

Week 4: Insect pests, diseases and special production problems of apple.

Objective:

The aim of this lecture is to give a knowledge to students on insect pests, diseases and special production problems of apple.

INSECT-PESTS AND DISEASES

1. Insect-pests:

- The insects like san jose scale, woolly apple aphid, red spider mite, tissue borers and defoliating beetles and caterpillars in apple are important insects, which causes great damage to plants.

(a) San Jose Scale (*Quadraspidiotus perniciosus*) :

- It is polyphagous pest which feeds on apple plants. The insect is covered with deep grey armature.
- By lifting armature, a yellow coloured insect underneath is seen. The nymph and adults suck sap from aerial parts.
- Heavily infested trees have bark covered with deep grey overlapping scales. The plant vigour is reduced which results in poor fruit setting and quality.

Control:

- Spray 2 per cent dormant oil (Servo orchard spray oil/ Hindustan petroleum spray oil) or 1.5 per cent summer oil like orchaks 796/ IPOL/shelter909 at half leaf to tight cluster stage.
- If oil spray is not applied then spray with 0.04 % chlorpyrifos (200ml durmet in 100 L water) after petal fall to kill the crawlers and newly settled scale.

(b) Woolly apple aphid (*Eriosoma lanigerum*) :

- It feeds on apple and lives in colonies on the aerial parts and roots of plant.
- On the aerial parts, it is seen as white woolly mass.
- Damage is caused by sucking of sap from stem, twigs and roots resulting in gall formation, plant remains stunted.
- Fruit set and quality also reduced under severe infestation.

Control:

- Spray infested trees with 0.04% chlorpyrifos(200ml durmet in 100 L water) during May-June and again in October.
- Aphid infestation on roots can be reduced by drenching the collar region of tree with chlorpyrifos (0.1%) in October- November using 10-15 litre solution per tree.
- Use Malling Merton (MM) series clonal rootstocks for raising nursery plants, which are resistant to woolly aphid.

(c) European red mite (*Panonychus ulmi*):

- This is a serious pest in apple and cause damage by feeding on green matter of leaves. The leaves turn bronze in colour and upward cupping, followed by leaf drop and weakening of fruit bud.
- The maximum population is observed during May-July. The mite complete 5-7 generation in a year.

Control:

- Spray 2 per cent dormant oil (Servo orchard spray oil/ Hindustan petroleum spray oil) at half leaf to tight cluster stage. Dormant oil spray as suggested for scale is effective against mites.
- Spray of 1 per cent summer oils like orchaks 796/ IPOL/shelter909@ 1 % at petal fall and again at walnut stage of fruit.
- If population is high, spray with fenazaquin (25 ml Magister 10 EC/100 L) or propargite (100 ml Omite/ 100 L water) twice at 20 days interval in June- July.

(d) Defoliating Caterpillars:

- They feed on newly emerged leaves and defoliate the trees. The growth of plants is retarded .

Control:

- Spray 0.05% Endosulfan (150 ml Thiodon or endocil 35 EC in 100 L water)15-20 days before flowering or when caterpillars appear.

2. Diseases

Diseases also cause a great damage to the apple trees. Apple scab, powdery mildew, premature leaf fall, canker and root rot are major diseases of apple plantation.

(a) Apple scab:-

- This is caused by fungus *Venturia inaequalis*.
 - Light brown or olive green spots which soon turn musty black appear on either or both sides of the young leaves in spring.
 - Young lesions are velvety brown to olive green becoming more distant with age, leading to curling of leaves.
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- On the fruits, small lesions develop and slowly increase leading to misshapening and cracking of fruits.

Control:

- Follow the spray schedule of dodine (0.1%) or mancozeb (0.3%) at silver tip to green tip, mancozeb (0.3%) + carbendazim (0.05%) at pink bud, benmyl/ carbendazim (0.05%) at petal fall, zineb (0.3%) or dodine (0.075%) at pea size fruit, mancozeb + carbendazim in June-July and urea 5% spray after fruit harvest to control the disease.

(b) Powdery mildew:-

- This disease is caused by fungus *Podosphaera leucotricha*, which survive as mycelium on dormant buds.
- The young leaves show white mildew growth on its surface and also on twigs and look silvery white.

Control:

- Prune off affected twigs .
- Spray during dormancy, green tip, petal fall and two weeks after petal fall with fungicides like wettable sulphur (200-300 g/100 L) or contaf (50 g / 100 L) or Baycor (50 g/ 100 L).

(c) Canker:-

- Many fungi have been reported to be involved in canker complex.
- Symptoms appear on trunk and branches, resulting in the production of wounds which develop length wise more rapidly.
- These are normally elliptical and the wound may increase up to a meter in length.
- The bark beneath the rough exterior becomes hard, dry and tough.

Control:

- Cut and burn the badly cankered portion of the tree.
- Scarify the cankered portions up to healthy portions and paint with Chaubattia paint.
- Immediately after pruning, apply chaubattia paste or copper oxychloride paint on cut portions of the shoot.
- Spray copper oxychloride (300 g) or captan (200 g) in 100 L of water after fruit harvest.

(d) White root rot:

- This is caused by *Dematophora necatrix* fungi.
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- Affected trees shows sparse foliage, slow growth, bronzing or yellowing of leaves. Such trees ultimately die. Root turns brown and remain covered with white cottony mycelial of fungi in rainy season.

Control:

- Improve the drainage of an orchard.
- After leaf fall, remove the infected roots and apply Chaubattia paste (Red lead, copper carbonate and linseed oil (1:1:1.25) or copper oxychloride (300 g/100L) in Nov- December on cut ends of the roots.
- Give at least four drenching of Carbendazim (100 g) along with mancozeb (300 g) in 100 L of water during April, June, July and September in infected trees.

SPECIAL PROBLEMS: Low Productivity in apple

Low Productivity in apple

- Decreased productivity of apple orchards in the recent years has become a serious concern of the growers in all the apple growing areas.
- The apple productivity has been fluctuating year to year between 2 MT to 8 MT/ ha.
- The factors which influence yields are climate, soil, cultivar, rootstocks and cultural management practices.
- Most of factors influencing yield are manageable to a large extent but the climatic factors are beyond the control.
- The appearance of certain diseases and pests in epidemic form has also adversely affected yield in recent years.
- The out break of red spider mite attack and premature defoliation of apple in the past 9-10 years has remained persistent problem in apple orchards.

Causes of Low productivity

1.Climatic factors:

- The low temperature at the time of flowering and fruit setting adversely affects production of fruits.
- The areas most vulnerable to the influence of low temperature are located between 5000 to 6000 feet elevation where good spring season with adequate sunshine promote apple flowering during mid March to mid April
- Fluctuating temperature during this period particularly rains accompanied by low temperature inhibits the cross pollination due to restricted bees activity and washing off pollen and poor pollen tube growth.
- It is well established that the flowers are killed below 2.20C and bee activity is completely inhibited below 4.4oC.

2.Varietals factors:

- In Himachal Pradesh, Delicious group of apple varieties constitutes more than 80 per cent of the total production of apple.
- The predominant varieties like Starking Delicious, Red Delicious, Rich-a-red and certain improved bud sports and spur types are self unfruitful and require cross pollination for fruitfulness.
- Moreover, these varieties have strong tendency of alternate bearing ,which is also one of the reasons for low production during the off years.

3.Inadequate pollinizer:

- In Himachal Pradesh, 25 to 33 per cent proportion of pollinizing varieties in orchards is recommended for adequate fruit set.
- But actual proportions of these varieties is only 5-10 per cent. The problem is further compounded due to predominance of Golden Delicious as a pollinizing variety, which does not synchronize in flowering of the Delicious varieties in many agro climatic situations, and strong tendency of alternate bearing.

4.Lack of pollinators:

- Honey bees are the major agents besides other wild pollinators for effective pollination in apple.
- Over the years the population of honey bees and other pollinators have declined due to indiscriminate use of pesticides.
- Placement of honeybees in the orchards has also not picked up due to scarcity of beehives.

5.Inadequate nutrition:-

- Apple cultivation is mostly done on the slopes which poses serious problem of water and nutrient losses.
- Frequent dry spells during April-June and September –November make the nutrients unavailable to the plants even if applied adequately in the soil.
- Contrarily leaching of the nutrients during rainy season from July –August further affects the health of the trees.
- It has also been noticed that the fertilizers are not applied according to the requirement of the trees.

6.Poor soil conditions:-

- In orchards which are planted on the slopes, run off losses render the soils nutritionally and structurally poor. In many orchards, soils which do not have adequate drainage, temporary water logging conditions develop during the rainy season killing feeder roots and temporarily restricting the uptake of the nutrients. All these factors adversely affect the plant health and productivity.

7 Poor canopy management:

- Dependence of the orchardists on hired pruners is increasing day by day. The plants are not properly trained and pruned by these untrained pruners resulting in poor canopy development.
- At lower elevation where the vegetative growth is excessively more due to warm conditions, hard pruning promotes more vegetative growth and reduces reproductive growth is considered a wrong orchard practice.
- In such conditions lesser heading back and more thinning out of shoots as per tree behavior is required to balance cropping and growth.

8. Senile orchards:

- Orchards more than 40 years of age face the problem of unfruitfulness more seriously than the young orchards.
- Such orchards do not produce adequate annual extension growth and usually have foliage of small size.
- The old orchards have also been planted under traditional systems of planting at a spacing of 20-25 feet, which take 15-20 years to come to commercial fruiting after planting.
- Use of ethephon for early maturity and colour improvement at lower elevation has also proved counter productive. Continuous use of ethephon beside poor orchard management practices is a cause of senility and poor shelf life and quality of the fruits.

9. Pathological factors:

- The number of disease has been found affecting the apple orchards. The most serious among these is apple scab .Besides apple scab others diseases are premature leaf fall, root rot, color rot, replant problem. Powdery mildew, cankers and viruses. Most of the pollinizing cultivar like golden Delicious and Red Gold have been found to be higher susceptible to scab.

10. Entomological factors:

- The magnitude of pest in incidence varies from region to region and orchard to orchards. Aphid is most dominant one affecting 82 per cent orchards followed by San Jose Scale (71%),blossom trips (70%),European mite (62%), apple leaf roller(43%) root borer(26%) stem borer(9%),defoliating beetle(6%) and hairy cater pillar (5%).

Suggested Remedial measures:

1. Among the standard varieties there should be more proportion of regular bearing varieties than the Delicious cultivars.
 2. Adequate proportion of pollinizing varieties should be compensated with has not been provided, top working of the trees with pollinizing varsities.
 3. Proper orchard soil and canopy management practices should be given adequate priority.
 4. There is an urgent need to go for high density plantation in different temperate fruit crops.
 5. Indiscriminate use of insecticides, pesticides and fungicides should be avoided in order to maintain the population of natural predators and avoid problem of tolerance by pests.
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SPECIAL PROBLEMS: Premature leaf fall

Premature leaf fall

- Apple plantations in Himachal Pradesh have been ravaged by a unique phenomenon of leaf shedding in mid-summer for the last few years.
- The problem starts in the month of June-July and by mid August majority of orchards affected and severe cases only fruits are seen hanging on the defoliated branches near maturation.
- The disease which was first noticed in 1995 in some orchards, which now spread to all apple growing districts of the State.
- All the commercial Delicious cultivars are susceptible. Premature leaf shedding has also been reported recently from Kashmir, neighboring Uttaranchal and Bhutan.

Symptoms

- Disease symptoms first appear as dark green circular patches on upper surface on the mature leaves giving rise to 5-10 mm size brown leaf spots especially in the months of June and July, which turn dark brown in the due course.
- When lesions are numerous they coalesce to form larger dark brown blotches and the surrounding areas turn yellow.
- Severe leaf shedding follows these symptoms in the following weeks quite a head of natural leaf fall in autumn.
- In affected orchards, fruits nearing maturity are commonly seen hanging on the defoliated branches.
- Symptoms also appear on the fruit as clear brown spots, which are initially circular (3-5 mm in diameter) and become oval, depressed and dark brown later.
- Numerous small black colour pinhead specks, the acervuli are visible in the affected tissues.

Casual organism and disease development

- This disease is caused by *Marssonina coronaria*, but *alternaria* leaf blight is also involved in this malady.
- This fungus is reported to perennate in the fallen leaf litter on the orchard floor. The seeds of the fungus are mature by the time of blooming in the spring and they are liberated in the orchard for a quite long period.
- In Himachal Pradesh, the perfect stage of this fungus is not frequently intercepted.
- This fungus was found to perennate in the infected leaf litter in the form of acervuli which produce fresh conidia in early summer to start primary infections.
- Frequent rains are helpful for disease development. Infections first appear on mature leaves turning yellow and abscise prematurely.
- Countless conidia and microconidia are formed on diseased leaves which cause secondary infections leading to epiphytotic development in favorable humid conditions.

Management

- This disease can be controlled effectively integrating different technologies like field sanitation, proper pruning and judicious use of fungicides as follows:
- The orchardists are advised to collect and destroy the fallen leaves from the orchard floor in winter. Urea (5%) spray on the leaf litter is also be helpful in reducing the primary inoculum by enhanced decomposition of leaves.
- Proper pruning allows adequate air circulation in the tree canopy thereby modifying the microclimate and reducing disease development.
- Protective 3-4 sprays of fungicides like mancozeb (0.3%), carbendazim (0.05%), thiophanate methyl (0.05%), benomyl (0.05%), propineb (0.3%), dodine (0.075%), ziram (0.3%), dithianon (0.05%) and zineb (0.3%) are effective in controlling the disease.

SPECIAL PROBLEMS: Replant Problem

Replant Problem

- Replantation pertains to the plantation of new plants of apple in the fields vacated by removal of old and declining trees.
- In India old trees in many apple orchards have either outlived their economic bearing life or declined due to the adverse effects of non-curable insect pests/diseases problems and/or natural calamities.
- Moreover, many growers want to introduce new improved and highly productive varieties in their old orchards, that too, sometimes under high density plantations.
- Because of land limitations, the growers the growers are mostly compelled to plant new apple trees on the old apple sites.

There has been increasing concern about poor growth, delayed fruiting and short life of apple trees planted in the old apple sites.. This problem being faced by the growers is termed as „Replant Problem“. It is also, sometimes, termed as „Replant Disease“ when only biotic causes are involved to develop such situation.

Causes of Replant Problem

- There are many causes of poor growth of young trees of apple and these vary from region to region or even orchard to orchard in a particular region. These can include weak or diseased nursery stock, poor planting and management techniques, water deficiencies or excessive, spray injuries or damage from insects, diseases, rodents etc. But our concern here is only with the soil related causes, which include biotic (harmful microorganisms) and a biotic (nutritional deficiencies or excessive soil pH, phytotoxins) factors in the soil.
- Various types of micro-organisms like fungi, bacteria, actinomycetes, nematodes and their interactions causes replant problem.
- When we remove the old plants, some of the root system (mainly fine roots) are left behind in the old site.
- The soil adhered to such roots consists a good population of micro-organisms which later almost rob the newly planted trees of their vital elements, thereby adversely affecting their growth.

- These micro-organisms can also directly affect the newly planted trees by causing some kind of maladies in their root system.
- A number of fungi belonging to oomycetes, hypomycetes and basidiomycetes have been reported as causal agents of replant disease.
- In England, Canada and U.S.A., many investigators have shown that species of *Phytophthora* and *Phythium* are the primary causes of replant disease, *Phythium sylvaticum* has been identified as cause associated with apple replant disease in Canada.

Management of Replant Problem

- Liming has been found effective in soils where *Dermatophthora* and *Phytophthora* are the causes of replant problem.
- The elements, N and P have been reported to suppress the growth of replant disease caused by fungi and bacteria and subsequently to promote the growth of bacteria antagonistic to these usual organisms.
- Replacing the soil at a replantation site with the steamed/fumigated old apple soil or some non-apple soil or potting soil mixture (containing peat, sand or soil, dolomite, lime, NPK fertilizer, minor elements) have also been reported as effective in attaining good growth of replanted apple trees.
- Inter-cropping with herbaceous crop and growing mustard and radish before planting greatly improved the growth of newly planted apple seedlings. Antagonistic crops like marigold (*Tagetes pastula*) successfully reduced the population of nematodes, *Pratylenchus penetrans* and the fungus, *Phythium* spp. In replant soil. Cultivation of red fescue (*Festuca rubra*) and red top (*Agrostis alba*) also reduces *P. penetrans* population.
- Soil sterilization by fumigation, steaming or even solarization checks the population of soil borne pathogens. Generally pre-plant treatments are more useful than the post-planting treatments.
- The recommendations to manage the replant problem in Himachal Pradesh include:
 - i) Dig out and destroy the stumps and roots of old/dead apple trees.
 - ii) The fresh layout of the orchard be done by avoiding frequently/possibly the old pit sites.
 - iii) New pits of bigger size (5 x 3 ft) should be dug and kept open for exposing to sunlight for about one month.
 - iv) Pre-plant soil sterilization by fumigation (early winter) or solarization (during summer) to check the population of soil borne micro-organisms. For fumigation, make 9 inch high heap of pit soil outside the pit, drench with formalin solution (1 litre of commercial formalin in 9 litres of water) and cover with transparent thin polyethylene sheet for atleast 48 hours. Remove the sheet and turn the soil daily for about a week so that formalin fumes escape from the treated soil. In case of solarization, 9 inch high heap of pit soil is covered with transparent polythene sheet for 2 months during summer before filling the pits.
 - v) Incorporate well rotten FYM along with 1 kg SSP fertilizer and 200 g Kanadane dust in treated pit soil and fill the pit upto one foot above ground level.
 - vi) Always use the healthy and strong rooted plants for replantation. In high problem areas preferably use tolerant rootstocks of apple like Merton793
 - vii) To improve the growth of newly planted apple seedlings, grow mustard, radish, marigold and red fescue (*Festuca rubra*) and red top (*Agrostis alba*) as decoy/biofumigation crops

SPECIAL PROBLEMS: Unfruitfulness in temperate fruits

Unfruitfulness in temperate fruits

- Unfruitfulness is a serious problem in apple, cherry, almond and walnut and is associated with both internal and external factors.
- The sterility is mainly due to (i) Impotence, (ii) incompatibility and (iii) abortion of embryo.

(1) **Impotence** : It relates to the condition when either one or both the sex organs fail to develop to required stage and fails to form flowers or abortion of male and female flower organs occur.

(2) **Incompatibility**: It relates to the condition, where both male and female flowers develop and their organs are functional but sterility is due to the incompatibility.

(3) In some cases both the male and female flowers are formed and function but embryo abortion occur.

- Sterility associated with internal functions may be related to evolutionary tendencies due to factors associated with constitution of protoplasm, genetic influence and physiological reasons,

A. Evolutionary tendencies:

a. Defective flowers:

- Self fertilization is not possible in many temperate fruit species due to imperfect flowers, heterostyly, dichogamy and pollen impotence.
- In most of temperate fruit plants like apple, pear, stone and nut fruits, flowers are perfect and present on the same plant (monoecious) but problem of unfruitfulness still occur due to incompatibility (apple, cherry and almond) and dichogamy (walnut , pecan nut and chestnut).
- In kiwifruit the male and female flowers are present on different plants which restrict self pollination.
- In apple, cherry and almond the cross incompatibility results in unfruitfulness.
- Some varieties of persimmon are staminate constant (bear staminate flowers every year) and pistillate constant
- The presence of short styles with long filaments or long styles and short filaments is dimorphism, a type of heterostyly and basal gap between filaments is more which allow the bees to enter without touching the stigma to collect nectar (in some apple varieties) results in unfruitfulness.

Abortiveness leading to impotence:

- Interference either in the development of flowers or in the full development of sex elements and their functions may lead to unfruitfulness.
 - In certain varieties of plum pistil is degenerated and unfruitfulness results. In pecan and walnut the terminal clusters consisting of pistillate flowers fall off before pollination leads to unfruitfulness.
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- In strawberry also late flowers are abortive and no fruit set occurs in these flowers.
- In some temperate fruits there are some varieties having defective pistil (plum), defective embryo and embryo-sac (apple) which also leads to unfruitfulness.

Non-viable pollen:

- When the pollen is not viable the production of fruit is not possible. Pollen of some varieties of plum, peach, pear and cherry are non-viable due to their abortion leads to unfruitfulness in these fruits.

Genetic factors:

- Hybridity is associated with sterility as well as unfruitfulness. Hybridity is also responsible for seedlessness in some varieties of temperate fruits.
- Hybridity and incompatibility are two type of sterility which are directly due to genetic factors.
- Self sterility depends on inheritance but its development is controlled by environment. Peach- plum hybrids known as Blackman are completely sterile. Similarly, Peach- sour cherry hybrid Kamdesa is completely sterile. Pyronia (Pear x quince) flowers and fruits freely but is always seedless.
- Incompatibility between pollen and ovule is one of the causes of unfruitfulness in apple, cherry, almond, pear, apricot, plum .

Physiological causes:

- Poor growth rate of the pollen tubes in the styles, possibly due to hormonal or chemotropic control (apple, pear, cherries) is known.
- The pollen tube growth is slow due to low temperature.
- Unfruitfulness can also results from difference in the stage of maturity of pollen grain vis a vis the pistil and embryo.
- The proper development of the flowers, its maturity and fertilization leading to development of a fruit with viable seeds is controlled by the abortive condition within plant existing at the time of pre-blooming and post-blooming stages.
- The nutritive status of the plant determines the time taken by the pollen to fertilize. Fertilization takes in shorter time in strongly vegetative condition then those in poorly vegetative condition.
- Defective pistils are formed in exhausted or weakned trees caused by overbearing, drought and poor nutrition.

External factors:

(1) Environment: the climatic conditions at the time of flowering affect pollen germination, pistil formation and transfer of pollen , pollen tube growth and ultimately on fruit set. Low temperature and rainfall at the time of flowering adversely affect the transfer of pollen and pollen tube growth thereby results in poor fruit set in most of temperate fruits.

(2) Nutrition: Proper nutrient supply affect fruit setting as well as unfruitfulness. Jonathan apple which is self sterile become self fruitful in rich soils having optimum level of nutrients in the

soil. Infect high nitrogen content in plant at the time of flowering encourages fruitfulness.

(3) Pruning: Moderate heavy pruning induces good setting and yield.

(4) Age and vigour of plant: Very young and vigorous tree set less fruits than the moderate vigorous and old trees.

(5) Water relations: Moisture stress promote the formation of abscission layers leading to flower and fruit drop.

Control :

- Pollination management by planting pollinizing varieties, placement of bee-hives .
 - Proper nutrient management
 - Irrigation
 - Proper pruning
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