AESA BASED IPM PACKAGE
PEACH

Department of Agriculture and Cooperation
Ministry of Agriculture & Farmers Welfare
Government of India

Directorate of Plant Protection, Quarantine and Storage
N. H.–IV, Faridabad, Haryana

National Institute of Plant Health Management
Rajendranagar, Hyderabad, Telangana

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Ministry of Agriculture & Farmers Welfare
Important Natural Enemies of Peach Insect Pests

Parasitoids

- Encarsia perniciosa
- Pales spp.
- Trichogramma cacaceae
- Fopius arisanus
- Diachasmimorpha spp.
- Xanthopimpla sp

Predators

- Big-eyed bug (Geocoris spp.)
- Earwig
- Reduviid bug
- Robber fly
- Orius spp.
- Black drongo

Plants Suitable for Ecological Engineering in Peach Orchard

- Alfalfa
- Sunflower
- Ocimum spp.
- Cosmos
- Spearmint
- Mustard
- Marigold
- Carrot
- Caraway
- Cowpea
- Buckwheat
- Maize
The AESA based IPM –Peach, was compiled by the NIPHM working group under the Chairmanship of Dr. Satyagopal Korlapati, IAS, DG, NIPHM, and guidance of Shri Utpal Kumar Singh, IAS, JS (PP). The package was developed taking into account the advice of experts listed below on various occasions before finalization.

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FOREWORD

Intensive agricultural practices relying heavily on chemical pesticides are a major cause of widespread ecological imbalances resulting in serious problems of insecticide resistance, pest resurgence and pesticide residues. There is a growing awareness world over on the need for promoting environmentally sustainable agriculture practices.

Integrated Pest Management (IPM) is a globally accepted strategy for promoting sustainable agriculture. During last century, IPM relied substantially on economic threshold level and chemical pesticides driven approaches. However, since the late 1990s there is a conscious shift to more ecologically sustainable Agro-Eco System Analysis (AESA) based IPM strategies. The AESA based IPM focuses on the relationship among various components of an agro-ecosystem with special focus on pest-defender dynamics, innate abilities of plant to compensate for the damages caused by the pests and the influence of abiotic factors on pest buildup. In addition, Ecological Engineering for pest management - a new paradigm to enhance the natural enemies of pests in an agro-ecosystem is being considered as an important strategy. The ecological approach stresses the need for relying on bio intensive strategies prior to use of chemical pesticides.

Sincere efforts have been made by resource personnel to incorporate ecologically based principles and field proven technologies for guidance of the extension officers to educate, motivate and guide the farmers to adopt AESA based IPM strategies, which are environmentally sustainable. I hope that the AESA based IPM packages will be relied upon by various stakeholders relating to Central and State government functionaries involved in extension and Scientists of SAUs and ICAR institutions in their endeavour to promote environmentally sustainable agriculture practices.

Date: 6.3.2014

(Avinash K. Srivastava)
FOREWORD

IPM as a holistic approach of crop protection based on the integration of multiple strategies viz., cultural, physical, mechanical, biological, botanical and chemical. Over the years IPM underwent several changes, shifting its focus from damage boundary, economic injury to economic threshold. Currently most stake holders rely upon economic threshold levels (ETL) and tend to apply chemical pesticides at the first instance in the event of a pest attack, through Government of India has advocated need based and judicious application of chemicals. This approach is likely to cause adverse effects on agro-ecosystems and increase the cost of agricultural production due to problems of pest resurgence, insecticide resistance and sustainability.

During the late 90s FAO started advocating Agro-Ecosystem Analysis (AESA) based IPM. Experience in different countries have since show that AESA, which takes into account ecological principles and relies on the balance that is maintained by biotic factors in an ecosystem has also resulted in reduction in cost of production and increase in yields. AESA based IPM also takes into account the need for active participation of farmers and promotes experiential learning and discovery based decision making by farmers. AESA based IPM in conjunction with ecological engineering for pest management promotes bio-intensive strategies as against current chemical intensive approaches, while retaining the option to apply chemical pesticides judiciously as a measure of last resort.

The resource persons of NIPHM and DPPQ&S have made sincere efforts in revising IPM packages for different crops by incorporating agro-ecosystem analysis, ecological engineering, pesticide application techniques and other IPM options with the active cooperation of crop based plant protection scientists working in state Agricultural Universities and ICAR institutions. I hope this IPM package will serve as a ready reference for extension functionaries of Central / State Governments, NGOs and progressive farmers in adopting sustainable plant protection strategies by minimizing the dependence on chemical pesticides.

(Utpal Kumar Singh)
PREFACE

Need for environmentally sustainable agricultural practices is recognised worldwide in view of the wide spread ecological imbalances caused by highly intensive agricultural systems. In order to address the adverse impacts of chemical pesticides on agro-ecosystems, Integrated Pest Management has evolved further from ETL based approach to Agro-ecosystem Analysis based Integrated Pest Management (IPM).

In AESA based IPM the whole agro-ecosystem, plant health at different stages, built-in-compensation abilities of the plant, pest and defender population dynamics, soil conditions, climatic factors and farmers’ past experience are considered. In AESA, informed decisions are taken by farmers after field observation, AESA chart preparation followed by group discussion and decision making. Insect zoo is created to enable the farmer understand predation of pests by Natural Enemies. AESA based PHM also results in reduction of chemical pesticide usage and conserves the agro-ecosystems.

Ecological Engineering for Pest Management, a new paradigm, is gaining acceptance as a strategy for promoting Biointensive Integrated Pest Management. Ecological Engineering for Pest Management relies on cultural practices to effect habitat manipulation and enhance biological control. The strategies focus on pest management both below ground and above ground. There is growing need to integrate AESA based IPM and principles of ecological engineering for pest management.

There is a rising public concern about the potential adverse effects of chemical pesticides on the human health, environment and biodiversity. The intensity of these negative externalities, through cannot be eliminated altogether, can be minimized through development, dissemination and promotion of sustainable biointensive approaches.

Directorate of Plant Protection Quarantine and Storage (DPPQS), has developed IPM package of practices during 2001 and 2002. These packages are currently providing guidance to the Extension Officers in transferring IPM strategies to farmers. These IPM package of practices, have been revised incorporating the principles of AESA based IPM in detail and also the concept of Ecological Engineering for Pest Management. It is hoped that the suggested practices, which aim at enhancing biodiversity, biointensive strategies for pest management and promotion of plant health, will enable the farmers to take informed decisions based on experiential learning and it will also result in use of chemical pesticides only as a last resort & in a safe and judicious manner.

(K. SATYAGOPAL)
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AESA BASED IPM PACKAGE FOR PEACH

Peach - Plant description:

The peach (*Prunus persica* L.; Family: Rosaceae) is a deciduous tree, native to Northwest China, in the region between the Tarim Basin and the north slopes of the Kunlun Shan mountains, where it was first domesticated and cultivated. The species name *persica* refers to its widespread cultivation in Persia, when it was transported to Europe. It belongs to the genus *Prunus* which includes the cherry and plum. The peach is classified with the almond in the subgenus Amygdalus, distinguished from the other subgenera by the corrugated seed shell.

Plant grows to 4–10 m tall and 15 cm in diameter and produces fruits for 10-20 years. The leaves are lanceolate, 7–16 cm long, 2–3 cm broad, pinnately veined. The flowers are produced in early spring before the leaves; they are solitary or paired, 2.5–3 cm diameter, pink, with five petals. The fruit has yellow or whitish flesh, a delicate aroma, and a skin that is either velvety (peaches) or smooth (nectarines) in different cultivars. The flesh is very delicate and easily bruised in some cultivars, but it is fairly firm in some commercial varieties, especially when green. The single, large seed is red-brown, oval shaped, approximately 1.3–2 cm long, and is surrounded by a wood-like husk. Peaches, along with cherries, plums and apricots, are stone fruits (drupes). There are various heirloom varieties, including the Indian peach, which arrives in the latter part of the summer.
I. PESTS

A. Pests of National Significance

1. Insect pests
   1.1 Stem borer: *Aeolesthes sarta* Solsky (Coleoptera: Cerambycidae)
   1.2 Flat headed borers: *Chrysochrothis mali* Horn & *Capnodis tenebrionis* L. (Coleoptera: Buprestidae)
   1.3 Peach tree borer: *Synanthedon exitiosa* (Say) (Lepidoptera: Sesiidae)
   1.4 Defoliating beetle: *Protaetia neglecta* Hope (Coleoptera: Cetoniidae)
   1.5 Hairy caterpillar: *Lymnaea obfuscata* Walker (Lepidoptera: Lymantriidae)
   1.6 San Jose-scale: *Quadraspidiotus perniciosus* Comstock (Hemiptera: Diaspididae)
   1.7 Apricot brown scale: *Lecanium corni* (Bouché) (Hemiptera: Coccidae)
   1.8 Plum/peach leaf curl aphid: *Brachycaudus helichrysi* (Anuraphis sp.) Kaltenbach (Hemiptera: Aphididae)
   1.9 Fruit fly: *Bactrocera zonata* (Saunders) (Diptera: Tephritidae)
   1.10 Termite: *Odontotermes obesus* Rambur (Isoptera: Termitidae)
   1.11 Peach fruit borer: *Conogethes punctiferalis* Guenee (Lepidoptera: Crambidae)

2. Diseases
   2.1 Frosty mildew: *Cercosporella persica* Sacc.
   2.2 Peach leaf curl: *Taphrina deformans* (Berk.) Tul
   2.3 Leaf spot: *Phyllosticta cerasicola* Speg.
   2.4 Powdery mildew: *Sphaerotheca pannosa* (Wallr.) Lév, *Podosphaera leucotricha* (Ellis & Everh.) E.S. Salmon
   2.5 Coryneum blight/shot hole: *Wilsonomyces carpophilus* (Lév.) M.B. Ellis
   2.6 Silver leaf and canker: *Chondrostereum purpureum* (Pers.) Pouzar
   2.7 White root rot: *Dematophora necatrix* Berl. exPrill
   2.8 Whisker rot: *Rhizopus stolonifer* Ehrenb
   2.9 Peach rust: *Tranzschelia discolour* (Fuckel) Tranz.
   2.10 Collar rot: *Phytophthora sp* & *Pythium sp*
   2.11 Bacterial canker and gummosis: *Pseudomonas syringae* pv. *morsprunorum* (Wormald) Yong
   2.12 Brown rot: *Sclerotina fructicola* (G. Winter) Rehm & *S. fructigena* (J.Schrüt.) Norton
   2.13 Yellow disease: *Peach yellow phytoplasma*

B. Pests of Regional Significance

1. Insect pests
   1.1 Green peach aphid: *Myzus persicae* Sulzer (Hemiptera: Aphididae)
   1.2 Tent caterpillar: *Malacosoma indrica* Walker (Lepidoptera: Lasiocampidae)
   1.3 Leaf rollers: *Archips argyrospila* Walker, *A. subsidiarius* (Meyrick) (Lepidoptera: Tortricidae)
   1.4 Peach twig borer/apricot fruit borer: *Anarsia lineatella* Zeller (Lepidoptera: Gelechiidae)
   1.5 Root borer: *Dorysthenes huegelli* Rdt. (Coleoptera: Cerambycidae)
   1.6 Conspere sting bug: *Euschistus conspersus* Uhler (Hemiptera: Pentatomidae)
   1.7 Peach fruit fly: *Bactrocera zonata* (Saunders), *B. ciliates* & *B. dorsalis* Hendel (Diptera: Tephritidae)
   1.8 Green capsid: *Lygus pabulinus* Franz and Wagner (Hemiptera: Miridae)
   1.9 Blossom thrips: *Taeniothrips spp*, *Frankliniella dampfi* Priesner (Thysanoptera: Thripidae)
   1.10 Rose chaffer beetle: *Macrodactylus subspinosus* Fabricius (Coleoptera: Scarabaeidae)
   1.11 Oriental fruit moth: *Grapholitha molesta* Busck (Lepidoptera: Tortricidae)
   1.12 Peach stem aphid/ brown peach aphid/peach black aphid: *Pterochlorus persicae* Cholodkovsky (Hemiptera: Aphididae)
   1.13 Chaffer beetle: *Adoretus spp* (Coleoptera: Scarabaeidae)
   1.14 Codling moth: *Cydia pomonella* L. (Lepidoptera: Tortricidae)
   1.15 Mealy plum aphid: *Hyaloferma pruni* Geoffroy (Hemiptera: Aphididae)
   1.16 Plum leafhopper: *Macropsis trimaculata* Fitch (Hemiptera: Cicadellidae)
   1.17 Blue beetle: *Haltica samipicenis* Jacoby (Coleoptera: Chrysomelidae)
2. **Weeds**

   **Broad leaf**
   
   2.1 Tropical spiderwort: *Commelina benghalensis* L. (Commelinaceae)
   
   2.2 Creeping wood sorrel: *Oxalis corniculata* L. (Oxalidaceae)
   
   2.3 Goat weed: *Ageratum conyzoides* L. (Asteraceae)
   
   2.4 Sowthistles: *Sonchus* spp. (Asteraceae)
   
   2.5 Congress grass: *Parthenium hysterophorus* L. (Asteraceae)
   
   2.6 Pig weed: *Amaranthus viridis* L (Amaranthaceae)
   
   2.7 Lambs quarter: *Chenopodium album* (Chenopodiaceae)
   
   2.8 Spurge: *Euphorbia hirta* L (Euphorbiaceae)
   
   2.9 Sorrel: *Rumex dentatus* L (Polygonaceae)
   
   2.10 Creeping thistle: *Cirsium arvense* (L.) Scop. (Asteraceae)

   **Grasses**
   
   2.11 Bermuda grass: *Cynodon dactylon* (L.) Pers. (Poaceae)
   
   2.12 Cogon grass: *Imperata cylindrica* (L.) Rauesch. (Poaceae)
   
   2.13 Blanket grass: *Axonopus compressus* (Sw.) Beauv. (Poaceae)
   
   2.14 Large crabgrass: *Digitaria sanguinalis* L. (Scop.) (Poaceae)
   
   2.15 Knot grass: *Paspalum distichum* L. (Poaceae)
   
   2.16 Cannary grass: *Phalaris minor* Retz. (Poaceae)
   
   2.17 Crow foot grass: *Dactyloctenium aegyptium* (L.) Willd. (Poaceae)

   **Sedges**
   
   2.18 Purple nut sedge: *Cyperus rotundus* L. (Cyperaceae)
   
   2.19 Flat sedge: *Cyperus iria* L. (Cyperaceae)

3. **Nematode**

   3.1 Root-knot nematode: *Meloidogyne incognita* (Kofoid & White)

**II AGRO-ECOSYSTEM ANALYSIS (AESA) BASED INTEGRATED PEST MANAGEMENT (IPM)**

**A. AESA:**

The IPM has been evolving over the decades to address the deleterious impacts of synthetic chemical pesticides on environment ultimately affecting the interests of the growers. The economic threshold level (ETL) was the basis for several decades but in modern IPM (FAO 2002) emphasis is given to AESA where growers take decisions based on larger range of orchard observations. The health of a plant is determined by its environment which includes physical factors (i.e. soil, rain, sunshine hours, wind etc.) and biological factors (i.e. pests, diseases and weeds). All these factors can play a role in the balance which exists between herbivore insects and their natural enemies. Understanding the intricate interactions in an ecosystem can play a critical role in pest management.

Decision making in pest management requires a thorough analysis of the agro-ecosystem. Grower has to learn how to observe the crop, how to analyze the orchard situation and how to make proper decisions for their tree management. This process is called the AESA. Participants of AESA will have to make a drawing on a large piece of paper (60 x 80 cm), to include all their observations. The advantage of using a drawing is that it requires the participants/growers to observe closely and intensively. It is a focal point for the analysis and for the discussions that follow, and the drawing can be kept as a record.

AESA is an approach, which can be gainfully employed by extension functionaries and growers to analyze the orchard situations with regards to pests, defenders, soil conditions, plant health and the influence of climatic factors and their relationship for growing a healthy crop. The basic components of AESA are:

- Plant health at different stages.
- Built-in compensation abilities of plants.
• Pest and defender population dynamics.
• Soil conditions.
• Climatic factors.
• Growers past experience.

**Principles of AESA based IPM:**

**Grow a healthy crop:**

• Select a variety resistant/tolerant to major pests.
• Select healthy seeds/seedlings/planting material
• Treat the seeds/seedlings/plant material with recommended pesticides especially biopesticides.
• Follow proper spacing.
• Soil health improvement (mulching and green manuring wherever applicable).
• Nutrient management especially organic manures and biofertilizers based on the soil test results. If the dose of nitrogenous fertilizers is too high the crop becomes too succulent and therefore susceptible to insects and diseases. If the dose is too low, the crop growth is retarded. So, the growers should apply an appropriate amount of nutrients for best results.
• Proper irrigation.

**Observe the orchard regularly (climatic factors, soil and biotic factors):**

Growers should

• Monitor the orchard situations at least once a week (soil, water, plants, pests, natural enemies, weather factors etc.).
• Make decisions based on the orchard situations and P: D ratio.
• Take direct action when needed (e.g. collect egg masses, remove infested plants etc.).

**Plant compensation ability:**

Compensation is defined as the replacement of plant biomass lost to herbivores and has been associated with increased photosynthetic rates and mobilization of stored resources from source organs to sinks (e.g., from roots and remaining leaves to new leaves) during active vegetative growth period. Plant tolerance to herbivory can arise from the interaction of a variety of plant traits and external environmental factors. The ability of the plant to compensate for the reduced acquisition of resources by the production of new organs or by remobilization of reserves may also mitigate biotic stress effects.
Understand and conserve defenders:

- Know defenders/natural enemies to understand their role through regular observations of the agro-ecosystem.
- Avoid the use of chemical pesticides especially with broad-spectrum activity.

Insect zoo:

In orchard various types of insects are present. Some are beneficial and some may be harmful. Generally growers are not aware about it. Predators (friends of the growers) which feed on pests are not easy to observe in tree orchard. Insect zoo concept can be helpful to enhance growers’ skill to identify beneficial and harmful insects. In this method, unfamiliar/unknown insects are collected in plastic containers with brush from the orchard and brought to a place for study. Each insect is placed inside a plastic bottle together with parts of the plant and some known insect pests. Insects in the bottle are observed for certain time and determined whether the test insect is a pest (feeds on plant) or a predator (feeds on other insects).

Pest: Defender ratio (P: D ratio):

Identifying the number of pests and beneficial insects helps the growers to make appropriate pest management decisions. Sweep net, visual counts etc. can be adopted to arrive at the number of pests and defenders. The P: D ratio can vary depending on the feeding potential of natural enemy as well as the type of pest. The natural enemies of peach insect pests can be divided into 3 categories 1. parasitoids; 2. predators; and 3. pathogens.

Model Agro-Ecosystem Analysis Chart

| Date:       |
| Village:    |
| Grower:     |

Soil conditions:

Weather conditions:

Diseases types and severity:

Weeds types and intensity:

Rodent damage (if any):

No. of insect pests:

No. of natural enemies:

P: D ratio:

Decision taken based on the analysis of orchard situations
The general rule to be adopted for management decisions relying on the P: D ratio is 2: 1. However, some of the parasitoids and predators will be able to control more than 2 pests. Wherever specific P: D ratios are not found, it is safer to adopt the 2: 1, as P: D ratio. Whenever the P: D ratio is found to be favourable, there is no need for adoption of other management strategies. In cases where the P: D ratio is found to be unfavourable, the growers can be advised to resort to inundative release of parasitoids/predators depending upon the type of pest. In addition to inundative release of parasitoids and predators, the usage of microbial biopesticides and biochemical biopesticides such as insect growth regulators, botanicals etc. can be relied upon before resorting to synthetic chemical pesticides.

**Decision making**

**Growers become experts in treemanagement**

Growers have to make timely decisions about the management of their crops. AESA growers have learned to make these decisions based on observations and analysis viz., abiotic and biotic factors of the tree ecosystem. The past experience of the growers should also be considered for decision making. However, as orchard conditions continue to change and new technologies become available, growers need to continue improving their skills and knowledge.

- Growers are capable of improving farming practices by experimentation.
- Growers can share their knowledge with other growers.

**AESA methodology**

- Go to the orchard in groups (about 5 growers per group). Walk across the orchard and choose 10 orchards/acre randomly. Observe keenly each of these plants and record your observations:
  - Tree: 5-6 samples per tree (fruits/leaves/inflorescence/stem bark/roots/soil/insects, host plants) should be collected where, one sample from top, four samples from all the four sides (north, south, east, west) and one from bottom/soil, depending upon the requirement of study/observations and if necessary.
  - Insect pests: Observe and count insect pests at different places on the tree.
  - Defenders (natural enemies): Observe and count parasitoids and predators.
  - Diseases: Observe leaves and stems and identify any visible disease symptoms and severity.
  - Water: Observe the water situation in the orchard.
  - Weather: Observe the weather condition.
- While walking in the orchard, manually collect insects in plastic bags. Use a sweep net to collect additional insects. Collect plant parts with disease symptoms.
- Find a shady place to sit as a group in a small circle for drawing and discussion.
- If needed, kill the insects with some chloroform (if available) on a piece of cotton.
- Each group will first identify the pests, defenders and diseases collected.
- Each group will then analyze the orchard situation in detail and present their observations and analysis in a drawing (the AESA drawing).
- Each drawing will show a tree representing the orchard situation. The weather condition, water level, disease symptoms, etc. will be shown in the drawing. Insects pests will be drawn on one side. Defenders (beneficial insects) will be drawn on another side. Write the number next to each insect. Indicate the plant part where the pests and defenders were found. Try to show the interaction between pests and defenders.
- Each group will discuss the situation and make a tree management recommendation.
- The small groups then join each other and a member of each group will now present their analysis in front of all participants.
The facilitator will facilitate the discussion by asking guiding questions and makes sure that all participants (also shy or illiterate persons) are actively involved in this process.

- Formulate a common conclusion. The whole group should support the decision on what orchard management is required in the AESA plot.
- Make sure that the required activities (based on the decision) will be carried out.
- Keep the drawing for comparison purpose in the following weeks.

**Data recording**

Growers should record data in a notebook and drawing on a chart

- Keep records of what has happened help us making an analysis and draw conclusions.

**Data to be recorded**

- **Tree situation (e.g. for AESA):** Plant health; insect pests, diseases, weeds; natural enemies; soil condition; irrigation; weather conditions
- **Input costs:** Seeds; Fertilizer; Pesticides; Labour
- **Harvest:** Yield (Kg/acre); Price of produce (Rs./Kg)

**Some questions that can be used during the discussion**

- Summarize the present situation of the orchard?
- What tree management aspect is most important at this moment?
- Is there a big change in tree situation compared to last visit? What kind of change?
- Is there any serious pest or disease outbreak?
- What is the situation of the beneficial insects?
- Is there a balance in the orchard between pests and defenders?
- Were you able to identify all pests and diseases?
- Do you think the tree is healthy?
- What management practices are needed at this moment?
- When will it be done? Who will do it? Make sure that responsibilities for all activities are being discussed.
- Are you expecting any problems to emerge during the coming week such as congenial weather conditions for pest buildup?
- What are the problems? How can we avoid it? How can we be prepared?
- Summarize the actions to be taken.

**Advantages of AESA over ETL**

One of the problems of the ETL is that it is based on parameters that are changing all the time, and that are often not known. The damage or losses caused by a certain density of insects cannot be predicted at all. In ETL the due recognition of the role of natural enemies in decreasing pest population is ignored. Growers cannot base their decisions on just a simple count of pests. They will have to consider many other aspects of the tree (tree ecology, growth stage, natural enemies, weather condition, etc.) and their own economic and social situation before they can make the right tree management decisions. In ETL based IPM, natural enemies, plant compensation ability and abiotic factors are not considered. In AESA based IPM emphasis is given to natural enemies, plant compensation ability, abiotic factors and P: D ratio.
**AESA and farmer field school (FFS):**

AESA is a season-long training activity that takes place in the grower orchard. It is season-long so that it covers all the different developmental stages of the tree and their related management practices. The process is always learner-centered, participatory and relying on an experiential learning approach and therefore it has become an integral part of FFS.

**Growers can learn from AESA:**
- Identification of pests and their nature of damage
- Identification of natural enemies
- Management of pests
- Water and nutrients management
- Influence of weather factors on pest buildup
- Role of natural enemies in pest management

**FFS to teach AESA based IPM skills:**

- **Participatory**
  - Active involvement of the farmers
  - Farmers learn from other IPM farmers
  - Not classroom training

- **Practical**
  - Active involvement of the farmers
  - Group meetings
  - Throughout cropping season
  - Guided by IPM facilitator

- **Regular meetings**
  - Design studies to solve problems
  - Learning by doing

- **Problem oriented**
  - Farmers choose topics
  - Learning about crop ecology

- **Learning through field experiments**
  - Understanding role of beneficial insects

**B. Field scouting:**

AESA requires skill, so only the trained growers can undertake this exercise. However, other growers also can do field scouting in their own orchard at regular intervals to monitor the major pest situation. Surveillance on pest occurrence at the main orchard should commence soon after tree establishment and at weekly intervals thereafter. In each tree, select five branches randomly for recording of insects as per procedure finalized for individual insects.

**Sampling in fruit crops:**

A person doing sampling is known as an inspector or scout. The fruit crops are perennial in nature and before starting the surveillance process an inspector or scout who is going to implement the activity should know about the nature of crop as well as different crop stages and its growth stages. Knowing crop and its nature helps in identifying the important pests and diseases because the pests and diseases infest and infect, respectively, certain stage or part of the plant.
Sampling patterns:
Different methods of sampling are reported and being utilized for sampling in crops as well as in fruit plants such as random, scattered etc. However, some of them are specific to the crop/disease/pests and growth stage (some of them are to be utilized at initial stage and/or for subsequent plant growth stage). Also the sampling methods may differ based on the nature and requirement of the study such as estimating disease incidence and/or disease severity. For a common orchard study, the assessment methods should not only be easy and quick in use for a wide range of conditions, but also adequately reliable, reproducible, and accurate/precise. However, this is not always possible. Generally, in fruit crops the following sampling patterns are used:

- **Zig-zag pattern.** Sampling a fallow orchard or one with no obvious symptoms in the current crop to see the incidence as well as sampling of viral, wilt disease.
- **Circle pattern.** Sampling within the drip line of trees and shrubs and for powdery mildew, downy mildew and leaf spot diseases etc.
- **Star pattern.** Sampling from a damaged area.

Sampling frequency:
Sampling frequency or interval depends on pest generation interval or number of generations per year, potential for population increase between generations, stage of crop- pathogen infection etc. Generally, if initial survey is already implemented and some results are with the surveillance manager, then based upon the results of pest/disease incidence/intensity and weather parameters, the surveillance frequency/interval is decided to get comprehensive view of the pests and diseases development/population dynamics as well as biocontrol agent’s population (if present in the crop ecosystem). In subsequent survey, monitoring for the pest, pathogen, and biocontrol agent must be carried out to get the following detailed information:

- **Relative pest measuring estimates:** Counting the representative samples in a given area.
- **Absolute pest measuring estimates:** Counting all individuals in a population in a given area which determine total pest population size in a given area. It is very effective pest surveillance research tool but very time consuming, therefore, not practical and/or not economically feasible.
- **Get an idea of number of pests per unit:** To estimate pests per plant and/or area to make the decision.
- **Get an idea of weather at the site:** In addition to the pest estimation, the prevailing weather conditions, which may affect pest development and/or population buildup, are observed and recorded.
- **Get an idea of biocontrol agents:** To strengthen the management strategies, biocontrol agent population size, if available, in a given area is to be determined.

For insect pests:
**For aphids, San Jose scales, thrips and mites:** Count and record the number of nymphs and adults present on five apical twigs each from top, middle and bottom portion randomly per plant (tapping method also can be used to count thrips).

**For Cydia:** During fruiting stage total number of fruits, damaged fruits due to Cydia and larval population can be counted on the fruits on the three top, three middle and three bottom branches randomly.

For diseases:
Whenever scouting, be aware that symptoms of plant disease problems may be caused by any biotic factors such as fungal, bacterial, viral pathogens or abiotic factors such as weather, fertilizers, nutrient deficiencies, pesticides and abiotic soil problems. In many cases, the cause of the symptom is not obvious. Close examination, and laboratory culture and analysis are required for proper diagnosis of the causal agent of disease. Generally fungal diseases cause the obvious symptoms with irregular growth, pattern & colour (except viruses), however abiotic problems cause regular, uniform symptoms. Pathogen presence (signs) on the symptoms can also be observed like fungal growth, bacterial ooze etc. Specific and characteristic symptoms of the important plant diseases are given in description of diseases section.
**Root sampling:** Always check plants that appear unhealthy. If there are no obvious symptoms on plants, examine plants randomly and look for lesions or rots on roots and stems. Observe the signs of the causal organism (fungal growth or ooze). It is often necessary to wash the roots with water to examine them properly. If the roots are well developed, cut them to examine the roots for internal infections (discolouration & signs). Count the total number of roots damaged/infested/infected due to rot should be counted and incidence should be recorded.

**Leaf sampling:** Examine all leaves and/or sheaths of each plant for lesions. Leaf diseases cause most damage during the seedling and flowering stages of plant growth. Observe for the symptoms and signs on the infected plant parts. Determine the percent area of leaf infection by counting the number of leaves (leaf area diameter)/plant infected due to disease and incidence should be recorded.

**Stem, flowers and fruits sampling:** Carefully examine the stem, flowers and fruits of plants for symptoms and signs of fungal or bacterial diseases. The stem, flower, and fruits should be split or taken apart and examined for discoloration caused by fungi and bacteria. Count the number of stems, flowers and fruits infected due to disease and percent disease incidence should be recorded.

**C. Surveillance through pheromone and fruit fly trap catches:**

Pheromone traps for *Cydia pomonella, Anarsia lineatella* and *Grapholita molesta* and fruit fly trap @ 4-5/acre have to be installed, if available. Install the traps for each species separated by a distance of >75 feet. Fix the traps to the supporting pole at the height of mid canopy. Change of lures should be made at 2-3 week interval (regular interval) or based on loss of lure efficacy. During each week of surveillance, the number of moths or flies/trap/week should be counted and recorded year round. The trapped moths should be removed and destroyed after each recording.

**D. Yellow /blue pan water/sticky traps:**

Set up yellow/blue pan water traps on the ground and sticky traps at the mid canopy level of the tree for monitoring aphids (yellow) and thrips (blue) @ 1 trap (15 X 7.5 cm)/5 trees. Locally available empty tins can be painted yellow/blue and coated and with grease/Vaseline/castor oil on outer surface may also be used as yellow/blue sticky trap. Count the number of aphids/thrips on the traps daily and take the appropriate decision regarding management practices.

**E. Light traps:**

Set up light traps @ 1 trap/acre at the mid canopy height for monitoring and mass trapping of adults of codling moth, hairy caterpillars, leaf roller and few beetles of stem/root borer. Light traps with exit option for natural enemies of smaller size should be installed and operated around the dusk time (6 pm to 10 pm).

**F. Nematode extraction:**

Collect 100 to 300 cm³ (200-300 g) representative soil sample. Mix soil sample and pass through a coarse sieve to remove rocks, roots, etc. Take a 600 cc subsample of soil, pack lightly into a beaker uniformly. Place soil in one of the buckets or pans half filled with water. Mix soil and water by stirring with paddle; allow to stand until water almost stops swirling. Pour all but heavy sediment through 20-mesh sieve into second bucket; discard residue in first bucket; discard material caught on sieve. Stir material in second bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 200-mesh sieve into first bucket; discard residue in second bucket. Backwash material caught on 200-mesh sieve (which includes large nematodes) into 250-ml beaker. Stir material in first bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 325-mesh sieve into second bucket; discard residue in first bucket. Backwash material caught on 325-mesh sieve (which includes small to mid-sized nematodes and silty material) into 250-ml beaker. Mix the contents of both the beakers and pass it through 325 mesh sieve. Backwash materials caught on 325 mesh sieve into a beaker. Prepare tissue paper-wire gauze fitting and pour the contents of the beaker on to the tissue paper-wire gauze fitting carefully place the fitting on a water filled petridish. After 24 hours, examine suspension of petridish under a stereoscopic microscope for presence of nematodes.
III. ECOLOGICAL ENGINEERING FOR PEST MANAGEMENT

Ecological engineering for pest management has recently emerged as a paradigm for considering pest management approaches that rely on the use of cultural techniques to effect habitat manipulation and to enhance biological control. Ecological engineering for pest management is based on informed ecological knowledge rather than high technology approaches such as synthetic pesticides and genetically engineered crops (Gurr et al. 2004).

Ecological Engineering for Pest Management – Below Ground:

There is a growing realization that the soil borne, seed and seedling borne diseases can be managed with microbial interventions, besides choosing appropriate plant varieties. The following activities increase the beneficial microbial population and enhance soil fertility.

- Keep soils covered year-round with living vegetation and/or tree residue.
- Add organic matter in the form of farm yard manure (FYM), vermicompost, tree residue which enhance below ground biodiversity of beneficial microbes and insects.
- Application of balanced dose of nutrients using biofertilizers based on soil test report.
- Application of biofertilizers with special focus on mycorrhiza and plant growth promoting rhizobia (PGPR).
- Application of Trichoderma harzianum/viride and Pseudomonas fluorescens for treatment of seeds/seedlings/planting material in the nurseries and field application (if commercial products are used, check for label claim. However, biopesticides produced by growers for own consumption in their orchards, registration is not required).

Ecological Engineering for Pest Management – Above Ground:

Natural enemies play a very significant role in control of foliar insect pests. Natural enemy diversity contributes significantly to management of insect pests both below and above ground.

Natural enemies may require:

1. Food in the form of pollen and nectar.
2. Shelter, overwintering sites and moderate microclimate, etc.
3. Alternate hosts when primary hosts are not present.

In order to attract natural enemies following activities should be practiced:

- Raise the flowering plants / compatible cash crops along the orchard border by arranging shorter plants towards main treecorn and taller plants towards the border to attract natural enemies as well as to avoid immigrating pest population.
- Grow flowering plants on the internal bunds inside the orchard.
- Not to uproot weed plants those are growing naturally such as Tridax procumbens, Ageratum sp, Alternanthera sp etc. which act as nectar source for natural enemies.
- Not to apply broad spectrum chemical pesticides, when the P: D ratio is favourable. The plant compensation ability should also be considered before applying chemical pesticides.
- Reduce tillage intensity so that hibernating natural enemies can be saved.
- Select and plant appropriate companion plants which could be trap crops and pest repellent crops. The trap crops and pest repellent crops will also recruit natural enemies as their flowers provide nectar and the plants provide suitable microclimate.

Due to enhancement of biodiversity by the flowering plants, parasitoids and predators (natural enemies) number also will increase due to availability of nectar, pollen and insects etc. The major predators are a wide variety of spiders, ladybird beetles, long horned grasshoppers, lacewing, earwigs, etc.
Plants Suitable for Ecological Engineering for Pest Management

Attractant Plants

- Cowpea
- Carrot
- Sunflower
- Buckwheat
- French bean
- Alfaalfa
- Mustard
- Cosmos
- Anise
- Caraway
- Dill
- Parsley
- White clover
- Tansy
- Yarrow
- Rye grass
- Marigold
Repellent plants

Ocimum spp.

Peppermint/Spearmint

Border plants

Maize

Sorghum

The flowering plants suggested under Ecological Engineering for pest management strategy are known as attractant plants to the natural enemies of the selected pests. The information is based on published research literature. However, the actual selection of flowering plants could be based on availability, agro-climatic conditions and soil types.
Biodiversity of natural enemies observed in Ecological Engineering field at NIPHM

Biodiversity of natural enemies: Parasitoids

Biodiversity of natural enemies: Predators

Biodiversity of natural enemies: Spiders
## IV. CROP STAGE-WISE IPM

<table>
<thead>
<tr>
<th>Management</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-planting</strong>*</td>
<td><strong>Common cultural practices:</strong></td>
</tr>
<tr>
<td></td>
<td>• Grow attractant, repellent plants around the field bunds (ecological engineering).</td>
</tr>
<tr>
<td></td>
<td>• Apply manures and fertilizers as per soil test recommendations</td>
</tr>
<tr>
<td><strong>Nutrients</strong></td>
<td>• Nutrient should be applied on the basis of soil test report and recommendation for the particular agro-climatic zone.</td>
</tr>
<tr>
<td></td>
<td>• Prepare land by ploughing and harrowing.</td>
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<tr>
<td></td>
<td>• The pits are dug in summer about a fortnight before planting and left undisturbed for solarization.</td>
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<tr>
<td></td>
<td>• Pits of about 1m x 1m x 1m size are dug at a distance of 4 to 5 meter in square system of planting.</td>
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<tr>
<td></td>
<td>• Under high density planting pits may be dug at a spacing of 4m x 1m.</td>
</tr>
<tr>
<td><strong>Weeds</strong></td>
<td>• Ploughing, harrowing, leveling and removing the weeds before planting.</td>
</tr>
<tr>
<td><strong>Termite</strong></td>
<td><strong>Cultural control:</strong></td>
</tr>
<tr>
<td></td>
<td>• Deep ploughing of orchard during summer between tree rows.</td>
</tr>
<tr>
<td></td>
<td>• Three summer ploughings at 10 days interval reduce resting stage of insect pests.</td>
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<tr>
<td></td>
<td>• Apply well rotten FYM only to discourage termite infestation.</td>
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<td></td>
<td>• Avoid late planting.</td>
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<td></td>
<td>• Destroy the crop residues which form the sources of infestation.</td>
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<tr>
<td></td>
<td>• Use of crude oil emulsion to destroy the termite colony in the termatorium.</td>
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<tr>
<td></td>
<td><strong>Mechanical control:</strong></td>
</tr>
<tr>
<td></td>
<td>• Dismantle termitaria (termite mounds) in the orchard and kill the termite queens.</td>
</tr>
<tr>
<td></td>
<td><strong>Biological control:</strong></td>
</tr>
<tr>
<td></td>
<td>• Apply neem cake @ 80 Kg/acre.</td>
</tr>
<tr>
<td></td>
<td>• Entomopathogenic nematodes (EPNs) can be applied at the rate of 25-50 infected larvae of <em>Galleria mellonella</em> per tree in termite infested orchard.</td>
</tr>
<tr>
<td><strong>Planting</strong>*</td>
<td><strong>Common cultural practices:</strong></td>
</tr>
<tr>
<td></td>
<td>• Use healthy and certified plants</td>
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<tr>
<td></td>
<td>• Timely planting</td>
</tr>
<tr>
<td></td>
<td>• Plant in rows with recommended spacing.</td>
</tr>
<tr>
<td></td>
<td>• Grow resistant/tolerant varieties</td>
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<tr>
<td></td>
<td>• Plant early maturing cultivars i.e, Prabhat, Partap, Florda Prince, Early Grande, Flordasun and Shand-e-Punjab for fruit fly.</td>
</tr>
<tr>
<td></td>
<td>• Irrigation should be done by ring method to reduce possibility of collar rot</td>
</tr>
<tr>
<td></td>
<td>• Avoid planting in low-lying areas and flooding.</td>
</tr>
<tr>
<td></td>
<td>• Do not delay irrigation until the crop exhibits moisture stress symptoms.</td>
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<tr>
<td></td>
<td><strong>Common mechanical practices:</strong></td>
</tr>
<tr>
<td></td>
<td>• Remove and destroy the diseased plant debris.</td>
</tr>
<tr>
<td><strong>Nutrients</strong></td>
<td>• Planting is done in pits already filled with top soil and organic manure during the months of December- January.</td>
</tr>
<tr>
<td></td>
<td>• Mycorrhiza culture should be applied at the time of planting or a basket of soil taken from old peach orchard is added to each pit to ensure mycorrhizal association with peach roots.</td>
</tr>
<tr>
<td></td>
<td>• At the time of planting, manures and fertilizers are applied @ 50 Kg FYM or compost and 20 g N + 15 g P + 15 g K per plant.</td>
</tr>
</tbody>
</table>
### Weeds
- Use weed free seedlings for planting.
- Remove existing weeds in and around the pits at the time of planting.
- During the initial 2-4 years, grow the intercrops like pea, bean, soybean, and cowpea to suppress the weeds.

### Soil borne diseases and nematodes
- Follow common cultural and mechanical practices (see page no. 15, 16)
- For resistant/tolerant varieties consult ICAR institutes/KVK's/SAU's

#### Cultural control:
- Resistant varieties
- Use healthy infestation-free plants.
- Application of neem cake @ 80 Kg/acre for nematode control.

*Application of *Trichoderma harzianum* / *viride* and *Pseudomonas fluorescens* for treatment of seedlings/planting material in the nurseries and field application (if commercial products are used, check for label claim. However, biopesticides produced by farmers for own consumption in their fields, registration is not required).

### Vegetative stage

#### Common cultural practices:
- Deep summer ploughing between the tree rows.
- Provide irrigation at critical stages of the crop
- Avoid water stagnation conditions.
- Collect and destroy diseased and insect infested plant parts.

#### Common mechanical practices:
- Remove and destroy alternate hosts and weeds
- Prune and burn infested shoots and branches.
- Collect and destroy eggs and early stage larvae
- Handpick the older larvae during early stages of the tree.
- The infested plant part may be collected and destroyed
- Handpick the gregarious caterpillars and the cocoons which are found on trees and destroy them in kerosene mixed water (do not hand pick the hairy caterpillars)
- Use yellow sticky traps for aphids and blue sticky traps for thrips @ 1 trap/ 5 tree.
- Use light trap @ 1/acre and operate between 6 pm and 10 pm
- Install pheromone traps @ 4-5/acre for monitoring adult moths (*Cydia*) activity (replace the lures with fresh lures after every 2-3 weeks)
- Erect bird perches @ 20/acre for encouraging predatory birds such as King crow, common mynah etc. (during the early stage of the orchard establishment)
- Set up bonfire during evening hours at 6-7 pm

#### Common biological practices:
- Conserve natural enemies through ecological engineering
- Augmentative release of natural enemies
- Enhance parasitic activity by avoiding chemical spray, when 1-2 larval parasitoids are observed

### Nutrients
- Apply fertilizers according to the age of plant @ 20 g N + 15 g P + 15 g K per plant in first year and doubling the dose each year till a stabilised dose is reached at 6th year.
- Apply manures @ 50 Kg per plant in Dec.- January every year along with full dose of P and K.
- The fertilizers should be applied in 20-30 cm deep and 30 cm wide trench along the drip line of the tree.

### Weeds
- Deep ploughing during the first year to check weed growth. Tool weeding on regular basis especially around the plants.
- Frequent tilling/ploughing up to 10 cm depth during winter.
- To suppress the weeds between rows, leguminous crops and vegetables can be grown as intercrops in the initial years. Use slashing and moving between the rows to control the weeds.
<table>
<thead>
<tr>
<th>Pest Type</th>
<th>Cultural Control</th>
<th>Mechanical Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stem borer/tree borer</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Keep orchard clean and healthy.</td>
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<tr>
<td></td>
<td></td>
<td>Prune and burn infested shoot and branches during winter.</td>
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<tr>
<td></td>
<td></td>
<td>Clean the hole and insert cotton wool soaked in emulsion of kerosene or petrol in each hole and plug them with mud.</td>
</tr>
<tr>
<td><strong>Defoliating beetles</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Use of plastic-lined trenches and vacuums for collecting adult beetles.</td>
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<tr>
<td></td>
<td></td>
<td>Use propane flamers to kill the adults.</td>
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<td></td>
<td>Collect and kill the beetles in kerosene water.</td>
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<tr>
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<td></td>
<td>Shake the non-bearing plant/trees over a cloth sheet at dusk and collect and destroy the beetles (defoliating and fruit eating).</td>
</tr>
<tr>
<td><strong>Hairy caterpillar</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Irrigate once to avoid prolonged mid-season drought.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prune, collect and destroy aphid/curled leaves.</td>
</tr>
<tr>
<td><strong>Plum/peach leaf curl aphid</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>In the early stages, wash away the aphids with a sharp spray of water from a hose pipe.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prune, collect and destroy aphid/curled leaves.</td>
</tr>
<tr>
<td></td>
<td><strong>Chemical control:</strong></td>
<td>Spray oxydemeton – methyl 25% EC @ 600-800 ml/acre</td>
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<tr>
<td></td>
<td></td>
<td>Spray carbofuran 3% CG @ 13320 g diluted in 600-800 l of water/acre</td>
</tr>
<tr>
<td><strong>Apricot brown scale</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td><strong>Fruit fly</strong></td>
<td>Follow common cultural, mechanical and biological practices (See page no. 15, 16)</td>
<td>Prior to harvest collect and dispose off infested and fallen fruits to prevent further multiplication and carry-over of population.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ploughing of the orchard below the trees exposes pupae to sun's heat which kills them.</td>
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<td></td>
<td>If infestation is heavy, bait splash on the trunk only, once or twice at weekly interval is recommended.</td>
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<td></td>
<td>Managing fruit flies also reduces anthracnose disease and prevents late fruit fall.</td>
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<tr>
<td></td>
<td></td>
<td>Collect and destroy the adult flies.</td>
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<tr>
<td></td>
<td></td>
<td>Use methyl eugenol baited fruit fly trap @ 4-5/acre</td>
</tr>
<tr>
<td><strong>San Jose scale</strong></td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Grow ecological engineering attractant plants for natural enemies: viz., sunflower family, carrot family plants and buckwheat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prune infested branches and twigs and destroy them</td>
</tr>
<tr>
<td>Pest Type</td>
<td>Cultural Control</td>
<td>Mechanical Control</td>
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</tr>
<tr>
<td>Green peach aphid** &amp; Peach black aphid**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Cultural control: Abiotic factors such as rain and wind reduce aphid infestations. Adopt the ecological engineering strategy by planting the attractant and repellent plants. Mechanical control: Prune curled leaves or new infested shoots and dispose them.</td>
</tr>
<tr>
<td>Tent caterpillar**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Mechanical control: Egg mass covered with yellowish hair are collected and destroyed (between August and March). Put a burlap at the base of tree trunk to destroy the larvae underneath the burlap.</td>
</tr>
<tr>
<td>Leaf roller**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Cultural control: Delayed dormant treatments and bloom time application done for other pests help keep leaf roller populations under control. Regular monitoring in each season is important so that prompt action can be taken.</td>
</tr>
<tr>
<td>Green capsid**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Mechanical control: Grow rootstock suckers, especially at the edges of orchards where the pest is removed.</td>
</tr>
<tr>
<td>Root borer**, Consperse sting bug**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Cultural control: Delayed dormant treatments and bloom time application done for other pests help keep leaf roller populations under control. Regular monitoring in each season is important so that prompt action can be taken.</td>
</tr>
<tr>
<td>Blossom thrips**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Mechanical control:</td>
</tr>
<tr>
<td>Chaffer beetle**</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Mechanical control: Remove the rose chaffer beetle from the plants mechanically and place them in a bucket of soap water to kill. Apply EPNs @ 25-50 infected larvae of <em>Galleria mellonella</em>/tree.</td>
</tr>
<tr>
<td>Frosty mildew</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Cultural control: Spraying at full bloom needs to be avoided. Alkathene bands cleaned at regular interval Mechanical control: Prune diseased leaves and malformed panicles harbouring the pathogen to reduce primary inoculum load.</td>
</tr>
<tr>
<td>Coryneum blight/shot hole/silver leaf and canker/ bacterial canker &amp; gummosis</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td>Cultural control: All the dead wood and pruning bark should be destroyed. Cover the wounds with a disinfectant solution. Mechanical control: Proper pruning should be done to avoid mechanical injury. Keep the trees as free as possible from mechanical wounds, winter injury, crotch separation and cankers. Cut wounds should be covered with superior white lead paint.</td>
</tr>
<tr>
<td>Condition</td>
<td>Treatment</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Cankers on the trunk and</td>
<td>Cankers on the trunk and in the crotches should be removed and the dead bark decorticated</td>
<td></td>
</tr>
<tr>
<td>in the crotches</td>
<td>along with 2 cm of the healthy bark.</td>
<td></td>
</tr>
<tr>
<td>White root rot</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
<td></td>
</tr>
<tr>
<td>Cultural control:</td>
<td>For replantation, infested soil should be treated with 3.0% formaldehyde and filled in the pits</td>
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</tr>
<tr>
<td></td>
<td>3 weeks before new plantation.</td>
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<tr>
<td></td>
<td>Avoid deep ploughing to avoid injuries to the roots, through which the fungus attacks.</td>
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<tr>
<td></td>
<td>Avoid excessive irrigation during winter.</td>
<td></td>
</tr>
<tr>
<td>Whisker rot</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td>Leaf spot</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
<td></td>
</tr>
<tr>
<td>Cultural control:</td>
<td>Avoiding injury during harvest and packing.</td>
<td></td>
</tr>
<tr>
<td>Mechanical control:</td>
<td>Prune the disease part and burn it.</td>
<td></td>
</tr>
<tr>
<td>Powdery mildew</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
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<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
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</tr>
<tr>
<td>Cultural control:</td>
<td>Avoid overcrowding of branches</td>
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<tr>
<td></td>
<td>Careful use of water and fertilizers input, especially nitrogen to minimize growth of large</td>
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<tr>
<td></td>
<td>dense canopies.</td>
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<td></td>
<td>Water only in the morning so that foliage will be dry by the evening.</td>
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<tr>
<td>Mechanical control:</td>
<td>Clip off mildewed twigs and destroy them.</td>
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<tr>
<td></td>
<td>Pruning cuts should be made close to the branches leaving no stubs.</td>
<td></td>
</tr>
<tr>
<td>Chemical control:</td>
<td>Spray lime sulphur @ 0.8 - 2 lit/acre</td>
<td></td>
</tr>
<tr>
<td>Peach yellow disease</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
<td></td>
</tr>
<tr>
<td>Cultural control:</td>
<td>Vector <em>Macropsis trimaculata</em> should be controlled.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use healthy planting material.</td>
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</tr>
<tr>
<td>Mechanical control:</td>
<td>Infected trees should be destroyed</td>
<td></td>
</tr>
<tr>
<td>Silver canker</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
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</tr>
<tr>
<td>Mechanical control:</td>
<td>Before pruning it is good orchard practice to clean up any dead wood which may be lying in and</td>
<td></td>
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<td></td>
<td>around the orchard.</td>
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<td></td>
<td>Pruning should be carried out during periods of dry weather between harvest and leaf fall.</td>
<td></td>
</tr>
<tr>
<td>Peach rust</td>
<td>Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For resistant/tolerant varieties consult ICAR institutes/KVK’s/SAU’s</td>
<td></td>
</tr>
<tr>
<td>Cultural control:</td>
<td>Avoid high nitrogen rates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Irrigation through angle sprinklers and drips reduce disease incidence.</td>
<td></td>
</tr>
</tbody>
</table>
| **Leaf curl** | • Follow common cultural, mechanical and biological practices (see page no. 15, 16)  
| | • For resistant/tolerant varieties consult ICAR institutes/ KVK’s /SAU’s  
| **Mechanical control:** | • Thinning (cut the infested and curled leaves from canopy)  
| | • Reduce drought stress (irrigate the orchard at critical time periods).  
| **Chemical control:** | • Spray lime sulphur @ 0.8 - 2 l/acre  
| **White root rot** | • Follow common cultural, mechanical and biological practices (see page no. 15, 16)  
| | • For resistant/tolerant varieties consult ICAR institutes/ KVK’s /SAU’s  
| **Cultural control:** | • Preparing the soil before planting with soil solarisation.  
| **Mechanical control:** | • Remove and destroy infected plants (all roots, litter and debris from infected plants must also be removed and destroyed).  
| | • Creating a trench with a shovel around infected areas prevent water runoff from distributing the fungal pathogen to nearby plants.  
| **Collar rot** | • Follow common cultural, mechanical and biological practices (see page no. 15, 16)  
| | • For resistant/tolerant varieties consult ICAR institutes/ KVK’s /SAU’s  
| **Cultural control:** | • Do not allow water to accumulate around tree crowns.  
| | • Provide adequate drainage, and avoid planting in heavy soils, low lying spots, and areas that flood frequently  
| **Brown rot** | • Follow common cultural, mechanical and biological practices (see page no. 15, 16)  
| | • For resistant/tolerant varieties consult ICAR institutes/ KVK’s /SAU’s  
| **Cultural control:** | • Avoid injury during picking  
| | • Select healthy unbruised fruits for marketing  
| **Mechanical control:** | • Collect and destroy the fruit mummies by burning or burying them in the soil.  
| | • The infected twigs should be cut out and burnt.  
| **Chemical control:** | • Spray lime sulphur @ 0.8 - 2 lit/acre  

**Flowering stage**

| **Nutrients** | • Nitrogen is applied in 2 splits, first half at 2-3 weeks before flowering and the remaining half a month later.  
| | • The fertilizers should be applied in 20-30 cm deep and 30 cms wide trench along the drip line of the tree.  
| **Weeds** | • Same as in vegetative stage  
| **Flat headed borer** | • Follow common cultural, mechanical and biological practices (see page no. 15, 16)  
| **Cultural control:** | • Wrap or paint the tree trunk above and 1 inch below the soil line with white, water-based paint or whitewash to protect the trunk from sunburn and flat headed borer invasions.  
| **Mechanical control:** | • Prune infested wood and burn or remove it from the orchard
### Hairy caterpillar, peach leaf curl aphid, apricot brown scale, San Jose scale and tent caterpillar**
- Same as in vegetative stage

### Codling moth
- Follow common cultural, mechanical and biological practices (see page no. 15, 16)

**Cultural control:**
- Use synthetic codlemone for mating disruption at a height of 6-8 feet or dispensers should be deployed within 1 meter of the top of the canopy prior to spring emergence during late May to 3rd week of July.

### Peach twig borer
- Follow common cultural, mechanical and biological practices (see page no. 15, 16)

**Mechanical control:**
- Mating disruption is most effective in orchards with low moth populations that are not close (a mile) to other untreated peach twig borer hosts or almond orchards.
- Install pheromone traps @ 4-5 traps/acre in orchards

### Root borer**, consperse sting bug**, blossom thrips**, chaffer beetle**, frosty mildew, leaf spot, powdery mildew, silver canker, white root rot, peach rust and collar rot
- Same as in vegetative stage

### Fruiting stage

#### Nutrients
- For mature trees, a mixture of 40 Kg FYM, 500 g N, 250 g P₂O₅ and 200 g K is recommended. The FYM should be applied during December-January along with full dose of P and K. Nitrogen is applied in 2 parts, first half at 2-3 weeks before flowering and the remaining half a month later.
- The band application of nitrogenous fertilizers should be preferred over broadcasting.
- Under rainfed conditions, apply N through 1 or 2 foliar sprays of urea (0.5%) after fruit set.
- Apply recommended micronutrients, if symptoms are observed. Fruits are deformed under boron deficiency.
- To avoid boron deficiency, apply H₂BO₃ (0.1%) as foliar spray.

#### Weeds
- Remove weeds around the plants.
- Use straw or black polyethylene mulch to avoid weed growth and to maintain soil moisture for longer period.
- Mulching tree basins with 10-15 cm thick dry grass also checks weed growth.
<table>
<thead>
<tr>
<th>Insect/pest</th>
<th>Control Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flat headed borer, hairy caterpillar, San Jose scale, root borer</strong>, <strong>tent caterpillar</strong> and codling moth**</td>
<td>• Same as in flowering stage</td>
</tr>
<tr>
<td><strong>Peach fruit fly</strong></td>
<td>• Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
</tr>
<tr>
<td><strong>Cultural control:</strong></td>
<td>• Harvest the ripening fruits and do not allow the ripe fruits on the tree.</td>
</tr>
<tr>
<td></td>
<td>• Regular removal of fallen fruits from the ground and bury the infested fruits at least at 60cm depth.</td>
</tr>
<tr>
<td></td>
<td>• Shallow ploughing with cultivator immediately after harvest is effective in exposing and killing the pupating larvae/pupae, which are mostly present at 4-6 cm depth.</td>
</tr>
<tr>
<td><strong>Mechanical control:</strong></td>
<td>• Hot water treatment of fruit at 48 °C for 60 min.</td>
</tr>
<tr>
<td></td>
<td>• Collect and destroy the adult flies</td>
</tr>
<tr>
<td><strong>Peach fruit borer</strong></td>
<td>• Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
</tr>
<tr>
<td><strong>Cultural control:</strong></td>
<td>• Mulching with green <em>Lantana camara</em> and <em>Vitex negundo</em> leaves @ 2 t/acre at 40 and 90 days after planting.</td>
</tr>
<tr>
<td><strong>Mechanical control:</strong></td>
<td>• Cut the infested shoots and destroy them to kill harbouring caterpillars</td>
</tr>
<tr>
<td></td>
<td>• Place light traps @ 1 /acre and operate between 6 and 10 pm to attract and trap the adult moths. Collect and kill the trapped moths</td>
</tr>
<tr>
<td><strong>Biological control:</strong></td>
<td>• Release of <em>Trichogramma chilonis</em> @ 40,000/acre. for Lepidopteran insect-pests.</td>
</tr>
<tr>
<td></td>
<td>• Spray neem oil (0.5%) as and when required.</td>
</tr>
<tr>
<td><strong>Peach twig borer</strong> and <strong>chaffer beetle</strong>**</td>
<td>• Same as in vegetative stage (chaffer beetle).</td>
</tr>
<tr>
<td></td>
<td>• Same as in flowering stage (peach twig borer).</td>
</tr>
<tr>
<td><strong>Oriental fruit moth</strong>**</td>
<td>• Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
</tr>
<tr>
<td><strong>Mechanical control:</strong></td>
<td>• Set up pheromone traps@4-5/acre</td>
</tr>
<tr>
<td><strong>Other diseases</strong></td>
<td>• Same as in vegetative stage</td>
</tr>
<tr>
<td><strong>Whisker rot</strong></td>
<td>• Follow common cultural, mechanical and biological practices (see page no. 15, 16)</td>
</tr>
<tr>
<td></td>
<td>• For resistant/tolerant varieties consult ICAR institutes/ KVK’s /SAU’s</td>
</tr>
<tr>
<td><strong>Mechanical control:</strong></td>
<td>• Preventing skin cuts and punctures during harvesting and packing is of prime importance in controlling <em>Rhizopus</em> rot.</td>
</tr>
<tr>
<td></td>
<td>• Clean containers and good housekeeping in the packing shed and storage area reduce the rot incidence.</td>
</tr>
<tr>
<td></td>
<td>• Store fruit at or below 39°F, the fungus does not grow at temperatures below 40°F.</td>
</tr>
</tbody>
</table>
Postharvest and dormant stage

<table>
<thead>
<tr>
<th>Disease</th>
<th>Mechanical control:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Take proper care in handling the fruits to avoid bruises.</td>
</tr>
<tr>
<td></td>
<td>• Don’t delay harvesting of fruits.</td>
</tr>
<tr>
<td></td>
<td>• Keep the trees as free as possible from mechanical wounds, winter injury, crotch separation and cankers.</td>
</tr>
<tr>
<td></td>
<td>• Collect and destroy the fallen fruits.</td>
</tr>
<tr>
<td></td>
<td>• Remove and destroy all the mummified fruits, dead fruits and pruned materials from the orchards</td>
</tr>
</tbody>
</table>

Note: Pesticides dosage use is based on high volume sprayer. The recommended chemicals given are as per CIBRC list updated on 31.10.2014.

** Pests of regional significance

V. INSECTICIDE RESISTANCE AND ITS MANAGEMENT

Insecticide resistance: Resistance to insecticides may be defined as ‘a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species’ (IRAC). Cross-resistance occurs when resistance to one insecticide confers resistance to another insecticide, even where the insect has not been exposed to the latter product.

Causes of resistance development: The causes and rate at which insecticide resistance develops depend on several factors, including the initial frequency of resistance alleles present in the population, how rapidly the insects reproduce, the insects’ level of resistance, the migration and host range of the insects, the insecticide’s persistence and specificity, and the rate, timing and number of applications of insecticide made. For instance, insect pests that survive in large populations and breed quickly are at greater advantage of evolving insecticide, especially when insecticides are misused or over-used.

General strategy for insecticide resistance management: The best strategy to avoid insecticide resistance is prevention and including insecticide resistance management tactics as part of a larger integrated pest management (IPM) approach.

1) Monitor pests: Monitor insect population development in fields to determine if and when control measures are warranted. Monitor and consider natural enemies when making control decisions. After treatment, continue monitoring to assess pest populations and their control.

2) Focus on AESA. Insecticides should be used only as a last resort when all other non-chemical management options are exhausted and P: D ratio is above 2: 1. Apply biopesticides/chemical insecticides judiciously after observing unfavourable P: D ratio and when the pests are in most vulnerable life stage. Use application rates and intervals as per label claim.

3) Ecological engineering for pest management: Flowering plants that attract natural enemies as well as plants that repel pests can be grown as border/intercrop.

4) Take an integrated approach to managing pests. Use as many different control measures as possible viz., cultural, mechanical, physical, biological etc. Select insecticides with care and consider the impact on future pest populations and the environment. Avoid broad-spectrum insecticides when a narrow-spectrum or more specific insecticide will work. More preference should be given to green labeled insecticides.

5) Mix and apply carefully. While applying insecticides care should be taken for proper application of insecticides in terms of dose, volume, timing, coverage, application techniques as per label claim.

6) Alternate different insecticide classes. Avoid the repeated use of the same insecticide, insecticides in the same chemical class, or insecticides in different classes with same mode of action and rotate/alternate insecticide classes and modes of action.

7) Preserve susceptible genes. Preserve susceptible individuals within the target population by providing unsprayed areas within treated fields, adjacent “refuge” fields, or habitat attractions within a treated field that facilitate immigration. These susceptible individuals may outcompete and interbreed with resistant individuals, diluting the resistant genes and therefore the impact of resistance.
### VI. NUTRITIONAL DEFICIENCIES

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Description</th>
<th>Correction measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen:</strong></td>
<td>Stunted growth of plants with pale green to light yellow color (chlorosis) appearing first on older leaves. Depending on the severity of deficiency, the chlorosis results in the drying and dropping of the older leaves.</td>
<td>Foliar spray of Urea @ 1-2 % at fortnightly intervals.</td>
</tr>
<tr>
<td><strong>Phosphorus:</strong></td>
<td>Symptoms appear on older leaves. The leaves are small and narrow with purplish or bronze discolouration. Leaves develop necrotic areas and fall off.</td>
<td>Foliar spray of DAP@2%.</td>
</tr>
<tr>
<td><strong>Potassium:</strong></td>
<td>Chlorosis along the edges of leaves (leaf margin scorching) occurs first in older leaves. Plants deficient in K will have weak stems with slow and stunted growth. The size and quality of fruits produces are poor which leading to reduced yield.</td>
<td>Foliar spray of KCl@1-2%.</td>
</tr>
<tr>
<td><strong>Magnesium:</strong></td>
<td>Yellowish blotch near the base of leaf, midrib and the outer edge. The leaves become entirely yellow and defoliate.</td>
<td>Foliar spray of MgSO4@1-2%.</td>
</tr>
<tr>
<td><strong>Sulphur:</strong></td>
<td>Younger leaves are chlorotic with evenly, light coloured veins. Plant growth is retarded and maturity is delayed. Plant stems are stiff, thin and woody. Symptoms may be similar to N deficiency and are most often found in sandy soils.</td>
<td>Soil application of gypsum @100 Kg/ acre.</td>
</tr>
<tr>
<td><strong>Iron:</strong></td>
<td>Thin and smaller younger leaves with interveinal chlorosis. Green tinge at the base of mid rib. Later the leaves become pale or whitish and shed. Older leaves remain green, fruits are and coarse light coloured.</td>
<td>Foliar spray of FeSO4 @ 0.5%.</td>
</tr>
<tr>
<td><strong>Manganese:</strong></td>
<td>Symptoms first appear as chlorosis in young tissues. Unlike iron chlorosis symptoms, Mn chlorosis shows up as tiny yellow spots.</td>
<td>Foliar spray of MnSO4 @1% at fortnightly interval.</td>
</tr>
</tbody>
</table>
VII. COMMON WEEDS

1. Tropical spider wort: *Commelina benghalensis* L. (Commelinaceae)

2. Creeping wood sorrel: *Oxalis corniculata* L. (Oxalidaceae)

3. Goat weed: *Ageratum conyzoides* L. (Asteraceae)

4. Congress grass: *Parthenium hysterophorus* L. (Asteraceae)

5. Bermuda grass: *Cynodon dactylon* (L.) Pers. (Poaceae)

6. Cogon grass: *Imperata cylindrica* (L.) Raesusch. (Poaceae)

7. Blanket grass: *Axonopus compressus* (Sw.) Beauv. (Poaceae)

8. Crab grass: *Digitaria sanguinalis* (L.) Scop. (Poaceae)

9. Knot grass: *Paspalum distichum* L. (Poaceae)
10. Sow thistles: *Sonchus* spp. (Asteraceae)

11. Purple nutsedge: *Cyperus rotundus* L. (Cyperaceae)

12. Pig weed: *Amaranthus viridis* L. (Amaranthaceae)

13. Brambles: *Rubus* spp. (Rosaceae)

14. Spurge: *Euphorbia hirta* L. (Euphorbiaceae)

15. Common sorrel: *Rumex dentatus* L. (Polygonaceae)

16. Lambs quarter: *Chenopodium album* L. (Chenopodiaceae)

17. Flat sedge: *Cyperus iria* L. (Cyperaceae)

18. Canary grass: *Phalaris minor* (Poaceae)

VIII. DESCRIPTION OF INSECT PESTS

1) Flat headed borer:

Biology:
Egg: The female lays yellow disk-like wrinkled eggs from May to August in cracks in the bark of trees, nearly always selecting a tree that is unhealthy, or a spot on a healthy tree where the bark has been injured, i.e. by sunscald or a bruise. Egg period is 2-3 weeks.

Larva: Upon hatching the larvae bore directly into the bark underneath the egg. If the tree or shrub is in a weakened condition or the bark has been badly damaged, the larva bores into the inner phloem, making irregular tunnels which become partially filled with powdery frass. The full-grown larva is about 1/2 inch in length, legless, yellow to yellowish-white color with a broad, flat enlargement of the body just back of the head from which the beetle name is derived - flat headed borers.

Pupa: The pupae overwinter within the galleries where they transform into adults which emerge from late spring through summer.

Adult: The adult beetles emerge from infested trees from spring through summer. The adults are dull bronze in color with metallic copper-colored spots on the wing covers. They are from 1/4 to 1/2 inch long. They fly for about 3-5 weeks and make a buzzing sound when flying. They are active insects, and will quickly conceal themselves or fly away when approached. Being sun lovers, they are inactive and rarely seen on cloudy days. The adults feed on pollen, foliage, or tender bark of trees and at times they may cause defoliation.

Life cycle:

Damage symptoms:
- Flat headed borers attack weakened or stressed plants.
- A single larva is capable of girdling and killing a young tree.
- Adult feeding may cause some defoliation, but the major damage to the plant is caused by larval feeding which creates galleries (mines) between the bark and the wood.
- The galleries are usually filled with coarse, excelsior-like fibers.
- The galleries, which nearly always begin on the sunny side of the tree, may extend completely around the tree thus girdling and killing the tree or infested branches.
- A full-grown larva may bore from 1 to 2 inches deep in the wood of the tree.
- Bark exterior to the galleries or mines may die and peel off.
- Sap may exude from these dark coloured dead areas of bark.
- The darkened areas of bark and fine bits of sawdust protruding through the bark indicate the presence of wood boring larvae.

*For management refer to page number 20.

2) Hairy caterpillar:

Hairy caterpillar populations will go through cycles in which the populations will increase for several years then decline, and then increase again. Area-wide outbreaks can occur for up to ten years, but generally population densities in localized areas remain high for two to three years.

Biology:
Egg: Females lay between 500 to 1000 eggs in sheltered areas such as underneath the bark of trees. The eggs are covered with a dense mass of tan or buff-colored hairs. The egg mass is approximately 3.75 cm long and 1.62 cm wide. The eggs are the overwintering stage of the insect. Eggs are attached to trees, houses, or any outdoor objects. The eggs hatch in spring (April) into caterpillars.
Larva: Hairy caterpillars are easy to identify, because they possess characteristic hairs not found on other leaf-feeding caterpillars. They have five pairs of blue dots followed by six pairs of red dots lining on the back side. In addition, they are dark-colored and covered with hairs. Young caterpillars primarily feed during the day whereas the older caterpillars feed at night. When present in large numbers, the older caterpillars feed day and night. Young caterpillars spread to new locations by crawling to the tops of trees, where they spin a silken thread and are caught on wind currents. Older caterpillars are approximately long. Larval period 66-100 days.

Pupa: In early summer (June to early July), hairy caterpillars enter a pupal or transitional stage. The pupae are dark brown, shell-like cases approximately 5 cm long and covered with hairs. They are primarily located in sheltered areas such as tree bark crevices or leaf litter. Pupal period is 10-14 days.

Adult: Females have white to cream-colored wings, a tan body, and a two-inch wingspan. Female moths cannot fly. Males, which are smaller than females, with 3.75 cm wingspan, are dark-brown and have feathery antennae. Both the adult female and male can be identified by the inverted V-shape that points to a dot on the wings. Moth has only one generation per year.

Life cycle:

Damage symptoms:
- Caterpillars are gregarious and voracious feeders.
- They eat voraciously on leaves at night time.
- Under heavy infestation entire leaf is eaten sparing only hard vein (skeletonization).
- Defoliation of host completely results in failure of fruit formation.

Natural enemies of hairy caterpillar:
Parasitoids: Telenomus sp, Cotesia melanoscela, Glyptapantelos sp, Pales spp. (Tachinid fly), Brachymeria sp etc.

For management refer to page number 17.

3) Defoliating beetles:

Biology:
Egg: Females lay eggs (app. 60) in soil in June and the 12-50 mm size eggs develop into larvae and are especially attracted to compost and manure piles. The eggs are whitish in appearance and be easily found over the soil. The egg period is 12 days.

Larva: They have head and legs. They live on soil surface and have a length of 2 inches. Their life includes three instars of which first and second get completed by autumn and the final in the spring season of second year. At rest they curl into C shape. When the larvae get matured they become 2 inches long and become cream colour. The body of larvae is stiff with brown hairs at the back of the thorax. These hairs are used for locomotion. They form hollow cells in the soil and pupate there. After a few days it reaches a size of 12-50 mm.

Pupa: Pupae develop by June-July. Its duration extends from 25-27 days. The pupae are of size 15 X 25 mm. They are whitish at initial stages and further change to cream colour as that of larvae stage. At the maturing stages they slightly shift the colour to green.

Adult: Adult emerge by June- November. Adults are velvet green in colour. Brownish bands are present around the edge of the wings and a bright metallic green at the ventral side. Adult females are 17 X 25 mm and adult males are 13 X 22 mm in size. At the head portion they are equipped with horn like projections for penetrating into the fruit skin. Adults are tremendous fliers.
Damage symptoms:
- The plant part affected mainly includes flower parts like pollen, petals and fruit.
- Larvae damage roots.

**Adult**
http://southwoodsforestgardens.blogspot.in/2014/12/beneficial-habitat-beetle-banks.html

*For management refer to page number 17.

### 4) Plum/peach leaf curl aphid:

**Biology:**

**Egg:** Females lay 2.5 eggs at bud base. Oviposition takes place from October until strong frosts. Overwintering takes place in egg. Eggs are located at bud base on young shoots of fruit trees.

**Nymph:** It lasts 6-11 stage days.

**Adults:** Pear-shaped body of apterous female is yellow-green. Its length varies from 1.5 to 2.0 mm. The insect has no visible marginal tubercles, but sometimes has 2 medial tubercles on 8th or both 7th and 8th segments of abdomen. Light 6-segmented antenna (with dark last segment) is half as long as body. There are no tubercles and flutes on flat frons. Covers are located on short, conic, dark-green siphunculi. The species has light, very short tail (as wide as long). Legs are light; but apices of femora, tarsi, and tibiae are dark. Life span of apterous females is about 24-49 days (depending on generation and meteorological conditions) their fecundity varies from 40 to 110 nymphs. Body of winged female reaches to 1.3-1.8 mm. Its head and thorax are dark; but its abdomen is green, with a dark spot on 3rd-6th segments. Round dark spots are also located on segments laterally. Dark antenna is 3/4 the body length. The aphid has dark visible tubercle on frons. Cylindrical siphunculi are dark, with covers. Both winged and wingless form breed parthenogenetically by producing the young ones.

**Life cycle:**

1. **Eggs**
2. **Nymphs**
3. **Adult**
   14-21 days

**Plum/peach leaf curl aphid:**
Brachycydaus helichrysis


**Damage symptoms:**
- Damage is severe because the aphid colonizes young shoots, buds, grafts and young plants.
- Nymphs and adults suck the sap from leaves, shoots and fruits
- It causes tightly curled leaves
- Wilting of terminal shoots and can stunt tree growth

**Natural enemies of leaf curling aphid:**

**Predators:** Scymnus, Chilomenes sexmaculatus, Chrysoperla zastrowii sillemi and other coccinellids, Preying mantids, ladybird beetles, Predatory mite and parasitic wasps etc.

*For management refer to page number 17.*
5) Mealy plum aphid:

Biology:

**Egg:** The eggs are deposited in small proportions on the trunks and branches of primary hosts and hatch in mid-April. 2-3 generations of apterae follow each other, dense colonies infesting the underside of leaves which exhibit only slight curling and take on a pale green colour.

**Nymph:** Look similar to adult but without wings and smaller in size. They feed on foliage.

**Adult:** Eggs hatch during bloom and wingless adults develop. 2.5-3 mm long; egg-shaped, narrow, pale green and mealy-coated; eyes brownish-red; antennae as long as half the body; cauda cone-shaped and twice as long as siphunculi; siphunculi twice as long as broad. Winged adults appear in June and July, as warm weather approaches, and migrate to reed grass or cattails. In fall, winged adults return to apricot trees where wingless females develop and mate with winged male.

**Life cycle:**

![Life cycle diagram](http://influentialpoints.com/Images/Hyalopterus_pruni_apterae_and_nymphs_paving_leaf_on_Prunus_institia.JPG)

**Damage symptoms:**

Infestations spread to the foliage, causing premature leaf fall, an atrophy of fruits and a significant loss of vigour of trees.

6) Green peach aphid:

Biology:

**Egg:** Eggs are deposited on trees. The eggs measure about 0.6 mm long and 0.3 mm wide, and are elliptical in shape. Eggs initially are yellow or green, but soon turn black. Mortality in the egg stage sometimes is quite high.

**Nymph:** Nymphs initially are greenish, but soon turn yellowish, greatly resembling viviparous (parthenogenetic, nymph-producing). Nymphs go through four instars with duration of each averaging to 2, 2.1, 2.3 and 2 days respectively.

**Adults:** Up to 8 generations may occur on Prunus in the spring, but as aphid densities increase winged forms are produced, which then disperse to summer hosts. Winged (alate) aphids have a black head and thorax, and a yellowish green abdomen with a large dark patch dorsally. They measure 1.8 to 2.1 mm in length. Winged green peach aphids seemingly attempt to colonize nearly all plants available. They often deposit a few young and then again take flight. This highly dispersive nature contributes significantly to their effectiveness as vectors of plant viruses.

**Life cycle:**

![Life cycle diagram](http://entnemdept.ifas.ufl.edu/creatures/veg/aphid/green_peach_aphid.htm)

**Damage symptoms:**

- Green peach aphids can attain very high densities on young plant tissue, causing water stress, wilting, and reduced growth rate of the plant.
- Prolonged aphid infestation can cause appreciable reduction in yield of root crops and foliage crops. Early season infestation is particularly damaging to potato, even if the aphids are subsequently removed.
- Contamination of harvestable plant material with aphids, or with aphid honeydew, also causes loss. Blemishes to the plant tissue, usually in the form of yellow spots, may result from aphid feeding.
Natural enemies of green peach aphid:
Parasitoid: Aphelinus spp.
Predators: Syrphid fly, lygaeid bug, coccinellid, lacewing
*For the management refer page no 18.

7) Apricot brown scale:

Biology:
Egg: The eggs are pink to dark red and they are laid under the adult female scale’s wax covering.
Nymph: The first instars are called crawlers. Crawlers are pink and as soon as they hatch, the first instars disperse, find a suitable feeding place and settle. The wax scale females develop through the second and third instars before becoming adults. The wax covering secreted around them gives them a star-like appearance. Nymphs are found on the leaves and twigs.
Adult: The adult scales are elliptical, reddish brown with short anal process. The adult female is coated with a thick layer of pinkish-white wax. Inside the wax, the body of the adult female is reddish. Adults are mostly found on twigs and branches. The size of the female is about 2 to 4 mm in length and 1 to 3.5 mm in width. Males are not known in this species.

Life cycle:
1. Eggs
2. Nymphs
3. Adults

Damage symptoms:
- The direct damage is caused by insertion of stylets into the stem/twig/shoot during feeding by the nymphs, which can cause premature leaf drop and twig dieback.
- High populations can cause host death. Severe infestations may result in shoot or branch dieback.
- When large populations of scale occur, sooty mold may become a problem due to the mold's growth on the large quantities of honeydew excreted by these scales.

Natural enemies of apricot brown scale:
Predator: Ladybird beetle, lacewings and mites etc.
*For management refer to page number 17.

8) San Jose scale:
Pest of 700 different species of fruits, shrubs and ornamental plants. Pest is active from March to December. Passes winter black cap stage in tree bark.

Biology:
Nymph: Female San Jose scales give birth to living young ones that emerge from under the edge of the scale covering. These tiny yellow crawlers wander in a random fashion until they find a suitable place to settle. Immediately upon settling, the crawlers insert their mouthparts into the host plant and begin feeding and secreting a white waxy material (white capstage); eventually the waxy covering turns black and is known as the black cap stage. Later the covers turn various shades from gray to black. Immature male and female scales are indistinguishable until the first molt. At this time, the male scale covering begins to elongate, while the females remain circular. Males molt a total of four times.
Adult: Following the final molt, adult male scales emerge from the scale covering as tiny, yellow winged insects. They mate with the females who remain under the scale covering. Female insect body covered with grey scales. Yellow lemon coloured female is visible when covering is lifted.
Female scales are very prolific and over a 6-week period can produce 200-400 young ones. San Jose scale produces living young ones called crawlers; most other scales produce eggs. It takes 25 days for males to mature and 31 days for females. Five to six generations in a year.

**Life cycle:**


**Damage symptoms:**

- Nymph and female scales attack all above ground parts.
- Feeding site turns into a characteristic purplish red colour.
- Initially, growth of plant is checked but as scale increases in number plant may die.
- Fruits will have distinct “measles” like spots on the surface.

**Natural enemies of San Jose scale:**

Parasitoids: Encarsia pergiosi, Aphytis diaspis etc.

Predators: Coccinellid, Pharsocymnus flexibilis & Chilocorus bijugus etc.

* For the management refer page no 17.

9) Tent caterpillar:

**Biology:**

**Egg:** In late spring or early summer, female moths deposit an egg mass (200-400 eggs) encircling small twig or on tree trunk. Egg masses are present on trees during most of the summer, fall and winter. The adult moth uses a sticky, frothy substance called spumaline as an adhesive to attach eggs to trunk bark or twigs. Spumaline is used as a hard protective covering around the egg mass. Pest inactive from March – May. In egg stage they pass 9 month of year.

**Larva:** Caterpillars hatch from the eggs in early spring about the time host plants leaf out. The tent caterpillar feed on new leaves, forming small webs within a few days after hatching and enlarging the webs as they grow. The web or tent is most often in a crotch of small limbs, and serves as a refuge for the larvae during the night and during rainy spells. Larvae move from the tents to feed on leaves, so damage can be found for some distance around the web. Tent caterpillars feed in groups, and thus concentrate their defoliation. The tent caterpillars form conspicuous, large webs that are easily recognized. Molting, or skin shedding, occurs several times as the larvae grow. The larvae do not live in these small webs at other times.

**Pupa:** During the last stage of larval development, which occurs in late spring, larvae wander considerable distances and may feed on a variety of tree, shrubs and even herbs before finding a site for pupation, or cocoon spinning. Cocoons are formed in the web, under bark, in dead plant material on the ground, or inside a rolled leaf. Cocoons are loosely constructed of silk and have a white or yellowish crystalline substance scattered throughout the mass. Cocoons should not be handled since the crystalline substance may cause skin irritation, especially to people with allergies.

**Adult:** Adult tent caterpillars are brown and yellowish moths with two distinct cross line running parallel on forewing. The distinct wing span is about 1 inch. They are attracted to light and can occasionally be very abundant. Adults do not feed. There is only one generation of tent caterpillars per year. Males are short lived and female may survive for 2 to 5 days.

**Damage symptoms:**

- Caterpillars during night rest at their nest and during day time they feed on leaves.
- In severe infestation, the entire plant may be defoliated and subsequently the caterpillar may feed on bark of twigs.
- In severe infestation, 40-50 per cent plants in orchard may be defoliated producing a poor harvest.

For the management refer page no 18.
**AESA based IPM – Peach**

**Life cycle:**

1. **Eggs**
2. **Larvae**
3. **Pupa**
4. **Adult**
   - Female: 2-5 days

**Damage symptom**

**Natural enemies of tent caterpillar:**
- Parasitoids: Tachnid fly (Pales sp) etc.

**Natural enemies of blossom thrips:**
- Predators: Coccinellid, predatory thrips, anthocorid bug, Lygaeid bug (*Tropidothorax leucopterus*)

**Biology:**

**Egg:** Adult deposit about 200 eggs singly within the plant tissue.

**Larva and pupa:** Larvae have two stages, which feed on plant tissues by rasping and sucking. The second instar larvae, when mature, fall to ground, where they molt to prepupae and then to pupae in the soil.

**Adult:** After emergence, the adults move to the growing parts of the plants such as young leaves, flowers, or young fruits, where they feed and lay eggs. Adults are usually found on young leaves, while larvae are found on lower or older leaves. Adults are winged, rasping sucking insects, ranging from 5-14 mm in length. Their slender bodies are shiny pale or black with silver stripes. Life cycle completed in 11-43 days. Produce many generations in a year. At 25°C, the life cycle is completed in approximately 17 days. In colder region, life cycle is longer with fewer generations.

**Damage symptoms:**
- Most species of plant feeding thrips, have rasping and sucking mouthparts.
- Both nymphs & adults lacerate all floral parts and tender leaves, vegetative buds. Consequently brown spots develops
- The surface of the leaf develops a crinkled silvery appearance as a result of damage to cells below the surface.
- Lightly-infested plants show silvery feeding scars on the under surface of leaves, especially alongside the mid rib and veins.
- Heavily-infested plants show silvering and browning of leaves, stunting of young leaves and terminal growth, with fruit scarred and deformed.
- Developing leaves become distorted in the growing tips.
- Heavily infested flowers bear sticky and faded appearance with indication of early senescence.

*For the management refer page no 18.*
11) Fruit fly

**Biology:**

**Egg:** Female flies insert eggs under the skin of fruit in clusters of 10 to 50 about 1/25 to 1/8 inch below the fruit surface. The eggs measure about 1/25 by 1/250 inch and are white, elongate, and elliptical. They hatch in 1-1/2 days.

**Maggot:** The white maggot is legless, and resembles an elongated cone. The mouth is at the pointed end of the body. There are 3 larval stages, or instars. The third instar is about 2/5 inch long. The entire maggot stage lasts for 11-15 days.

**Pupa:** When mature, maggot drops to the ground and pupate in the soil. The puparium is yellowish-brown and seed-like. Adults emerge in about 10 days.

**Adult:** Generally, the abdomen has two horizontal black stripes and a longitudinal median stripe extending from the base of the third segment to the apex of the abdomen. These markings may form a "T" shaped pattern, but the pattern varies considerably. Females begin to lay eggs about 8 days after emergence from the puparium. Under optimum conditions, a female can lay more than 3,000 eggs during her lifetime, but under field conditions approximately 1,200 to 1,500 eggs per female is considered to be the usual production. Ripe fruit are preferred for egg laying, but immature ones may be also attacked.

**Life cycle:**

![Fruit fly life cycle diagram](http://entnemdept.ufl.edu/creatures/fruit/tropical/bactrocera_dorsalis)

**Damage symptoms:**

- The female punctures outer wall of mature fruits with the help of its pointed ovipositor and insert eggs in small clusters inside mesocarp of mature fruits.
- On hatching, the maggots feed on fruit pulp and the infested fruits start rotting due to further secondary infection.

**Natural enemies of fruit fly:**

**Parasitoids:** Fopius arisanus, Diachasmimorpha kraussii etc.

*For management refer to page no 22.

12) Termites:

**Biology:**

**Egg:** Eggs are dull, kidney shaped and hatch in 30-90 days.

**Nymph:** Nymphs moult 8-9 times and are full grown in 6-12 months.

**Adult:** Adults are creamy coloured tiny insects resembling ants with dark coloured head.

**Life cycle:**

![Termites life cycle diagram](http://www.termitenewyorkcity.com/more-about-termites/life-cycle/)

**Damage symptoms:**

- Termites chew and eat stem cuttings.
- Affected stem cuttings grow poorly, die and rot.
- In older plants, termites chew and enter the stems.
- This weakens the stems and causes them to break easily.
- Termite damage occurs mostly in the dry season.
Biological control of termites through EPNs:
EPNs seek out and kill all stages of harmful soil-dwelling insects. They can be used to control a broad range of soil-inhabiting insects and above-ground insects in their soil-inhabiting stage of life. The IJs emerge from cadaver, search for termites, infect, kill and again multiply and remain in the moist soil. Termites which are major pests in sugarcane can be managed by using EPNs effectively. EPN can be produced even at farmer level using either *Galleria* or *Corcyra* as a host.

Mass multiplication of EPNs

Emergence of EPNs

Termite killed by EPNs

*For management refer to page number 15.

13) Peach fruit borer:

Biology:
**Egg:** Eggs are pink, oval, flat laid singly or in group on leaves and other soft and tender parts of the plant. The eggs hatch in 2-6 days.

**Larva:** The larvae pass through 4–5 instars and are full-fledged in 12- 16 days. Fully grown larvae are light brown with sparse hairs.

**Pupa:** Pupation takes place inside the seed or sometimes in the grass that collects after feeding. Pupation takes place in lose silken cocoon in larval tunnel. The pupal stage lasts about 7-10 days.

**Adult:** It is a medium sized moth with a wingspan of about 20 mm; the wings are orange-yellow with minute black spots. Three generations are completed in a year.

Life cycle:

Damage symptoms:
- The larvae bore into fruit and feed on internal tissues.

Favourable conditions:
- Temperature range 30 - 33°C and relative humidity range 60 - 90%.

Natural enemies of peach fruit borer:
**Parasitoids:** *Xanthopimpla quadridens*, *Bracon brevicornis*, *Mysoma* sp., *Apanteles* sp. etc.

**Predators:** *Chrysoperla* zastrowii sillemi, Braconid wasp, dragonfly, spider, robberfly, reduviid bug, praying mantid, red ant, ladybird beetle, king crow etc.

*For management refer to page no 22.
14) Codling moth:

Depending on the climate, codling moth can have two, three, and sometimes four generations per year.

**Biology:**

**Egg:** Eggs are deposited singly on fruit and leaves. Each egg is about the size of a pin head and is translucent, gradually darkening as the egg nears hatching. Eggs hatch in six to 14 days, depending on temperature. The number of eggs laid per female ranges from 30 to 70.

**Larva:** Within 24 hours of hatching the larvae burrow into the fruit. The first instar larvae have a pink body with a black head and are approximately 1/10 inch in length. Codling moth overwinters as full-grown larvae within thick, silken cocoons under loose scales of bark and in soil or debris around the base of the tree. Larvae appears to be cannibalistic. Full grown larva pinkish or creamy white with brown head and pupates in the soil litter.

**Pupa:** After completing development they leave the fruit and drop from the trees to search out pupation sites and continue the life cycle in the soil or on debris under the tree; some crawl back up the tree to pupate in bark crevices. The larvae pupate inside their cocoons in early spring.

**Adult:** Emerge mid-March to early April. The moths are active only a few hours before and after sunset, and they mate when sunset temperatures exceed 62°F. Adults are about 1/2 to 3/4 inch long with mottled gray wings that they hold tent like over their bodies. Their appearance blends well with most tree bark, making them difficult to detect. If you are trapping the adults, you can distinguish codling moth from other moths by the dark, coppery brown band at the tip of their wings. Adult forewings are dark grayish with waxy lines with a copper colored eye like circle toward margin.

**Life cycle:**

![Life cycle diagram](image)

**Damage symptoms:**

- It is a direct pest and hence causes severe damage to the fruit.
- Neonate larva enters the fruit through calyx and feeds on seed.
- Infested fruits lose their shape and fall prematurely.

**Natural enemies of codling moth:**

- **Parasitoid:** Trichogramma embryophagum, T. cacaceae etc.
- **Predators:** Parus major, Passer domesticus, birds etc.

*For management refer to page number 21.

15) Root-knot nematode:

- Most species of plant parasitic nematodes have a relatively simple life cycle consisting of the egg, four larval stages and the adult male and female. They are microscopic in size.
- Development of the first stage larvae occurs within the egg where the first moult occurs. Second stage larvae hatch from eggs to find and infect plant roots or in some cases foliar tissues.
- Under suitable environmental conditions, the eggs hatch and new larvae emerge to complete the life cycle within 4 to 8 weeks depending on temperature.
- Nematode development is generally most rapid within an optimal soil temperature range of 70 to 80°F.
Life cycle:
Life stages are microscopic in size

Damage symptom:
• Formation of galls on host root system is the primary symptom
• Roots branch profusely starting from the gall tissue causing a ‘beard root’ symptom
• Infected roots become knobby and knotty
• In severely infected plants the root system is reduced and the rootlets are almost completely absent. The roots are seriously hampered in their function of uptake and transport of water and nutrients
• Plants wilt during the hot part of day, especially under dry conditions and are often stunted
• Seedlings infected in nursery do not normally survive transplanting and those surviving have reduced flowering and fruit production
• Nematode infection predisposes plants to fungal and bacterial root pathogens

Survival and spread:
Primary: Egg masses in infected plant debris and soil or collateral and other hosts like Solanaceous, Malvaceous and Leguminaceous plants act as sources of inoculum
Secondary: Autonomous second stage juveniles that may also be water dispersed

Favourable conditions:
• Loamy light soils

*For management refer to page no 16.

Natural Enemies of Peach Insect Pests
Parasitoids

Egg parasitoid

1. Trichogramma embryophagum
2. Trichogramma cacaceae
3. Telenomus spp.
Pupal parasitoids

4. Pales spp.
5. Brachymeria spp.

Nymphal/larval and adult parasitoids

6. Fopius arisanus
7. Diachasmimorpha sp.
8. Bracon brevicornis

9. Xanthopimpla sp
10. Encarsia perniciosi
11. Aphytis diaspidis

Predators

1. Lacewing
2. Ladybird beetle
3. Reduviid bug
4. Spider
5. Robber fly
6. Red ant
7. Black drongo
8. Common mynah

9. Big-eyed bug (Geocoris spp.)
10. Earwig
11. Ground beetle
12. Pentatomid bug

13. Preying mantid
14. Damsel bug
15. Predatory mite
16. Predatory thrips

17. Oligota spp.
18. Orius spp.
19. Hover fly
20. Mirid bug

IX. DESCRIPTION OF DISEASES

1) Frosty mildew:

**Disease symptoms:**
- Irregularly shaped necrotic lesions were observed on leaves in orchard.
- The main signs and symptoms are expressed as conical white to cream coloured tufts of the causal fungus on the brown lesions, followed by premature defoliation.

**Survival and spread:**
- Pathogen does not overwinter on apricot; primary inoculum comes from infected roses in spring. Remove nearby roses to reduce sources of inoculum

**Favourable condition:**
- Relative humidity 100% and temperature is 18°C

*For the management refer page number 18.

2) Powdery mildew:

**Disease symptoms:**
- Powdery mildew appears as web like white growth on fruit, leaves, and stems. Older lesions on fruit are scabby.
- Yellowing or distortion of leaves, stunted shoot growth, reduced yield
- White powdery residue, which is a mixture of the fungal mycelium and spores on leaves and fruit.

**Survival and spread:**
- *Sphaerotheca pannosa* does not overwinter on peach. Primary inoculum comes from infected roses in spring. Remove nearby roses to reduce sources of inoculum.

**Favourable conditions:**
- The disease is more under dry condition to the end of the winter months.

*For the management refer page number 19.
3) Coryneum blight/shot hole:

**Disease symptoms:**

- Infections on leaves will develop small round purple to tan lesions that are seldom 1/4 of an inch in diameter.
- Infected tissues can become raised and scurfy will often drop out as the diseased tissue cannot expand with the growing leaf.
- Lesions can be circular to slightly ellipsoid. These diseased leaf tissues will tear along the lesion margins and may hang on at one attached point, but eventually drop out giving the shot hole appearance.
- Infected buds will often develop a canker that can expand to girdle the twig and kill it.
- Often infected buds will show signs of gumming.
- These infected buds are easily recognized as they are often darker than healthy non-infected buds.
- Infection on fruit often appears first as small purple spots that become white to gray lesions, often accompanied by gumming.
- Infections on fruit degrades their quality and often will result in the loss of the fruit.

![Disease symptoms (Infected fruit and leaves)](http://utahpests.usu.edu/plugins/work/blogger/17/images/tf-2012/09-27/coryneum-peach-2012.JPG)

**Survival and spread:**

- The fungus survives within infected buds and on twigs. Spores are rain splashed and disease increases during the rainy season. Fruit infection is favored by wet spring weather.
- Shot hole is often confused in coastal orchards with fog spot. However, fog spot, does not cause leaf lesions, and the lesions it causes on fruit have a red margin.

**Transmission and favourable conditions:**

- The fungal pathogen can infect a suitable host if moisture is continuous for 24 hours or longer at 36°F, meaning that infections can occur when host plants are still dormant.

*For the management refer page number 18.*
4) Silver leaf and canker:

**Disease symptoms:**
- Silver leaf causes dieback of a tree, branch by branch. Leaves appear silvery and a brown stain is produced in the inner tissue.
- The silvery leaves themselves are not infectious; their abnormal appearance is caused by toxins produced by the fungus in the wood of stems and branches.
- Often the fungus is not visible on the exterior, even on trees showing pronounced silvering.
- However, as the infected branches die, the fungus bursts through the bark and appears at the surface.
- The bracket-like toadstools are often numerous and more or less overlapping, varying in size from 8 mm to 5 cm across. Silver leaf is often confused with false silver leaf, a common disorder which as the name suggests looks like silver leaf at first glance.
- Leaves are silvery, but the effect appears all over the tree rather than progressively along a branch.
- A cut branch reveals that the staining of silver leaf disease is absent. The cause of false silver leaf is starvation, cold weather or irregular watering.

**Survival and spread:**
- The airborne spores of this fungus are released from the bracket-shaped fruiting bodies found on dead branches.
- These spores infect healthy branches through wounds, especially pruning cuts.
- The fungus grows down into the wood and kills it, producing a dark stain.

**Favourable conditions:**
- Spores are released mainly in the autumn and winter months under damp conditions.

*For the management refer page number 18.

5) White root rot:

**Disease symptoms:**
- Yellow foliage, shrunken fruit, and little or no new growth are symptoms of Dematophora root rot.
- Cottony, white mycelia cover small feeder roots, and roots decay. Mycelia grow into soil and upward in the tree, forming small, pale patches under or in bark of major roots, the root crown, and lower trunk, which eventually decay.
- Older mycelium become grey or black. The fungus can also cause a purple canker in wood at the root crown of young trees.
- Diseased trees will defoliate and always die prematurely, usually within 1 to 3 years of initial infection.

**Survival and spread:**
- The fungus persists for years in buried wood and organic matter in soil.
- It spreads to nearby trees through root grafts and can also be moved longer distances in infected soil or wood. Spores apparently are not important in causing disease

**Favourable conditions:**
- Spores are released mainly in the autumn and winter months under damp conditions.
6) Whisker rot:

Disease symptoms:
- *Rhizopus* rot begins much like brown rot as a small, brown, circular spot—but with a detectable difference.
- The skin of *Rhizopus* rot-infected fruit slips readily from the underlying flesh, while the skin of brown-rotted areas is tough and leathery.
- At normal temperatures, the small spots of *Rhizopus* rot enlarge rapidly and can involve the entire fruit in 24 to 48 hours.
- A white, whiskery mold appears on the surface of infected fruits, spreading to nearby fruit and the walls of the container.
- By this time, the fruit tends to leak and to smell like vinegar. Finally, tiny, black, spherical structures are produced on stalks above the white mold.
- Each of these contains thousands of spores that are released to float in the air. At this stage, the mold looks mostly black.

Survival and spread:
- An injury through the fruit skin must be present for the first infections to occur and injuries as tiny as the prick of a pin are sufficient.
- In packed fruit or clustered ripe fruit on trees, the fungus can spread over the uninjured skin from an infected nearby fruit and eventually cause a rot.

Favourable conditions:
- High temperatures and humidities favour the rapid growth of the fungus and the decay of the fruit.
7) Collar rot:

**Disease symptoms:**
- Symptom expression depends upon how much of the root or crown tissues are affected and how quickly they are destroyed.
- Generally, crown rots advance rapidly and trees collapse and die soon after the first warm weather of spring.
- Leaves of such trees wilt, dry, and remain attached to the tree. Chronic infections, usually of the roots, cause reduction in growth and early senescence and leaf fall.
- These trees may be unthrifty for several years before succumbing to the disease.
- *Phytophthora* infections typically kill young trees because their root systems and crown areas are small compared to those of mature trees.

**Survival and spread:**
- Periods of 24 hours or more of saturated soil favor *Phytophthora* infections.
- Conversely, good soil drainage and more frequent but shorter irrigations reduce the risk of root and crown rot.

**Favourable conditions:**
- These fungi are more active in soils with high moisture and in temperatures ranging from 13 to 21 °C.


*For the management refer page number 20.

8) Yellow disease:

**Disease symptoms**
- Leaf buds, even those which should normally remain dormant, develop prematurely. The leaves are yellowed, stunted and the tree forms spindly branched shoots.
- In an advanced stage of the disease, the shoot tips die back. Severely affected trees die within 2-3 years but survival for 6 years is possible.
- The disease caused by the little peach strain is slightly different. At the beginning of the growing season, the foliage is greener and proliferation of leaves on short side branches gives the tree a bushy appearance.
- The leaves become chlorotic during the season. The symptoms are first seen on one branch or part of the tree, then spread to the whole tree. Fruits ripen late (by up to 3 weeks) and are small and insipid.
**Disease symptoms**


**Survival & transmission:**
- The phytoplasma is transmitted by a leafhopper, *Macropsis trimaculata*. It has an incubation period of 1-3 years in trees in the orchard or less than 60 days.
- The pathogen is most likely to be spread internationally in infected planting material or possibly in vectors carried on plants.

*For the management refer page number 19.*

**Disease cycles:**

1. **Powdery mildew:**

2. **Coryneum blight/shot hole:**
X. SAFETY MEASURES

A. At the time of harvest:

Harvest indices: Attached to the tree: Peaches are best picked when the fruit separates easily from the twigs. If it is hard to pull off the tree, it is not ripe yet. Peaches will not ripen further once removed from the tree (they only "soften")

Colour: Green is definitely unripe, but you cannot use red colour as an indicator of how ripe a peach is. Different peach varieties have differing amounts of red blush in their natural colouring. Pick them when the ground colour changes from green to yellow, orange, red (or a combination). The skin of yellow-fleshed varieties ripens to an orange tint, while the skin of white-fleshed varieties changes from greenish- to yellow-white.

Softness: Unless you like your peaches very firm, pick your peaches with just a little "depress" when gently pressed. Peaches at this stage are great for eating, freezing, and baking. Peaches won't ripen very much after picking.

Odour: It should smell sweet and ripe.

Picking: A peach is softer than most fruit, so it is important to pick a peach gently, with little pressure. Using the sides of your fingers rather than your fingertips helps to avoid bruising. Grab the peach firmly and pull it straight off the branch. Do not drop the peach into the basket, but place it in gently.

B. During post-harvest storage:

Peaches should be transported from orchard to packinghouse and cooler as soon as possible after harvest. Clean the fruits at the packinghouse. Sort the fruits to eliminate fruit with visual defects and sometimes to transfer the fruit of high surface colour to a high-quality pack. While sorting out the fruits, close attention to details on sorting line need to be paid as peaches have a range of colours, sizes, and shapes. For size segregation, either weight or dimension needs to be considered. Pack the most of the yellow-flesh peaches into two layer (tray) boxes, while small size yellow-flesh peaches into volume-fill packs. Pack the most of the white-flesh and “tree ripe” peaches into one layer (tray) boxes.

Optimum storage conditions: The peaches should be stored at an optimum temperature of -1 to 0 °C (30.5-32 °F) and relative humidity of 90-95% and an air velocity of approximately 50 CFM.

### XI. DO’S AND DON’TS IN IPM

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Do’s</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be kept exposed to sun light at least for 2-3 weeks.</td>
<td>Do not plant or irrigate the field after ploughing, at least for 2-3 weeks, to allow desiccation of weed's bulbs and/or rhizomes of perennial weeds.</td>
</tr>
<tr>
<td>2</td>
<td>Grow only recommended varieties.</td>
<td>Do not grow varieties not suitable for the season or the region.</td>
</tr>
<tr>
<td>3</td>
<td>Always treat the seeds with approved chemicals/biopesticides for the control of seed borne diseases/pests.</td>
<td>Do not use seeds without seed treatment with biopesticides/chemicals.</td>
</tr>
<tr>
<td>4</td>
<td>Plant in rows at optimum depths under proper moisture conditions for better establishment.</td>
<td>Do not plant beyond 5-7 cm depth.</td>
</tr>
<tr>
<td>5</td>
<td>Apply only recommended herbicides at recommended dose, proper time, as appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.</td>
<td>Pre-emergent as well as soil incorporated herbicides should not be applied in dry soils. Do not apply herbicides along with irrigation water or by mixing with soil, sand or urea.</td>
</tr>
<tr>
<td>6</td>
<td>Maintain optimum and healthy tree stand which would be capable of competing with weeds at a critical stage of tree weed competition</td>
<td>Crops should not be exposed to moisture deficit stress at their critical growth stages.</td>
</tr>
<tr>
<td>7</td>
<td>Use NPK fertilizers as per the soil test recommendation.</td>
<td>Avoid imbalanced use of fertilizers.</td>
</tr>
<tr>
<td>8</td>
<td>Use micronutrient mixture after sowing based test recommendations.</td>
<td>Do not apply any micronutrient mixture after sowing without test recommendations.</td>
</tr>
<tr>
<td>9</td>
<td>Conduct AESA weekly in the morning preferably before 9 a.m. Take decision on management practice based on AESA and P: D ratio only.</td>
<td>Do not take any management decision without considering AESA and P: D ratio</td>
</tr>
<tr>
<td>10</td>
<td>Install pheromone traps at appropriate period</td>
<td>Do not store the pheromone lures at normal room temperature (keep them in refrigerator).</td>
</tr>
<tr>
<td>11</td>
<td>Release parasitoids only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation</td>
<td>Do not apply chemical pesticides within seven days of release of parasitoids.</td>
</tr>
<tr>
<td>12</td>
<td>In case of pests which are active during night spray recommended biocides/ chemicals at the time of their appearance in the night.</td>
<td>Do not spray pesticides at midday since, most of the insects are not active during this period.</td>
</tr>
<tr>
<td>13</td>
<td>Spray pesticides thoroughly to treat the undersurface of the leaves, particularly for mites, scales, thrips whiteflies, etc.</td>
<td>Do not spray pesticides only on the upper surface of leaves.</td>
</tr>
<tr>
<td>14</td>
<td>Apply short persistent pesticides to avoid pesticide residue in the soil and produce.</td>
<td>Do not apply pesticides during preceding 7 days before harvest.</td>
</tr>
<tr>
<td>15</td>
<td>Follow the recommended procedure of trap or border crops technology.</td>
<td>Do not apply long persistent on trap crop, otherwise it may not attract the pests and natural enemies.</td>
</tr>
</tbody>
</table>
## XII. SAFETY PARAMETERS IN PESTICIDE USAGE

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Pesticide Classification as per insecticide rules Colour of toxicity triangle</th>
<th>WHO classification of hazard</th>
<th>Symptoms poisoning</th>
<th>First Aid measures Treatment of poisoning</th>
<th>Waiting period from last application to harvest (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbofuran Externally toxic</td>
<td>Class Ib Highly hazardous</td>
<td>Constriction of pupils, salivation, profuse sweating, muscle in coordination, nausea, vomiting, diarrhea, epigastric pain, tightness in chest</td>
<td>Treatment of poisoning: Atropine injection 1-4 mg. repeat 2 mg when symptoms begin to recur (15-16 min interval) excessive salivation- good sign, more atropine needed</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><img src="poison_icon.png" alt="POISON" /></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Oxydemeton-methyl Highly toxic</td>
<td>Class Ib Moderately hazardous</td>
<td>Severe – diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.</td>
<td>First Aid measures: Atropine sulphate Treatment of poisoning: For ingestion lavage stomach with 5% sodium bicarbonate, if not vomiting. For skin contact, wash with soap and water (eyes – wash with isotonic saline). Wear rubber gloves while washing contact areas. In addition to atropine give 2 – PAM (2 – pyridine aldoximememet hiodide). 1 g and 0.25 g for infants intravenously at slow rate over a period of 5 minutes and administer again periodically as indicated. More than one injection may be required. Avoid morphine, theophylline, aminophyllin, barbiturates Phenothiazines</td>
<td>7 days</td>
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<tr>
<td></td>
<td><img src="poison_icon.png" alt="POISON" /></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
XIII. BASIC PRECAUTIONS IN PESTICIDE USAGE

A. **Purchase**
   1. Purchase only just required quantity e.g. 100, 250, 500, 1000 g/ml for single application in specified area.
   2. **Do not** purchase leaking containers, loose, unsealed or torn bags; **Do not** purchase pesticides without proper/approved labels.
   3. While purchasing insist for invoice/bill/cash memo

B. **Storage**
   1. Avoid storage of pesticides in house premises.
   2. Keep only in original container with intact seal.
   3. **Do not** transfer pesticides to other containers; **Do not** store expose to sunlight or rain water; **Do not** weedicides along with other pesticides
   4. Never keep them together with food or feed/fodder.
   5. Keep away from reach of children and livestock.

C. **Handling**
   1. Never carry/ transport pesticides along with food materials.
   2. Avoid carrying bulk pesticides (dust/granules) on head shoulders or on the back.

D. **Precautions for preparing spray solution**
   1. Use clean water.
   2. Always protect your nose, eyes, mouth, ears and hands.
   3. Use hand gloves, face mask and cover your head with cap.
   4. Use polythene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polythene bag contaminated with pesticides).
   5. Read the label on the container before preparing spray solution.
   6. Prepare the spray solution as per requirement
   7. **Do not** mix granules with water; **Do not** eat, drink, smoke or chew while preparing solution
   8. Concentrated pesticides must not fall on hands etc while opening sealed container. Do not smell pesticides.
   9. Avoid spilling of pesticides while filling the sprayer tank.
   10. The operator should protect his bare feet and hands with polythene bags

E. **Equipments**
   1. Select right kind of equipment.
   2. **Do not** use leaky and defective equipments
   3. Select right kind of nozzles
   4. Don't blow/clean clogged nozzle with mouth. Use old tooth brush tied with the sprayer and clean with water.
   5. **Do not** use same sprayer for weedicide and insecticide.

F. **Precautions for applying pesticides**
   1. Apply only at recommended dose and dilution
   2. **Do not** apply on hot sunny day or strong windy condition; **Do not** apply just before the rains and after the rains; **Do not** apply against the windy direction
   3. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer
   4. Wash the sprayer and buckets etc with soap water after spraying
   5. Containers buckets etc used for mixing pesticides should not be used for domestic purpose
   6. Avoid entry of animals and workers in the field immediately after spraying
   7. Avoid tank mixing of different pesticides

G. **Disposal**
   1. Left over spray solution should not be drained in ponds or water lines etc. throw it in barren isolated area if possible
   2. The used/empty containers should be crushed with a stone/stick and buried deep into soil away from water source.
   3. Never reuse empty pesticides container for any other purpose.
## XIV. PESTICIDE APPLICATION TECHNIQUES

<table>
<thead>
<tr>
<th>Equipments</th>
<th>Category A: Stationary, crawling pests/diseases</th>
<th>Category B: Field flying pests/airborne pests</th>
<th>Category C: Weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vegetative stage</strong></td>
<td><strong>Insecticides and fungicides</strong></td>
<td><strong>Insecticides and fungicides</strong></td>
<td><strong>Weedicide</strong></td>
</tr>
<tr>
<td>i) For crawling and soil borne pests</td>
<td>- Lever operated knapsack sprayer (droplets of big size)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hollow cone nozzle @ 35 to 40 psi</td>
<td>• Motorized knapsack sprayer or mist blower (droplets of small size)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lever operating speed = 15 to 20 strokes/min</td>
<td>- Airblast nozzle</td>
<td>• Lever operated knapsack sprayer (droplets of big size)</td>
</tr>
<tr>
<td></td>
<td>- or</td>
<td>- Operating speed: 2/3rd throttle</td>
<td>- Flat fan or floodjet nozzle @ 15 to 20 psi</td>
</tr>
<tr>
<td></td>
<td>- Motorized knapsack sprayer or mist blower (droplets of small size)</td>
<td>- or</td>
<td>- Lever operating speed = 7 to 10 strokes/min</td>
</tr>
<tr>
<td></td>
<td>- Airblast nozzle</td>
<td>- Battery operated low volume sprayer (droplets of small size)</td>
<td>- Trolley mounted low volume sprayer (droplets of small size)</td>
</tr>
<tr>
<td></td>
<td>- Operating speed: 2/3rd throttle</td>
<td>- Spinning disc nozzle</td>
<td>- Battery operated low volume sprayer (droplets of small size)</td>
</tr>
<tr>
<td>ii) For small sucking leaf borne pests</td>
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<tr>
<td>Reproductive stage</td>
<td><strong>Insecticides and fungicides</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lever operated knapsack sprayer (droplets of big size)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hollow cone nozzle @ 35 to 40 psi</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- Lever operating speed = 15 to 20 strokes/min</td>
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<tr>
<td><strong>Reproductive stage (Field Pests)</strong></td>
<td><strong>Insecticides and fungicides</strong></td>
<td><strong>Mosquito/ locust and spatial application (migratory Pests)</strong></td>
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<td></td>
<td></td>
<td><strong>Insecticides and fungicides</strong></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Fogging machine and ENV (exhaust nozzle vehicle) (droplets of very small size)</td>
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<td></td>
<td></td>
<td>- Hot tube nozzle</td>
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<tr>
<td>Category C: Weeds</td>
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<tr>
<td><strong>Post-emergence application</strong></td>
<td><strong>Weedicide</strong></td>
<td><strong>Weedicide</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lever operated knapsack sprayer (droplets of big size)</td>
<td>- Trolley mounted low volume sprayer (droplets of small size)</td>
<td></td>
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<tr>
<td></td>
<td>- Flat fan or floodjet nozzle @ 15 to 20 psi</td>
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<tr>
<td></td>
<td></td>
<td>- Spinning disc nozzle</td>
<td></td>
</tr>
<tr>
<td><strong>Pre-emergence application</strong></td>
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</tr>
</tbody>
</table>
### XV. OPERATIONAL, CALIBRATION AND MAINTENANCE GUIDELINES IN BRIEF

1. For application rate and dosage see the label and leaflet of the particular pesticide.

2. It is advisable to check the output of the sprayer (calibration) before commencement of spraying under guidance of trained person.

3. Clean and wash the machines and nozzles and store in dry place after use.

4. It is advisable to use protective clothing, face mask and gloves while preparing and applying pesticides. Do not apply pesticides without protective clothing and wash clothes immediately after spray application.

5. Do not apply in hot or windy conditions.

6. Operator should maintain normal walking speed while undertaking application.

7. Do not smoke, chew or eat while undertaking the spraying operation.

8. Operator should take proper bath with soap after completing spraying.

9. Do not blow the nozzle with mouth for any blockages. Clean with water and a soft brush.
XVI. REFERENCES

- http://lissartf.files.wordpress.com/2012/07/img_1447.jpg
- http://beetlesinthebush.files.wordpress.com/2008/06/p10101902.jpg
- http://nfrec.ifas.ufl.edu/MizellRF/WoodyBug/images/brown.jpg
- http://upload.wikimedia.org/wikipedia/commons/1/17/Forest-tent-caterpillar-malacosoma-disstria.jpg
- http://www.domyownpestcontrol.com/images/content/earwig%201.jpg
- http://www.nhm.ac.uk/natureplus/servlet/JiveServlet/download/10148-3627/P1010355.JPG
- http://2.bp.blogspot.com/6kNNm8vQQXQ/U5IBvy14jdl/AAAAAAAAMxE/wSNYJ0SMJAs/s1600/plantbugP1220912.jpg
- http://www7.inra.fr/hyppz/IMAGES/7031711.jpg
AESA based IPM – Peach

- http://www.fruitipedia.com/ Apricot.htm
- http://agritech.tnau.ac.in/agriculture/agri_min_fldcrops_fruits.html
- http://farm8.static.flickr.com/7412/8849464003_2d25e2101a_m.jpg
- http://upload.wikimedia.org/wikipedia/commons/1/14/Rumex-obtusifolius-foliage.JPG
- http://swbiodiversity.org/imglib/seinent/Chenopodiaceae/photos/ Chenopodium-album-FL-web-.jpg
- http://flowers.la.coocan.jp/Cyperaceae/Cyperus%20iri/a/DSC03569.JPG
- http://upload.wikimedia.org/wikipedia/commons/8/87/Phalaris_aquatica.jpg
- https://books.google.co.in/books?id=NWMa741kG_gC&pg=PA420&lpg=PA420&dq=peach+termites+odontotermes&source=bl&ots=k86kWBKXTh&sig=s1SHi9RK3JILT5xnM-QCK8tSE84&hl=en&sa=X&ved=0CCYQ6AEwAWoVChMlpqTs qe2OyAIVCwiOCh3BQaP#v=onepage&q=peach%20termites%20odontotermes&f=false
- https://www.jstage.jst.go.jp/article/aez1966/24/1/24_1_1/_article
- Gurr, GM, Wratten, SD and Altieri MA (2004a) Ecological Engineering for Pest Management Advances in Habitat Manipulation for Arthropods. CSIRO PUBLISHING, Collingwood, Australia.
Important Natural Enemies of Peach Insect Pests

**Parasitoids**
- Encarsia perniciosa
- Pales spp.
- Trichogramma cacaceae
- Fopius arisanus
- Diachasmimorpha spp.
- Xanthopimpla sp

**Predators**
- Big-eyed bug (Geocoris spp.)
- Earwig
- Reduviid bug
- Robber fly
- Orius spp.
- Black drongo

Plants Suitable for Ecological Engineering in Peach Orchard
- Alfalfa
- Sunflower
- Ocimum spp.
- Cosmos
- Spearmint
- Mustard
- Marigold
- Carrot
- Caraway
- Cowpea
- Buckwheat
- Maize