatic buds. Incidence of apical necrosis in the field is always high when the temperature reaches below 0°C for a few nights.




Control

Sprays of copper based fungicide or antibiotic like Streptomycin starting from swollen bud upto bud elongation have significant effects to control apical necrosis.

14.1.2 Powdery Mildew

Causal Organism ***Oidium mangiferae*** **(Fungus)**

The symptoms can be noticed on the inflorescence, stalk of inflorescence, leaves and young fruits. The characteristics symptoms of disease are white superficial powdery growth of the fungus on these parts. The effective flowers may fall prematurely and young fruits may remain on the tree until they reach up the marble size and then drop prematurely. Dropping of unfertilized infected flowers and young fruits leads to serious crop loss by 20-80%.

Epidemiology

The fungus is very crazy. Condia germinate at 9-32°C with less than 25 % relative humidity and disease proliferates at 10-31°C with 60-90% relative humidity. The plants deficient in phosphorous and possessing malformed panicles are more prone to this disease.





Procedure for observation:

The number of inflorescence(s) affected under each of the ratings out of 10 inflorescences examined should be entered while recording the observation.

Disease scoring scale for powdery mildew is as given below.

0 : Inflorescence free from infection.
1 : Less than 25% of the inflorescence covered by powdery mildew
2 : 26-50 % of the inflorescence covered by powdery mildew
3 : 51-75% of the Inflorescence covered by powdery mildew
4 : More than 75 % of the inflorescence covered by powdery mildew

Control:-

1. Pruning of diseased leaves and malformed panicles reduces primary inoculums.
2. Three sprays of systemic fungicides during flowering season are recommended at 12-15 days intervals.1st spray is recommended when there is 25% flowers

14.1.3 Anthracnose/ Blossom Blight

Causal Organism ***Colletotrichum gloeosporioides, Alternaria sp.*** **(Fungi)**

Anthracnose manifests on different parts of mango tree. On the inflorescence, the earliest symptoms of the disease are the production of blackish brown specks on peduncles and flowers. Small black spots appear on the panicles and open flowers, which gradually enlarge and cause death of flowers. The infected flowers fall off, leaving the more persistence spikes on the peduncles, this leads to serious crop loss by 10-90%

Epidemiology

The disease development occurs at 25-23°C and more than 90% relative humidity. The plants excessive in Nitrogen, possessing malformed panicles, diseased & dried branches and mummified fruits and soil touching branches are more susceptible to this disease.





Procedure for observation:

Blossomblight (Anthracnose on flowers) is recorded with the same severity scale as mentioned for Powdery mildew.

Control:-

1. Diseased leaves, flowers, twigs and fruits lying on the floor of the orchard should be collected and all infected twigs from the tree should be pruned and burnt.
2. Blossom infection can be controlled effectively by two to three sprays of contact or systemic fungicides during spring season at 12-15 days interval. The spray should be started before flowering.

14.1.4 Mango malformation

Causal Organism ***Fusarium mangiferae*** **(Fungus)**

Malformation is a serious threat to the mango growing areas of Pakistan as it causes crop loss upto 70%. Recent findings have demonstrated that the disease may be of fungal origin. Two distinct types of symptoms described by the workers are vegetative malformation and floral malformation. Vegetative malformation is more pronounced in young seedlings as well as seedling trees than in the grafted plants. The affected seedlings developed excessive vegetative branches, which are of limited growth, swollen and have very short internodes.

Malformation of inflorescence is a disease of inflorescence. The most characteristic symptoms of are the reduction and compact of internodes giving malformation a broom like appearance.

Epidemiology:

Infected grafting material and diseased plant parts are the main source of disease inoculum. The primary infection is very rare but most of the spores of the fungus .





Procedure for observation:

Vegetative malformation: Count all the malformed shoots/twigs in a tree and record.

Floral malformation: Count all the inflorescence with malformation in a tree and record.

Control:-

At present, no definite control measures for mango malformation can be advocated. However the following may reduce the incidence of malformation

i. It is advisable to avoid scion stick from trees bearing malformed inflorescence for propagation.
ii. Only certified saplings should be used for propagation.
iii. As soon as the disease symptoms are well expressed, the affected terminals should be pruned along with the contiguous 30 cm apparently healthy portion and burnt.

iv. Sprays of systemic fungicides during fruit development and vegetative phase will also minimize the infection harbor on the apical buds during fruit development and vegetative phase of mango. High relative humidity favors the infection as well as disease development.

14.2 Leaf diseases:

Mango plant more or less is prone to various leaf diseases which are mentioned below but the most important ones are discussed in detail:

1. Anthracnose
2. Scab
3. Phoma blight
4. Grey blights
5. Alternaria leaf spot
6. Bacterial canker

14.2.1 Anthracnose

Causal Oraganism *(Colletotrichum gloeosporioides)*

Characteristics symptoms appear as oval or irregular brown to deep brown spot of various sizes scattered all over the leaf surface. Under damp conditions, the fungus grows rapidly. Young leaves are more prone to attract than the older ones. Insect attack may facilitate the entry of pathogen resulting into heavy incidence of disease.

Epidemiology

As mentioned in blossom blight.





Procedure for Observation

Recording of anthracnose on rachis is based on per cent leaves on rachis infected following the severity grades of no infection, mild, high and severe infections.

0% affected leaves	No infection
1-5% affected leaves per rachis	Mild
6-10% affected leaves per rachis	Mild
>11% affected leaves per rachis	severe

Number of infected rachis in respect of the severity scale out of 10 rachis of the selected tree should be recorded.

Control:-

i. The foliar infection can be controlled by sprays of copper based fungicides during fruit development and vegetable phases of mango after each rainfall.

14.2.2 Alternaria leaf spot

Causal Organism*(Alternaria alternata)*



Symptoms first appear as small, brownish circular spots on the surface of leaves. Later on, high concentration of brown black spots occurs evenly over the leaf lamina. Symptoms are more prominent on the lower side of the leaves. The tender leaves are found to be more susceptible than mature ones.

Control:-

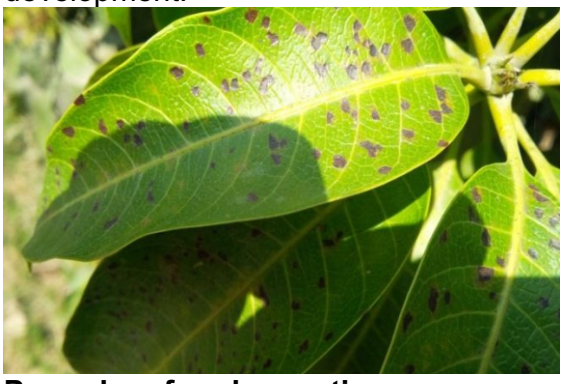
i. Field spray program described for the control of anthracnose is also effective for the control of this disease.

14.2.3 Bacterial Canker *(Xanthomonas mangiferae)*

On leaves, minute water soaked irregular to angular raised lesions is usually crowded at the apex. On young leaves halos are larger and distinct, while on older leaves, they are narrow could be observed only against light. Under severe infections, the leaf turns yellow and drop off.

Epidemiology

Rainy weather with 90 % R.H and 25 – 30 °C are very conducive for disease development.





Procedure for observation

The rating to be used for bacterial blight is based on percentage lead area Affected on the selected shoot for sampling.

Control:-

i. Regular inspection of orchards, sanitation and seedling certification are

recommended as preventive measures against the disease.

ii. Spray of copper based fungicides has been found effective in controlling bacterial canker

Control

Spray of fungicide from Triazole group showed good results.

14.3 DECLINE DISORDERS

Decline is a general term and mango plant is affected with different decline disorders which are usually associated with biotic as well as abiotic stresses. Mango Decline is becoming a serious problem in Punjab and Sindh. Sporadic decline symptoms are very common in sick soil. Old plants show the symptoms of declining trend invariably. Initially the symptoms appear on older leaves with the collapsing of tissues. The younger leaves mostly remain unaffected up to 2 to 3 months after their emergence. It gradually leads to mortality of upper twigs progressing further to larger branches. Affected trees have thin canopies of lusterless green leaves and sickly look.

Generally mango decline disorders which are prevalent in the mango orchards are listed below:

1. Twig Blight
2. Die back
3. Gummosis
4. Bark Splitting
5. Wilting
6. Mango Sudden Death

Each mango decline disorder is being described in detail along with its causal organism and facilitating factors for the pathogen to come in contact with host plant (pre-disposing factors). Keeping in view these factors , the management options may vary from orchard to orchard.

14.3.1 Die back

Causal Organism ***Lasiodiplodia theobromae, Natrassia mangiferae***

The disease is noticeable throughout the year but it is most conspicuous during October and November. It is characterized by drying up of twigs from top to downward particularly in the older trees followed by drying up of leaves which gives an appearance of fire scorch. The upper leaves lose their color and gradually dry. Drying of the whole leaf is accompanied by upward rolling of the margin. Such leaves shrivel, fall off within a month leaving the shriveled twigs all together bare, which is the characteristic symptom in the advance stage of the disease.








Predisposing Factors

Drought, hard pain, high temperature, weak trees, sun scorch, high humidity, nutrition deficiency & physical damage, excessive irrigation, poor soils & old & unpruned trees.

Procedure for observation

Die back severity counted on (1-5 scale) out of 10 trees per orchard

Disease scoring scale for die back disease

1. Trees free of disease
2. An early stage of infection characterized by browning of leaf petioles and mild veins and presence of distal or marginal leaf blade necrosis in one or two branches.
3. The presence of dead leaves, which may remain attached in the tip of several branches, vascular browning and evidence of pathogen invasion of vascular tissue, formation of tylosis in xylem vessels, and dark inclusions and fungal hyphae present in stem upon breaking
4. Dead leaves and progressive defoliation extend to many larger branches along with increased severity and spread of vascular system.
5. Severe die-back that extended to major portions of the tree.

Control:-

i. Pruning of affected twigs (3 below the infection site) followed by spraying of copper based fungicides is the most effective method for the control of disease.

ii. In severe cases, the soil amendment with the removal of soil up to 9 inches deep under the canopy of the diseased tree and refilling with the canal silt, recommended doses of chemical fertilizers and FYM with pruning of affected twigs followed by three consecutive sprays of copper based fungicides at 15 days interval is also recommended.

iii. Formation of flat top basin around the tree trunks is very effective to minimize the rates level in the soil under the canopy.



Trench Technology to treat dieback affected plants

The disease which causes mango plant to dry and shrivel, starting from the plant top towards the base, is termed as dieback. In Pakistan, the outbreak of dieback is aggravating. It is believed that the presence of salts in plants' root zone is the cause of this specter. These raised salts in root zone influence the immune system of plants. The affected plants start drying and shedding leaves; its branches become black. To prevent immune system of plants from collapsing by this malaise, Mango Research Station, Shujabad has conceived a technique named Trench Technology. In this novel technology, affected plants are encircled according to their canopy and a deep trench, 1.5 feet width and 3 feet depth, is dug on this round, encircling the plant. In this way, affected plants are separated from the main orchard and are irrigated separately only in the trench. Upon evaporation of water in the trench, it is again filled with water. As a result, all the salts will begin diverting towards the trench. It is advised to avoid getting fruit from these trenched plants for one year, at least. Lastly, it must be remembered that this trench is not meant to be filled with any fungicides or any other chemical but only water.





14.3.2 Twig blight

(Lasiodiplodia theobromae, Nattrassia mangiferae, Colletotrichum gleosporioides)

Disease produces elongated black necrotic areas on the twigs. The leaves droop down slowly during up and ultimately fall off. The very young braches start drying from tip downward.



Predisposing Factors

Injuries, Insect attack, high temperature weak plant, water stress, frost & physical damage.

Control:-

i. Diseased twigs lying on the floor of the orchard should be collected and all infected twigs from the tree should be pruned and burnt.
ii. Foliar sprays of copper based fungicides reflect good control.



14.3.3 Gummosis

Causal Organism ***Lasiodiplodia theobromae***

About 30-40% of young mango trees are affected by the gummosis especially when the mango tree is planted in sandy soil but its prevalence has also been noticed in other mango growing soils. The diseases is characterized by the presence of profuse oozing of gum on the surface of affected wood, bark of the trunk and also on larger branches but more common on the crack branches. In severe cases, droplets of gum trickle down on stem and bark turns dark brown with longitudinal cracks.







Predisposing Factors

Injuries, high temperature, weak plants, water stress, sun scorch, high humidity, nutrient deficiency, physical damage and frost bite.

Control:-

i. The disease can be controlled with the regular sprays of copper based fungicides.

ii. The diseased bark / portion should be removed, cleaned and covered with copper based fungicides paste.

iii. Application of copper sulphate 500g in the sandy soil around the tree trunk is also advocated.

14.3.4 Bark cracking

Causal Organism ***Unknown etiology***

Bark cracking is characterized by the development of deep longitudinal cracks. Rooting is not associated with the cracks but the underlying wood is found severely pitted. Gum pockets are also noticed along with the cracks. Later bark gets dried and pulled off resulting in girdling effects, yellowing and shedding of leaves followed by the die back of branches.






Predisposing Factors

Sun scorching, water stress, physical damage, nutrition deficiency

Control:-

i. Spraying of copper based Fungicide.
ii. Soil application of copper sulphate.
iii. Removal of dead bark & pasting Bordeaux paste.
vi. Application of Bordeaux paste on the trunks after planning
v. Covering of stem with peddy straw etc.

14.3.6 Mango Sudden Death Disease *(Ceratocystis fimbriata, Lasiodiplodia theobromae)*

Mango Sudden Death Disease (MSD) has become an important disease in Pakistan since 1997 which is closely associated with infections by Ceratocystis fimbriata possibly in concert with Botryosphaericaceous fungi like Lasiodiplodia theobromae. Improper irrigation and root injuries have been found as major predisposing factors for this disease. Affected mango trees have wilting symptoms. Cankers may develop over areas of vascular discoloration and the cankers my exude gum from the stem. Wilted leaves typically become dry and curled rather suddenly but remain attached to the tree for several weeks. It is a serious disease and aggravating day by day by which apparently healthy looking mango plants die within days and it is destroying the precious wealth of Pakistan. Up till now 4-12% mortality rate has been observed in different mango growing areas of Pakistan.

Predisposing Factors

Root injuries, insect infestation, improper irrigation, declining Plants of mango.







Control:-

Early detection is very important for the proper management of this disease. For this purpose scientists have divided this Disease into five categories (0-5 stages) with collective wisdom. The detailed pictorial presentation of each stage has been developed for the guideline of mango growers under ASLP project. However some important points are being discussed over here.





0 stage = No Disease
1 & 2 stage = Less than 25 % disease severity
3 & 4 stage = More than 25 % disease severity
5 stage = Dead & totally wilted plants

i. Uproot the plants showing 3, 4 & 5 stages immediately and treat the soil with fungicide. Soil solarization of this area is also recommended.

ii. Treat the plants falling in 1 & 2 stages with the following way:

   a. Scratching of the infected portion followed by three pasting of Thiophanate methyl or @ 250 g/liter with one week interval
   b. This fungicide @ 100 g/20 liter of water may be injected 2-3 times at 15 days interval into main trunk through Macro Infusion System (MIS) using knap sac sprayer.
   c. Optimize the soil conditions of the diseased plants through the application of FYM phosphorus, potash and gypsum (if required).
   d. Minimize the plant requirements through de-blossoming, timing of fruit, pruning and foliar spray of micronutrients

iii. The following recommendations are given for the plants showing no diseases (0 stage).

   a. Do proper irrigation whenever it is required.
   b. Keep the water 3 to 4 ft away from the stem by making “watt” or slope.
   c. The area under canopy should be at field level.

d. Avoid intercropping in mango orchards.
e. Properly control bark beetle and termite infestation.
f. Follow the recommendations for fertilizer application.
g. Organic matter should be added in the form of FYM or green manure preferably every year.
h. Always avoid hoeing and ploughing in mango orchards.
i. The foliar spray of fungicides against other diseases should be done in a way covering the whole area of the tree up to ground level.
j. Injections of these fungicides for healthy plants as preventive measure are also advocated.
k. The plants showing any type of decline disorders other than MSDmay be treated accordingly.

14.3.7 New Decline Expressions in Mango Orchards

Mango decline is a general term used for several diseases, generally referred as decline disorders. The previous studies reveal that different mango decline disorders viz. tip die back, twig blight, gummosis, stem bleeding / cankers, wilting and bark splitting as independent or in combination with each other are predominantly prevailing in mango orchards of Punjab. Recently a new problem mostly resembling with twig blight / shoot wilt has been being observed for the last few years. Apparently blighted and wilted shoots with scorched leaves are noticed amongst the rest of the healthy tree foliage. The pathogenesis on leaves initially depicts the rusty and leathery appearance, upward curling and then drying with chlorosis. Necrosis on leaves may also be observed in advance stage.

Lasiodiplodia theobromae, Nattrassia mangiferae, Colletotrichum gloeosporiodes and *Alternaria sp* have always been found associated with mango decline disorders. The predisposing factors for each disorder are always evaluated through the prevailing environmental conditions and the practices done in the orchard .The perceivable history of the inputs always reflects the mal exercises and amongst these, facilitating factors for the menace may be assessed.

The isolations made from the collected leaf samples from different locations confirmed the presence of *Nattrassia* and *Alternaria* (photo attached).These entities are opportunistic fungi and always attack when the plants are under stress conditions and decline symptoms become visible on leaves, shoots or stem. These stresses are being listed below.

- High and low temperatures
- High soil E.C and pH
- Inadequate organic matter
- Flood / wind storms / hail storms
- Extensive hoeing and ploughing

- Intercropping
- Non judicious use of fertilizers
- Improper irrigation
- No canopy management
- Inadequate plant protection measures
- Soil texture
- Hard pan in soil substrata

Apart from these stresses, the followings are the salient observations which are being hypothesized for this type of decline expressions in mango.

Indiscriminate use of PBZ in all types of soils and plants might be the main reason for this malady arresting the vegetative growth .PBZ (anti gibberellin) is also a derivative of Triazole which remains active in soil for several years and can severely affect the growth and development of the subsequent crops mainly by reducing vegetative vigor through chocking the xylem. The applied dose of PBZ in soil is not always appropriate because no quantification is done nor it is taken into consideration when deciding its dose as its residues always remain in the soil from the previous cycle of application.

Secondly, the repeated fungicidal sprays in one year from the same group (triazole) including Difenoconazole, Penconazole, Tebuconazole, Propiconazole and Flutriafol alone or in combination with other fungicides with high lethal dose may disturb the photosynthetic apparatus resulting in the damage of the plant biomass because of their harmful potential. Triazoles don't have any degree of systemic movement. They are xylem mobile in nature, readily taken up by the leaves and move inside. Their three droplets may cover the entire leaf within one day. The initial concentration of these droplets gradually starts to increase after 3-7 days of application which may attain its peak level after 14 days. So the application of fungicides from this group requires wise rotation in disease management program.

Further, continuous application of copper based fungicide in combination with Zinc, Ferrous and Boron or shortly sprayed before or after the sprays of these trace elements always cause phyto toxicity. This practice if done may also attribute towards this syndrome and other decline disorders as well even where PBZ was not applied. Such types of the cases are still need to explore.

MAIN SUGGESTION:

Collection of the soil samples with and without PBZ application history and then quantification of PBZ from the lab equipped with high performance liquid chromatography (HPLC) and this facility may be available at Pesticide Residue Lab at Kala Shah Kaku.

OTHER SUGGESTIONS:

1. Pruning of the wilted branches followed by the spray of copper hydroxide @250g/100 L.
2. Two subsequent sprays of Fosetyl Aluminium @ 250g/100lit at 10-12 days interval, being used as channel opener because of its base pital movement property.
3. Avoid the spray potassium nitrate on such affected plants during flowering season.
4. Don't spray any fungicide from the Triazole group on these plants as it may more impair usual photosynthesis.
5. De-blossoming practice is strongly recommended for rehabilitation purpose.
6. Avoid abusive use of any fungicide from Triazole group on rest of the plants as well. However, selection of the Strobilurin fungicides may help in stress management in future.
7. Some organic solvents like acetone and petroleum ether may be used in soil for PBZ degradation but it needs still exploration and research.
8. Potassium permegnate as oxidizing agent may eliminate the toxic effects of PBZ if it is applied near tree trunks. Further, addition of Humic acid in soil might be more beneficial. Initially, this treatment is advised to adopt on small scale.

DECLINE EXPRESSIONS IN MANGO AT A GLANCE



(Alternaria) *(Nattrassia)*

14.4 FRUIT DISEASES

14.4.1 Anthracnose

Causal Organism ***(Colletotrichum gloeosporioides)***

The disease is more common on young fruits and during transit and storage. Latent infection during pre-harvest stage is responsible for postharvest rots. On storage, black spots are produced. Initially the spots are round but later form large irregular blotches on the entire fruits the spots have large deep cracks and the fungus penetrates deep into the fruit causing extensive rotting.





Procedure for observation

Number of anthracnose infected fruits in respect of the severity scale (0-4) out of 10 fruits selected in situ (not to be plucked) on trees at random in the orchard being monitored should be recorded.

Control:-

i. Pre-harvest infections can be managed by spraying the fungicides from strobilurin group after completion of heavy showers.
ii. Post-harvest infections can be managed as pre harvest sprays in the field to reduce the latent infection and treatment of the fruit with hot water/ along with fungicides after harvest is effective to eradicate left over latent infection.

14.4.2 Stem End Rot

Causal Organism ***(Lasiodiplodia theobromae, Phomospsis mangiferae)***

The fruit while ripening suddenly becomes brown to black typically at stem end. Within two three days whole fruit becomes a black and disease progress downwards, thus involving half of the area of the fruits. Though the flush of the whole fruit often wrinkles are also observed. Affected skin remains firm but decay sets into the pulp below and emits unpleasant odor.





Control:-

i. Prompt and proper handling of the fruit can minimize disease incidence.
ii. Fruit should be harvested with 10mm stalk.
iii. Pre-harvest sprays of any systemic fungicides or copper based fungicides reduce the incidence of SER.
iv. Post-harvest dip of fruit in hot water supplemented with fungicides also controls the remaining infection.

14.4. 3 Black Tip

This physiological disorder is mainly due to the effects of fumes emitted from burning coal from the brick kilns operating in the vicinity of mango orchards. The first symptom of the disease is the development of a small etiolated area at the distal end of the fruit which gradually spreads, turns nearly black and covers the tip completely. Finally the tissues of tip decay and become pulpy.

Control

1. Restricting the sites of brick kilns at almost about 5-6 K .m away from the orchards.
2. The kilns operation should be stopped during the entire mango season.
3. The chimney of kiln should be erected at least 40-50 feet.
4. The experiments for spraying alkaline substances like caustic soda or washing soda are still under way.



14.4.4 Bacterial Canker

The disease is noticed on leaves, twigs, branches and fruits initially producing water soaked lesions, later turning into typical canker.

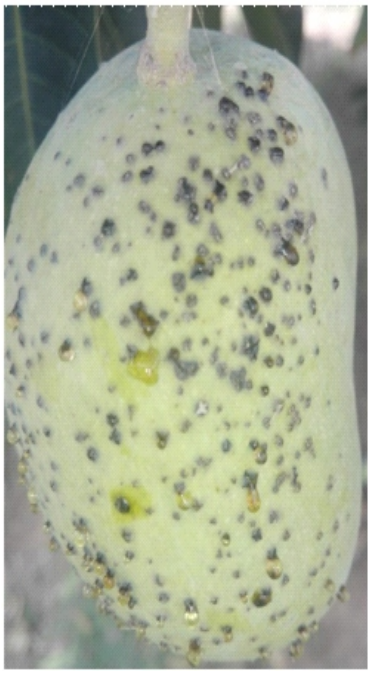
On fruit, water soaked dark brown to black color lesions are observed which gradually develop into cankerous, raised or flat spots. These spots often burst extruding gummy substances. Recently, incidence of this disease has been recorded on commercial Cvs. of mango especially Langra.

Control

1. Regular inspection of orchards and sanitation are recommend as preventive measures against the disease.
2. Selection of stones from healthy fruits for root stock is advisable.
3. Spray of copper based fungicide preferably copper hydroxide @ 250 g and streptomycin @ 25 g per 100 Liter of water is always recommended if rain falls occur during fruit development stage.







1 4 .5 Minimizing Diseases of Mango

Much is lost in mango due to poor handling and storage practices. The losses are estimated to worth millions of rupees. One vital step to alleviate the problem is to reduce wastage/losses. Based on the comprehensive data generated, some useful tips are given below which may be of immense use for different categories of persons involved in various operations pertaining to mango production, handling, storage etc.

1. Start controlling post-harvesting diseases before harvest.
   Reason: Many post-harvest diseases begin while the crop is still in field. Some harvested commodities carry latent infection that may not be detected at harvest.
2. Avoid injuring the commodity throughout the entire distribution process from harvesting to marketing.
   Reason: Bruises, wounds and other mechanical injuries serve as portal of entry for microorganism.
3. Clean the commodity of soil and other sources of infection after harvest.
   Reason: These may carry the microorganisms from the field.
4. Keep the fruit dry after washing.
   Reason: Free moisture on the fruit s surface enhances the growth of spores.
5. Separate ripe from unripe fruits either in the containers or storage rooms.
   Reason: Ripe fruits serve as sources of inoculum (decay-causing microorganisms)
6. Handle the fruits carefully during harvesting, sorting, packing and storing.
   Reason: Careless handling may bruise the fruits, thus providing entry points for disease-causing microorganisms.
7. Separate diseased commodities from healthy ones.
   Reason: Diseased Commodities may contaminate healthy fruits when they come in contact with diseased ones.
8. Store commodities at recommended temperature.
   Reason: Disease causing microorganisms do not grow at low temperatures. Growth will resume upon transfer of commodity to room temperature.
9. Provide aeration in storage areas and keep the commodity free of excess moisture.
   Reason: Moist conditions favor the growth and multiplication of disease-causing microorganisms.
10. Practice sanitation and cleanliness at all times in transit, storage areas, containers and market stalls.
    Reason: Dirty and unsanitary containers and areas may serve as source of infection.

14.6 List of Fungicides / Bactericides for theControl of Mango Diseases

Sr. #	Disease	Active Ingredient	Dose / 100L water
1	**Powdery Mildew**	Penconazole	50ml
		Tebuconazole	150ml
		Miclobutanil	50ml
		Flusilazole	50ml
		Hexaconazol	150ml
2	**Anthracnose**	Mancozeb	250g
		Propineb	250g
		Copper oxychloride	250g
		Copper Hydro oxide	250g

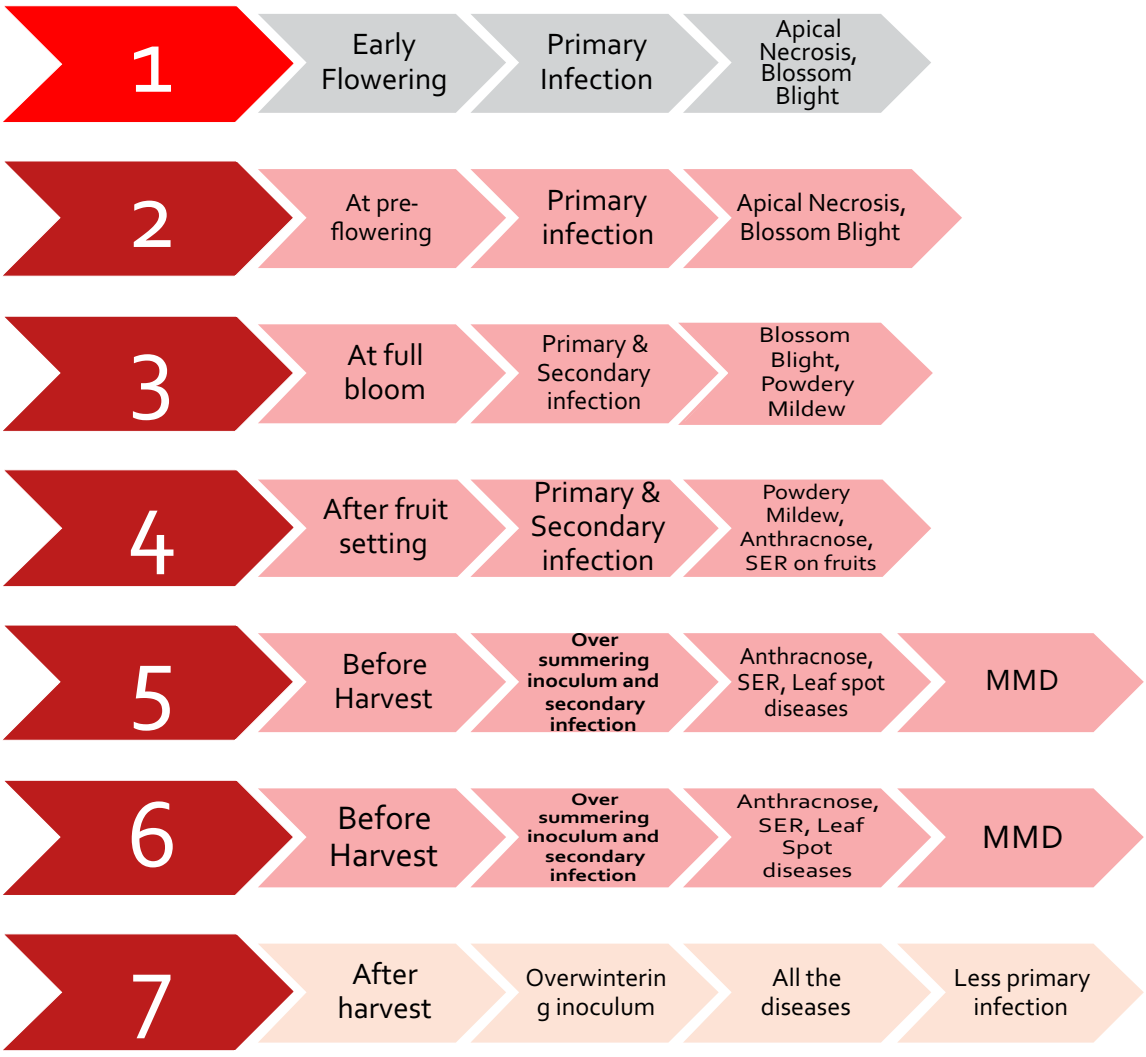
BROAD SPECTRUM FUNGICIDES:

Sr. #	Active Ingredient	Dose / 100L water
1	Thiophanate methyl	200g
2	Difenoconazol	50ml
3	Carbendazim	150ml
4	Pyrachlostrobin + metiram	150g
5	Trifloxystrobin + Tebuconazole	65-80g
6	Azoxystrobin + Flutriafol	50ml
7	Azoxystrobin + Difenoconazol	50ml
8	Azoxystrobin + Tebuconazole	60ml
9	Copper oxy chloride + cymoxanil	
10	Difenoconazol + Propineb	50ml

BACTERICIDES:

Sr.	Active Ingredient	Dose / 100L water
1	Streptomycin	100g
2	Kasugam-1cin	

Spray module for mango disease management



15. Insect Pests and their Management

15.1 Mango Hopper

Scientific Name: *Amritodus atkinsoni, Idioscopus niveosparsus, I. nitidulus*
Family: Cicadellidae
Order: Hemiptera

Description

Three different species of hopper are common.
Nymphs and adults attack on lower sides of the tender leaves and inflorescence. It sucks sap from leaves, tender shoots, buds, inflorescence and fruits. This pest may reduce the yield up to 60%.

Appearance

Nymphs are pale yellow and adults vary in size from small to large depending on the species. Adults may be dark with wavy lines on wings. After sucking the cell sap, both nymph and adults secrete honeydews on which the development of sooty mould (fungus) is common. This sooty mold blocks the photosynthetic activities of leaves and affects fruit setting. In severe attack buds, tender branches and flowers turn black, wilt and finally dry up. Characteristic clicking sound could be heard during higher infestation periods of hoppers produced by the movement of hopper amidst leaves. Hopper shelters in the cracks and crevices of the bark or underside the leaves of the trees in extreme weather and during winter. Both nymphs and adults jump quickly when they are disturbed. First out-break appears in February - April and is most active during spring & monsoon season.

Life cycle

The female lays minute eggs which are inserted singly into the plant tissues through slits make on the shoots and flower stalk. Female lays about 200 eggs in entire life. The egg period ranges from 4-7 days and after that the small nymphs appear and feed on sap. The nymphal period ranges from 8-13 days having 3 instars.

ETL

5/leaf (in summer), 1/leaf (in winter), 10/inflorescence or twig.

Management

Pruning of over lapped branches after harvesting for good light penetration and removal of new growth from stem as these places provide shelter in extreme weather conditions.





15.2 Mango Mealy Bug

Scientific name: *Drosicha mangiferae*
Family: Margarodidae
Order: Hemiptera

Description

Nymphs and adults suck the plant sap and reduce the vigor of the plants. Excessive de-sapping of infected tissues causes wilting, drying and finally fruit setting is affected. They also secrete honeydew, a sticky substance, which facilitate the development of sooty mould.

Life Cycle

Adult: Female wingless, oval, flattened, body covered with mealy powder. Male dipterous, forewings black, hind wings modified as halters, body crimson in color. The eggs hatch in 2nd fortnight of December and the nymphs come out. They crawl up the plants during January. The female adult crawls down the tree in the month of April-May and enter in cracks of soil for laying eggs. These eggs are found in clusters of 350-400, all encased in white pouch of silky materials. The eggs are laid about 25-50 mm deep in soil around the tree trunks. The eggs remain in the soil for 5-6 months. Just after hatching mostly in December-January, the minute newly hatched pink to brown colored nymphs crawl up the tree. After climbing up the tree, they start sucking the sap of tender plant parts. They are considered more important because they infest the crop during the flowering season.

Active Period:

January - June.

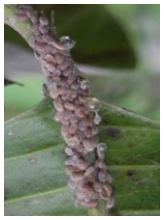
No of Generations Per Year: One

Control

Conserve natural enemies that eat the mealy bug such as the ladybird beetle. Proper training and pruning of the trees will help light get into the plant and this destroys the shaded environment in which they multiply. Flooding of orchards

with water in the month of October may destroy the eggs. Light hoeing under canopy of trees in the month of September will result in exposure of the eggs to the sun heat. Polythene bands of 25 cm width fastened around the tree trunk have been found effective barrier as a slippery surface to stop the ascent of nymphs to the trees. The band should be fastened well in advance before hatching of eggs, i.e. during November-December. The trees should be pruned in such a way that branches should be about 2 feet above the ground level to stop the path of nymphs to crawl on tree.






15.3 Mango Inflorescence Midge

Scientific Name: *Erosomyia indica*
Family: Cecidomyiidae
Order: Diptera

Description

The pest lives in association with the mango crop from January to May. It infests and damages the crop in three different stages. The most damaging one is the first attack in which the entire inflorescence is destroyed even before flowering and fruiting. It has become a major pest in most of the mango orchards. Incidence is noticed more where moderate to high temperature with low humidity is prevailing during January – March. The adult is minute yellowish midge with grayish back. The wings are broad; claw is slender, strongly arched and dentate.

Life Cycle

The female lays about 1500 eggs on the inflorescence peduncle or at the base of the fruit. The eggs hatch within 2-3 days. The larval period varies from 7-10 days. After this period the larva drops on the soil with swift jump leaving small exit pores, it remains in pupation in dry soil for 5-7 days and becomes adult. There are 3-4 overlapping generations of the pest spreading over during January-March. This pest goes to diapause in soil till December and next year it again attacks after emerging from soil mostly during February-March.

Damage

It is the major pest which may destroy inflorescence up to 70% of fruit set. The midge infests and damages the crop in three different stages. First attack is at

the floral bud burst stage. The eggs are laid on newly emerging inflorescence; the larvae tunnel the axis and thus destroy the inflorescence completely. The mature larvae make small exit holes in the axis of the inflorescence and slip down into the soil for pupation. When the tender fruits are attacked they slowly turn yellow and finally drop. The third attack on tender new leaves encircling the inflorescence.

Control

As the larvae pupate in the soil, light hoeing of the orchard will expose pupating larvae to the sun help in killing them. Similarly irrigation at this stage will also destroy the larvae present in soil. Placement of plastic sheets under the canopy of trees during inflorescence period is also an efficient management against this pest.





15.4 Mango Fruit Borer

Scientific Name: *Citripestis eutraphera*
Family: Pyralidae
Order: Lepidoptera

Description

Mango fruit borer is becoming a major insect pest in mango orchards for the last 2 to 3 years; however it remained prevalent as a minor pest of mango since last decade. The extent of damage is variable in orchards and varieties. The compact and dense mango orchards are always its target. Similarly, the varieties bearing the fruits in the clusters like Sindhri are badly affected and its individual fruits are almost found free from its attack. The affected fruits can easily be judged on the trees or heaps with the characteristics symptoms of its damage. The symptoms do not appear unless the fruit gains remarkable size.

Life Cycle

Newly laid eggs are white and turn red after 1 day having size of 1mm in diameter. Eggs are laid on the skin within the top third of the fruit. If two fruits are hanging on the tree and touching, eggs are sometimes laid on the skin surface

where the two fruit make contact. Hatching takes place in 2-3 days. Initially the newly hatched larvae are pale pink-brown in colour with 4 bands of black spots that run along the body. The larvae will initially feed by chewing the surface of the skin and then tunnel into the flesh. As the larvae become mature they become darken to red brown and attain the size of 15mm in length. Wet looking frass is seen on the outside of the fruit. Larvae take 14 days to mature and pupate. Pupation takes place in loosely woven silken cocoon in soil adjacent to the fallen fruits. After 14 days, the adults emerge from those pupae. In adults the forewings are dark brown and hind wings are pale white-grey with a grey band around the margin. Adults can live for up to 10 days.

Management

Timely removal of all malformed panicles
Removal of weeds from the field
Collection and destruction of the affected fruits to break down the life cycle
Canopy management after fruit harvest







15.5 Thrips

Scientific name: *Rhipiphorothrips cruentatus*
Family : Thripidae
Order : Thysanoptera

Description

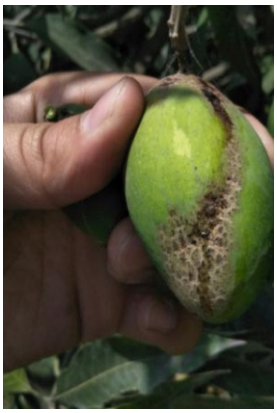
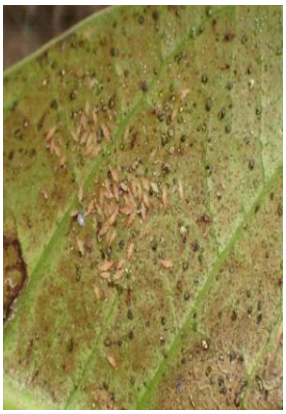
Thrips are polyphagous feeder in nature and are widely distributed around mango growing regions. Nymphs and adults are creamy yellow to brown insects with fringed wings, largely seen on ventral surface of the tender leaves although present on inflorescence and fruits. Adult is of dark brown body, antennae, legs and fore wing pale with the veins and all basically being yellow. Head with complex irregular sculpture, with a transverse ridge near posterior and basal reticulate collar; cheeks sharply incut behind eyes and constricted to basal neck.

Symptoms

Thrips infested leaves show silvery shine with the leaf edges curled upwards. It sucks the sap from tender shoots and new leaves and the severe infestation may be observed on new growth during the spring season. During fruiting season, the severe infestation may result in dropping of premature fruits. Laceration of leaf tissues may result by sucking of the cell sap by nymphs and adults. Silvery shine on affected leaves bearing small spots of faecal matter.

Life cycle

A female can lay about 50 eggs in its life cycle. The adult female lays eggs in notches in the epidermis of leaves. The incubation period lasts for 4-6 days. There are four nymphal instars. These stages normally develop in 10-25 days in winter while pupal stage hibernates in soil. The total life span ranges from 14-33 days and there are 5-8 generations in a year.



15.6 Mango Fruit Fly

Scientific Name: *Bactrocera zonata, Bactrocera dorsalis*
Family: Tephritidae
Order: Diptera

Description

Fruit flies are major quarantine pests that are most active during hot and humid season. Damage starts when the female fruit fly punctures the fruit with its long and sharp ovipositor. Fruit skin is breached from where bacteria enter and the fruit starts to decay. Fruits having fruit fly larvae in them will decay quickly. Crop losses may vary from a few to 100%, and losses of 90% or over are common. Obviously this pest is a major threat in export of mango to many countries.

Life Cycle

Fruit flies complete their life cycle by passing through complete metamorphoses. A female lays cylindrical white-creamy eggs in mature or fallen fruits using its sting like ovipositor. About 150-200 eggs are laid by a female in her life time of about one month. Eggs hatch within 3 - 5 days and young larvae feed on pulp. The young larva is white translucent. The larvae that hatch from the eggs feed on the decaying fruit tissues, and on the yeasts and bacteria that multiply in it. It is believed that fruit fly females carry bacteria with them that they inject into the fruit at the point of oviposition so that the fruit decays faster (making it more nutritious for the larvae). Fruit ripens prematurely and falls down and the damaged fruit is unfit for marketing.

Full fed larvae come out of fruit by boring an exit-hole pop up to find a place to pupate in the soil. The larval period ranges from 6-8 days depending upon the temperature. Pupation period lasts for 5 - 7 days and adult flies emerge and continue the life cycle.

Management

MAT (Male Annihilation Technique) Fix two plywood blocks (5×5×1.5 cm) per acre soaked for 24 hours in Methyl Eugenol and contact insecticides (10:1) and recharge it after 15 days. Cotton wicks are soaked in an attractant i.e. Methyl Eugenol poisoned with insecticide and placed in traps hanged on trees. Five traps should be installed in area of one acre for effective control.

BAT (Bait Application Technique) Mix protein hydrolysate (300ml) with insecticide like malation (30ml) dissolved in water (9670ml) and spray this solution @100ml per tree on 1 m^2 area of non fruiting branches in the canopy of each tree. About 50% trees are sprayed once and further the spray application must be repeated after 10 days.

Sanitation Collect and destroy all infected fallen fruits twice a week and bury them about 50cm deep. Uproot non-useful host plants with fruits e.g. neglected

citrus, guava, hot and sweet pepper in the farm or nearby. Pick out infected fruits with dimples and those that leak clear sap and destroy. If possible, cover young fruits in paper bags or newspapers to put off fruit flies.





15.7 Scale Insect

Scientific name: *Aspidiotus destructor*
Family: Diaspididae
Order: Hemiptera

Description

White elongate hard scales with pinkish active crawlers are seen on leaves, twigs and panicles. Scales are usually dispersed by birds and bats through their feathers and fur. Severe infestation completely coats the underside of leaves which become yellow and die. It also causes cracking of bark and decline symptoms. Flower spikes and fruits may also be infested. The vigor of the plants is reduced as both nymphs and adult scales suck the sap of the leaves and other tender parts, secrete honeydew which encourages the development of sooty mould on leaves and other tender parts of the mango plant. Flower spikes and fruits may also be infested. Severe scale infestation tends to adversely affect the growth and fruit bearing capacity of the tree. The active period of this pest is from September to late November.

Life Cycle

Male scale is reddish in appearance and smaller in size as compare to female scale. Female scale is oval in shape having transparent skin coat. Life cycle is completed in 31-35 days with around ten generations in a year. A large number of eggs are produced by the females ranging from 600-700 and these eggs hatch within 7-8 days. Eggs hatch into young nymphs and disperse over the plant to new feeding sites on leaves or stems where they attach themselves. Once a feeding site has been selected the scale will not move losing their legs and secreting wax like coating under which they hide. There are up to 10 generations in a year.

Management

Use planting or propagation material that is free of scales.

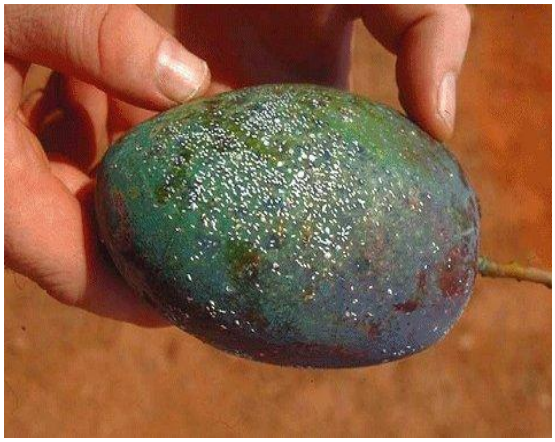
Ensure adequate plant spacing and pruning.

Conserve natural enemies such as ladybird beetles, parasitic wasps, or lacewings.

Avoid spraying insecticides when there are enough natural enemies to control the scales.







15.8 Mango Bark Beetle

Scientific Name: *Hypocryphalus mangiferae*
Family: Scolytidae
Order: Coleoptera

Description

This pest prefers diseased and dried portion of wood and marks tiny holes about 2mm in diameter from which sawdust is emitted. Upon peeling off the bark from the woody stem, irregular galleries can be observed having black appearance due to the presence of fungus in their galleries.

Life Cycle

After mating, they make a breeding gallery the form of which is fairly species specific. All the development stages feed under the inner bark. After maturation feeding, adult emerges from brood material and colonized healthy or stressed plants.

The eggs are cylindrical, shining and creamy white in color. Both the ends of the eggs are broadly rounded. Eggs are laid along the margins of parental galleries. Egg laying starts on 6^{th} day in batches with average of 42 eggs laid by female and maximum eggs were laid during 7^{th} and 8^{th} day. The eggs hatch after 4-5 days. The larvae, on hatching are legless, wrinkled, minute, cylindrical and creamy white in color. Full grown larva is a stout, yellowish white and fleshy grub. There are five larval instars and larval period is 16-20 days.

The pupation takes place near the exit hole. The pupae are soft and creamy white in appearance while the Pupal period is of 3-5 days. There are 3-4 overlapping generations per year. Adults generally appear in hot weather.

Management

Improve the plant health by adequate supply of nutrition in order to avoid the attack of this pest as it preferably feeds on unhealthy / stressed plants.





15.9 Termites

Scientific name: *Odontotermes obesus*
Family: Termitidae
Order: Isoptera

Description

Presence of brown muddy layers as earthen galleries on tree trunk is seen. Fresh muddy layers when examined by removal of mud would have live termites that are white and active. In termites the head is highly sclerotized and mandibles of soldier termites are well developed. The worker termites feed on roots, shoots and trunks of the mango tree moving upward making the tunnels. Mud galleries on tree trunk which shows the damage caused due to feeding of tissues inside. The workers cover a long distance inside the soil in search of food and attack of feeding root which may result in death of the trees.

Life Cycle

Termites are white in color, prefer darkness and remain underground. They feed on root or move upward making the tunnels with the construction of mud galleries on tree. The larvae having hatched from the eggs turn into nymphs that then develop into one of three adult phases: reproductive adults, workers or soldiers. The queen of a colony can lay up to 1,000 eggs per day.

Management

Do not injure the plants as this may provide easy entry routes for termites.
Ensure plants are not sick or water stressed.
Whitewash the trunks with milk of lime.
Get rid of affected plants and destroy the termites.
Avoid making heaps of pruned materials or dead trees in the orchard.
Avoid the use of un-rotten Farm Yard Manure (FYM).









15.10 Mango Gall Midges

Scientific name: *Procontarinia Spp.*
Family: Cecidomyiidae
Order : Diptera

Description

Mango leaf gall midges produce wart-like galls on leaves resulting in reduced photosynthesis, leading to leaf drop and lowered fruit production. Younger branches may die while older branches fail to recover normal growth after repeated attacks.

Life Cycle

Midges are very small flies, 1-2mm in length. The female lays eggs into the tissue of young leaves leaving a small reddish spot. The leaf tissue under the red spot becomes swollen and soft due to certain toxins released by the female during egg laying. Gall formation begins within seven days and attains a maximum diameter of 3-4 mm. Adults usually emerge from the underside of the leaf leaving the pupal skin protruding from the emergence hole.

Hosts

The only known host of mango leaf gall midge is mango (*Mangnifera indica L*)

Management

Proper pruning to ensure the availability of light inside the tree canopy





15.11 Leaf Miner

Scientific Name: *Acrocercops syngramma*
Family: Gracillariidae
Order: Lepidoptera

Description

Light brown caterpillars mine the dorsal epidermis of tender leaves and feed within. Mining results in greyish- white blisters on leaves. Damage is usually confirmed to the younger trees. It causes severe damage to young foliage and new shoot growth. All ages of trees are affected.

Life cycle

After two days of mating, single female laid 5-8 eggs on newly flushes of mango varieties. The female deposits eggs on the epidermal layer of leaves which incubate in 3-6 days. The larvae feed within leaf tissues for 14 days. Full grown larvae come out of tunnel and then pupate as oval white cocoon on the green portion of the leaves. The leaf miner larva completes its developments in five stages (instars) in the period of 9-12 days. The pupal stage may lasts for 7-10 days and pupation takes place mostly in the soil. Adult of the mango leaf miner is silvery gray colored moth with silvery bands on the fore wings. Usually the female has bigger size as compared to the adult male.





