



IPM PACKAGE NO. 57



**INTEGRATED  
PEST MANAGEMENT  
PACKAGE**

FOR

**WALNUT**



Government of India  
Ministry of Agriculture  
Department of Agriculture & Cooperation  
**Directorate of Plant Protection, Quarantine & Storage**  
N. H. IV, Faridabad - 121 001.

# IPM PACKAGE FOR WALNUT

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Government of India  
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**DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE**

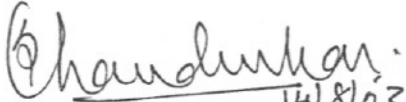
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**FOREWARD**

Integrated Pest Management (IPM) approach has been globally accepted for achieving sustainability in agriculture. It has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities, low input cost based Crop Production Programme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitise extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, the scattered information on various components of this eco-friendly approach forms basic necessity. In this direction, initial attempts were made in 1992 to harmonise the IPM Package of Practices of various crops. Subsequently, concerted efforts were made in 1998, 2001, 2002 and 2003 to update and develop IPM Package of Practices for agricultural and horticultural crops. Presently, IPM Package of Practices for 77 crops have been finalized to help the extension workers and farmers to manage the pests and diseases and to minimize the over use/misuse of chemical pesticides. Efforts have been made to incorporate the relevant available technical input provided by the scientists of ICAR Institutes/ SAUs and State Departments of Agriculture/Horticulture. However, suggestions for further improvement in future publication/ revision will be of immense help. Hopefully, these IPM Package of Practices will be useful for the Researchers, Plant Protection Workers and Farmers alike.

  
(P. S. CHANDURKAR)  
14/8/03

## P R E F A C E

In order to minimize the indiscriminate and injudicious use of chemical pesticides, INTEGRATED PEST MANAGEMENT (IPM) has been enshrined as cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM is an eco-friendly approach for managing pest and disease problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. The greater emphasis has been given on biological control including use of biopesticides.

With a view to provide technical knowledge to the extension functionaries and farmers in the States, first National Workshop on IPM for harmonization of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized on April 15-17, 1998 and Nov. 5-6, 1998 at the Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM Package of Practices for 20 crops were finalized on rice, cotton, vegetables, pulses and oilseeds. In this series, two National Workshops on IPM have been conducted at NPPTI, Hyderabad and Dte. of PPQ&S, Faridabad during 14-17, 2001 and Feb. 20-22, 2002 respectively to update 20 available IPM Packages and develop 31 new IPM Packages especially for horticultural crops. Sixth and Seventh National Workshop held at Central Insecticides Laboratory, Faridabad on 4<sup>th</sup>-5<sup>th</sup> July, 2002 and 9<sup>th</sup>-10<sup>th</sup> January, 2003 respectively for 18 IPM Packages and Eighth National Workshop was held at NPPTI, Hyderabad on 28<sup>th</sup>-29<sup>th</sup> May, 2003 for 8 IPM Packages. In these Workshops, 77 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), commercial crops (Cotton, Sugarcane, Tobacco, Tea, Betelvine, Saffron), pulse crops (Pigeonpea, Gram, Black gram/Green gram, Pea, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Olive, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitacious vegetables, Broccoli, Spinach, Lablab bean, Garlic), fruits (Citrus, Banana, Apple, Mango, Guava, Grapes, Jackfruit, Pineapple, Sapota, Pomegranate, Litchi, Papaya, Apricot, Peach, Pear, Cherry, Walnut, Ber, Amla, Loquat, Strawberry, Watermelon, Fig, Phalsa, Persimmon, Custard apple, Raspberry, Kiwi, Passion fruit), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalized.

IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. The IPM packages encompass various management strategies for containing the pest and disease problems. Pest monitoring is one of the important components of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (AESAs), field scouting, light, pheromone, sticky/yellow pan traps. The economic threshold levels (ETL) of important pests and diseases are also given in the packages to take appropriate control measures when pest population crosses ETL.

These IPM packages developed with the technical inputs from experts from Indian Council of Agricultural Research, State Agricultural Universities, Central Directorate of Plant Protection, Pesticide Industries and State Departments of Agriculture/Horticulture will provide technical backup in the management of pests, diseases, weeds, nematodes and rodents in the agriculture and horticulture. These will also be useful in reducing the pesticide residues in agricultural commodities and would also help in the management of pests/diseases/weeds/nematodes which may get inadvertently introduced in the country.

IPM Package of Practices for agricultural and horticultural crops will be helpful to minimize the ill-effects of chemical pesticides to promote the IPM for sustainable production. These IPM packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

7<sup>th</sup> October, 2003



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# IPM PACKAGE FOR WALNUT

## I. MAJOR PESTS

### A. PESTS OF NATIONAL SIGNIFICANCE / MAJOR PESTS :

#### 1. Insect Pests :

- |                       |                                    |
|-----------------------|------------------------------------|
| 1.1 Stem borer        | ( <i>Acolesthes sarta</i> )        |
| 1.2 Pin hole borer    | ( <i>Scolytis nitidus</i> )        |
| 1.3 Hairy caterpillar | ( <i>Lymantria obfuscata</i> )     |
| 1.4 Leaf roller       | ( <i>Archips argyrospilus</i> )    |
| 1.5 Mealy bug         | ( <i>Drosicha dalbergia</i> )      |
| 1.6 Grey weevil       | ( <i>Mylocerus sp.</i> )           |
| 1.7 Defoliator        | ( <i>Chaetoprota sp.</i> )         |
| 1.8 Walnut weevil     | ( <i>Alcides porrectirostris</i> ) |

#### 2. Diseases :

- |                    |   |
|--------------------|---|
| 2.1 Leaf spot      | ( <i>Alternaria sp.</i> )   |
| 2.2 Leaf blotch    | i) ( <i>Marsonina juglans</i> )<br>ii) ( <i>Gnomonia leptostyla</i> ) |
| 2.3 Dieback        | ( <i>Glomerella cingulata</i> )                                       |
| 2.4 Powdery mildew | ( <i>Phyllactinia rubonis</i> )                                       |

### B. PESTS OF REGIONAL SIGNIFICANCE / MINOR PESTS :

#### 1. Insect Pests :

- |                    |  |
|--------------------|--|
| 1.1 Walnut aphid   | i) ( <i>Chromaphis juglandicola</i> )<br>ii) ( <i>Panaphis juglandis</i> ) |
| 1.2 Codling moth   | ( <i>Cydia pomonella</i> )   |
| 1.3 San-Jose-Scale | ( <i>Quadraspidiotus perniciosus</i> )                                     |

## **II. PEST MONITORING**

### **A. Agro Eco System Analysis (AESAs) :**

AESA is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basic components of AESA are :

1. Plant health at different stages.
2. Built-in-compensation abilities of the plants.
3. Pest and defender population dynamics.
4. Soil conditions.
5. Climatic factors.
6. Farmers past experience.

### **B. Survey / Field Scouting :**

The objective of surveys through roving surveys is to monitor the initial development of Pest and Disease in the endemic areas. Therefore, in the beginning of the crop season i.e. from 1st week of March, depending on the earlyness or lateness of the season survey routes based upon the endemic areas or otherwise also are required to be identified to undertake roving surveys from the bud swell / early pink bud stage. Based upon the observations of the roving surveys, the state extension functionaries have to concentrate for greater efforts at block and village levels as well as through farmers to initiate field scouting especially to know / identify the proper bud stage i.e. pre-bud swell state for applying the delayed dormant oil spray or other fungicidal sprays as per the recommendations of the SAUS or Department of Horticulture. Therefore, for field scouting farmers should be mobilized to observe the pest and disease occurrence at the intervals as stipulated under different fruit developmental stages. The plant protection measures are required to be taken only when pest and disease cross ETL as per results of field scouting.

#### **1. Roving Surveys :**

Undertake roving survey at every 10-12 km distance or after every 5 orchards depending, on the plantation stretch both in linear and deep horizontal magnitude, at 10 days intervals depending again on pest population intensity. Identify the proper bud / growth stage for applying the dormant oil spray after



taking the prevailing temperature into consideration which would not be less than 4°C for at least 48 hours. Observe 5 plants randomly in zig zag fashion in each orchard for indentifying the proper growth stage for applying dormant oil sprays, and for recording the intensity / population of sucking pest and defoliators at the later growth stages. Record population of potential different biocontrol fauna to arrive at the decision making stage. Record the major diseases and their intensity like leaf spot, leaf blotch, die back, leaf curl & blight along with deficiency related disease exhibited by the plant during the course of fruit development.

## 2. **Field Scouting** :

Field scouting for pest and biocontrol fauna by extension agencies and farmers once in a week should be undertaken to work out ETL and pest defender ratio. For sucking pest different methodology is to be adopted. In case of San-jose-scale, scale count should be taken per unit area after flagging the particular limb of the plant while in case of mite, count should be taken per leaf after taping the leaves randomly from periphery of the selected trees at chest / head height. The State Departments of Horticulture should make all possible efforts by using different media, mode and publicity to inform the farmers for field scouting in the specific crop area having indication of pest and disease build up.

## 3. **Pest Monitoring through Traps** :

- 3.1 **Through yellow sticky traps** : Setup fast coloured sticky traps, for monitoring the aphids, one trap / 5 trees. Locally available empty yellow palmolive-tin coated with grease / casline / castor oil on outer surface may also be used.
- 3.2 **Through pheromone traps** : Certain pests like gypsy moth and codling moth require installation of pheromone traps to monitor initial pest build up and suppression of their increasing population. Sticky pheromone traps may be used @5-7 per ha. for effective monitoring.
- 3.3 **Through light traps** : Most of the moths of leaf roller caterpillars and a few beetles of root / stem borers get attracted towards light during night. Therefore, installation of light traps in the orchards help in monitoring of initial build-up of pest population.

## C. **Economic Threshold Levels (ETLs)** :

Based upon the results of survey / field scouting etc., the extension



functionaries are to determine the ETLs for different pests to advise farmers to initiate pest management practices accordingly. For some fruit pests, adequate sampling techniques are not available. This is particularly true for pests with non-uniform distribution such as San-jose-scale, trunk borers, green fruit worms. Economic threshold for sp. which attack foliage are difficult to establish because of the large number of variables involved, such as fruit to leaf ratio, weather, variety, time of year and tree vigour. However, it seems certain that there is a considerable tolerance for loss of leaves or leaf function in fruits tree and some insight into tolerable levels (or ranges) can be of value.

The determination of economic injury levels, and the development of effective survey techniques made possible the treating of portions of the orchard where predator prey ratio are unfavourable for biological control.

E.T.L : Economic threshold is the population density of pest at which control measures should be determined to prevent increasing pest population from reaching the economic injury level (E.I.L.).

E.I.L. : It is the lowest population density of pest that will cause economic damage (E.D.)

E.D. : It is the amount of injury which will justifying the cost of artificial control measures. These costs should be measured in the broadest sense possible.

S.No.	Name of Pest	Range	Intensity Size	Sample	Remarks
1.	San-jose-scale	a) 1-5 scales/sample	Low	1.4cm <sup>2</sup> .	
		b) 6-12 scales/sample	Medium	1.4cm <sup>2</sup> .	
		c) 13 & above/sample (serious)	High	1.4cm <sup>2</sup> .	
2.	Mites	a) 1-4 mites/leaf	Low	1 Leaf	From petal
		b) 5-8 mites/leaf	Medium	1 Leaf	fall stage to
		c) 8 & above/leaf	High	1 Leaf	fruit dev. stage.
		d) 20 & above mites/leaf	High	1 Leaf	Post harvest stage

**III. AGRO ECO SYSTEM ANALYSIS**

**The methodology of AESA is as under**

**A. Field Observations :**

- a) Enter the orchard atleast 10 - 15 feet away from road / bund. Select an Almond / Walnut grafted tree of medium size randomly.
- b) Record the visual observations on the following parameters :
  - i) Flying insects (both pest and defenders).
  - ii) Close observations on pest and defenders which remain on the plant.
  - iii) Observe the pest like scale insects, Mites, Aphids, Defoliators, Borers and defenders like LBB, Green Lace Wings, Authocorids, Bugs, Spiders, Phytoseid, Mites, Syrphids and other bioagents.
  - iv) Record various diseases and their intensities.
  - v) Record insect damage in percentage or otherwise in case of non-uniform pests like scale insects.
- c) Record parameters like number of mites / leaf randomly only around the tree canopy on the periphery at chest and head height. Regular counts of motile mite and predator (LLB) population on a 7 - 10 day interval are needed. The mite population is sampled by determining the number of motile stages on at least 10 leaves collected around the tree and from five or more trees per selected orchard. The number of trees selected for sampling would depend largely on the size of the orchard. The trees selected for sampling should be representative of the entire orchard in size and cultivar, preferably cultivars which are sensitive to pest attack should be taken for sampling. The predator population is surveyed on the same tree where pest sampled / observations have been taken. The predators / bioagents count is accomplished by slowly walking around the periphery of the sampling tree and recording the number of adults and larvae / grubs visually. The predators / parasitoids survey should be done before leaves are collected / disturbed / observed for sampling the pest population. Similarly for scale count,

the main limbs of the representative/sampling tree infested with scale insects are observed, where number of scales / unit area (say 1.4 cm<sup>2</sup> at a marked position) should be painted/flagged for making observations in the following weeks.

- d) Record soil conditions viz dry, wet or water lodged.
- e) Observe rodent live burrows.
- f) Repeat the steps from b to e at least on 5 trees in a diagonal row or criss cross fashion across the orchard to have overall average assessment of the orchard.
- g) Record the climatic factors viz, sunny, partially sunny, cloudy, rainy etc. for the proceeding week.

B. **Drawing :**

First draw the plant with actual number of main limbs in the centre of a chart. Then draw pests on left side and defenders on the right side. Indicate the soil condition, rodent damage, etc. Give natural colours to all the drawings, for instance draw healthy plant with green colour, diseased plant / leaves with yellow colour. While drawing the pests and the defenders on the chart care should be taken to draw them at appropriate part of the plant, where they are seen at the time of observation. The common name of the pest and defender and their population count should also be given alongwith diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant, if it is sunny. If cloudy the clouds may be drawn in place of sun. In case of partially sunny, the diagram of sun may be half masked with clouds.

C. **Group Discussion and Decision Making :**

The observations recorded in the previous and current charts should be discussed among the farmers and apprentice trainees by raising questions relating to change in pest and defender population in relation to crop stages, soil conditions, weather factors, such as rainy, cloudy or sunny etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P:D ratio and take judicious decision for specific pest management practices.

**D. Strategy for Decision Making (Example) :**

- a) When number of mites is 8 or above 8/leaf the group may advocate for any recommended pesticides especially when the weather is hot and likely to prevail during petal fall stage.
- b) When number of mites is 5 to 8 or more at later stages but there is enough population of LBB's, Spiders and Green lace wings and phytoceiid mites especially during the period from June to mid of September, the group may advocate for monitoring and surveillance only to see the impact of defenders.
- c) The group members may closely observe the representative fruit trees for the prominent / characteristic disease symptoms of leaf curl, blight and leaf spot and their intensities along with prevailing weather conditions and may accordingly suggest for sprays or no sprays.
- d) In case of San-jose-scale if 50% of scales are parasitised by its parasitoids or 2-3 Lady Bird Beetles (LBB) are present per infested twig then there is no need of chemical spray.

**AESA BY EXTENSION FUNCTIONARIES :**

The extension functionaries during the regular visit to the village should mobilize the orchardists to conduct AESA and critically analyse the various factors such as the pest population viz-a-viz defender population and their role in natural suppression of the pest, the influence of prevailing weather conditions / soil conditions on the likely build up of defender / pest population. They may also take the decision based on the AESA, like release of defenders, application of neem formulations / safe pesticides for specific pest situation. Such an exercise may be repeated by the extension functionaries during every visit to the village and motivate the orchardists to adopt AESA in their fields.

### **AESA BY FARMERS :**

After a brief exposure during IPM demonstrations / field trainings, orchardist can practice AESA in their own orchards. Trained farmers can train their fellow farmers in their villages. Thus a large group of orchardist could be made efficiently competent in undertaking weekly AESA thereby empowering themselves in decision making on any specific pest situations. Farmers-to-farmers training approach will go a long way in practicing IPM on a large area on sustainable basis.

## **IV. INTEREGRATED PEST MANAGEMENT STRATEGIES**

### **A. Cultural Practices :**

- ◆ Avoid planting of pest infested saplings.
- ◆ Apply balanced dose of chemical fertilizers and FYM to up keep the vigour of the plant and to reduce the attack of shot hole, bark beetles and other pests.
- ◆ Nitrogen application be made in 2 - 3 splits.
- ◆ Proper selection of cultivars having commercial value and suitable for effective cross pollination be made.
- ◆ Before planting of walnut trees, the proper soil selection be made, and the most suitable soil is loam with abundant organic matter.
- ◆ Irrigate the plants 1 - 2 fortnights before expected harvesting.
- ◆ To avoid wilting due to long dry spell of summer irrigate the plants.
- ◆ Orchard management practices be followed strictly like clean cultivation.
- ◆ Ensure cultivation of 2 cultivars in an orchard with 33% pollinizers.
- ◆ Pesticides should be purchased from registered dealers.
- ◆ Arrangement of efficient pruning tools be made before undertaking pruning job.
- ◆ If the plants / trees exhibit the deficiency of micronutrients, especially of boron go for the application of the same on the basis of soil and leaf analysis.
- ◆ 2 or 3 varieties of walnut are required to be planted for adequate pollination.

### **B. Mechanical Practices :**

- ◆ Prune and destroy the scale, borer and canker infested twigs / branches.
- ◆ Clip of diseased/ mildewed shoots.

- ◆ Remove and destroy dead and drying trees from the orchards.
- ◆ Collection and destruction of egg masses of hairy caterpillar.
- ◆ Collect and destroy the fallen walnut weevil infested fruits.
- ◆ Whenever infestation of mealy bug is noticed, slippery bands of Alkathane sheets above the ground be applied during April.
- ◆ Collection and destruction of fallen foliage in autumn.
- ◆ Burlap skirts around the tree trunks infested with hairy caterpillar for collection and destruction of larvae / pupae of the pest from May to end of June.
- ◆ Cover the exposed part of the stem to sun with dry grass or gunny bags soaked with methyl parathion (0.1%) once a month from March to October for controlling borer infestation.
- ◆ Complete collection, destruction of foliage and pruned wood in the orchards after leaf fall.
- ◆ Fallen fruits be collected and destroyed at every 10 days interval on the community basis.

### C. Biological Practices :

#### 1. Soil borne diseases :

Root rot and collar rot control.

1.1 Before laying or raising of plant nursery make use of *Trichoderma viride* and *T. harzianum* to control root rot disease and at later stages for control of collar rot also

1.2 Make use of neem cakes while raising plant nurseries to ward off any soil pest.

1.3 Solarisation of nursery beds be made to ward off soil borne pests.

#### 2. Conservation :

2.1 Conserve the predators like Lace wings, Lady bird beetles, Carabids, Syrphids, Anthcoridbugs, Mirid bugs, Nabid bugs, Capsid bugs, Spiders,



Predatory Ants, Phytoseiid mites, Parasitoids like *Encarsia*, *Aphytis*, *Trichogramma*, *Telenomus* etc. in orchard.

- 2.2 Growing of flowering plants, especially Marigold and Maiz on the peripheries and legumes as inter cropping help in conservation of both predators and parasitoids and helps in nematode management.
  - 2.3 Collecting of egg masses of Hairy caterpillars and putting in a fine meshed cage for emergence of egg parasites (*Anastatus sp.*) protect the parasites from orchard sprays . The larvae hatched may be destroyed.
  - 2.4 Collect the different larval instars of hairy caterpillars (suspected parasitized) from orchard and place them in wire meshed cages for emergence of larval parasite like different species of *Exorista.*, *Drino*, *Apanteles*, *Saracophages.*, *Pollania*, *Anilastus*, *Anithomyia*, *Euplectrus.*, to protect them from scheduled spray effects.
  - 2.5 Collection of pupae of hairy caterpillars from the orchard and placing them in wire mesh cages for emergence of pupal parasite like *Brachymeria sp.*, *Monodontomerus sp.*, *Hyposoter sp.*, *Exorista sp.* and *Pimpla sp.* protects the parasitoids from scheduled spray effects.
3. Augmentation :
- 3.1 Monitor the incidence of sucking pests like San-jose-scale, Mite, Aphis and make the release of :
    - A. Predators : Lady bird beetles - *Chilocorus bijugus*, *Pharoscmmus horni*, *Coccinella septumpunctata*, *Chlilochorus tristis*, *Adalia bipunctata*, *Synharmonia sp.* *Exochomus quadripustulatus*, *Hippodamia convergens*, @ 30-50 adults / infested tree.
    - ii) Green lace wings *Chyrsoperla sp.* and *Syrphus sp.* 10-20 Ist instar larvae/tree.

B. Parasitoids : *Encarcia perniciosi* and *Aphytis diaspidis* @ 2000 / infested tree after 15 days of insecticidal sprays and 10 days after fungicidal sprays against San-jose-scale. The dosage may vary depending upon the intensity and extent of damage.

D. **Chemical Control Measure :**

- 1 Need based, judicious and safe application of pesticides are the most vital tripartite segments of chemical control measures under the ambit of IPM. It involves developing IPM skills to play safe with environment by proper crop health monitoring . Observing ETL and conserving natural biocontrol potential before deciding in favour of use of chemical pesticides as a last resort. Therefore, it is not necessary to rely upon pesticides.
2. Following suggestions have important bearing for success control measures in the context of IPM strategy :
  - 2.1 Avoid mixing of two or more insecticides/tank mixing.
  - 2.2 Repeated application of same pesticides should be avoided.
  - 2.3 Avoid use of synthetic pyrethroids (Fenprothrin) which may cause resurgence of sucking pests.
  - 2.4 Use selective insecticides (Endosulfan) during early fruiting phase of crop growth.
  - 2.5 Encourage use of neem based formulations.
  - 2.6 Proper spray equipments should be used .
  - 2.7 Use proper spray volume per unit area.

### 3. Cautions during spraying :

- 3.1 If operator feels giddiness, uneasy, he must discontinue spraying / dusting at once.
- 3.2 Operator should not spray/dust for more than 4 hours at a stretch in a day.
- 3.3 Operator should not take up spray/dusting work with empty stomach.

### 4. Rodent Management :

- 4.1 Adopt orchard sanitation.
- 4.2 Do not cultivate fodder crops especially oats in orchards.
- 4.3 Make use of Bromodiolon bait (0.005% a.i.) in two application at an interval of one week.
- 4.4 Adoption of community approach may be taken.

## **V. MANAGEMENT PRACTICES FOR ENDEMIC PESTS**

### **A. Borers (Stem, Shot hole and Bark Eating Borers) :**

1. Clear the holes with flexible wire and then insert 0.5gm. of para-dichlorobenzene (PDCB) in the hole and plug it with puddling material or insert cotton wick soaked with patrol or methyl parathion 1ml./lt. water or dichlorvos 0.15ml/lt/water and pug the hole.
2. Place small amount of crystals of PDCB on the surface of the soil around the trunks of the tree during the fall (September - October). The amount of PDCB to be applied will vary with size of the tree. Apply the crystals in a ring completely encircling the trunk, not closer to the bark than 1.0 inch nor at greater distance than 3.0 inch Cover the crystals with the earth to confine the PDCB gas. Don't apply treatment during summer and late fall.
3. In case of localized infestation, swab the infested part with methyl parathion (0.2%) or spray with fenitrothion (0.05%).
4. Remove webbing and treat the main limbs and trunk of the attacked tree in March and September / October with 0.1% methyl parathion 50 Ec or inject into the holes excavated by the caterpillars.
5. Swab the infested branches and tree trunk with 10% carbaryl dust and soil in the ratio of 1:6 mixed with Rice and Wheat straw.

### **B. Chaffer Beetles :**

Applying phorate 10G or aldicorb 10G @ 1.5 kg. ai/in the soil against the grubs of chaffer beetles.

C. **Termites** :

1. Drench the soil with chlorpyrifos (0.1%).
2. Treat the tree trunk and main roots of the affected plant with chlorpyrifos (0.1%).

D. **Nematodes** :

Use carbofuran granules 3 G @ 60 kg/ha. in nursery beds and 100-300 gms/tree in orchards depending on the size of tree after fruit harvest.

E. **Collar Rot** :

1. Clean the infested collar area with a sharp knife and apply bordeaux paint.
2. Remove the soil around the collar region and expose the affected portion to sun.
3. Apply *Trichoderma harzianum* and *T. viride*.
4. Irrigate 30cm. radius around tree trunk with mancozeb (300-400 gms/100 lts of water) or copper oxychloride (500-1000g/lts of water).

## **VI. HARVESTING PRACTICES**

### **Walnut :**

1. Orchard floor should be maintained under sod culture.
2. Walnuts should be harvested when hull colour changes from green to yellowish with cracks.
3. Irrigate the orchard / walnut plantation 1 - 2 fortnights before expected harvest.
4. Before knocking off nuts, orchard floor should be cleaned and covered with tarpuline sheet.
5. Immature nuts should not be harvested and over matured conditions favour for pest infestation.
6. Nuts should be properly de hulled, washed and dried to avoid the attack of moulds.

## VII. DO'S & DON'TS IN WALNUT FRUIT MANAGEMENT

DO'S	DONT'S
<b>A. Grow only recommended Cultivars :</b>	Don't grow under script material which vary greatly in fruiting pattern and pest susceptibility.
<b>B. Agronomical Practices :</b>	
1. Orchards should be laid in well drained, silt loamy soils with abundant organic matter.	Don't lay orchards in alkaline soils and sandy sub soils.
2. Orchards should be laid in locations/ areas which are free from frost in spring and from extreme heat in summer.	Orchards should not be laid in the areas prone to hail storm and frost.
3. For raising walnut nursery nuts from current seasons crop with good shell seal should be sown.	Don't sow old nuts for raising nursery.
4. Solarisation of nurseries be adopted while raising plant nurseries.	Seeds of fallen fruits which have been affected by any other organism should be avoided for raising root stock.
5. Irrigate the trees during dry spells of summer wherever facility exists or go for sod culture and mulching to conserve moisture.	Don't force the trees to dry spells.
6. Sod culture should be maintained under the walnut trees, which is useful during harvesting.	Orchards should not be laid on the areas having poor air and soil drainage.
7. To check the infestation of soil borne fungus in the nursery make use of antagonistic fungus i.e. <i>Trichoderma viride</i> and <i>T. harzianum</i> . Neem cakes can also be used to ward off any soil pest.	



<p>8. Root stock should be taken of sweet or bitter almond seedling.</p> <p>9. Every third row should be a pollinizer row.</p> <p>10. For getting good yield prune 1/5th of the fruiting wood each year.</p> <p>11. Prune only older branches that are 1/2 to 3.7cm in dia metre.</p> <p>12. Unwanted water sprouts and suckers should be removed.</p> <p>13.2 - 3 bee hives must be kept / acre in an orchard at the time of bloom.</p> <p>14. Trees should be supplied with recommended quantum of FYM and balanced dose of chemical fertilizers and micro nutrients on the basis of soil and leaf analysis.</p> <p>15. Fertilizers &amp; FYM should be applied 30.0 cm. an away from the tree trunks in case of old trees.</p> <p>16. Orchards must be ploughed thoroughly in Autumn for retention of moisture and destruction of live rodent burrows.</p>	<p>Don't take root stock from peach.</p> <p>Don't prune the branches more than 1/5th of fruit wood.</p> <p>Don't prune the new branches.</p> <p>Don't allow the unwanted suckers and sprouts to grow on the plant.</p> <p>Don't over irrigate the orchards.</p> <p>Don't under/overdose the tree with any of the fertilizers.</p> <p>Don't apply FYM and fertilizer close to the trunks.</p>
<p><b>C. Pest Management :</b></p> <p>1. Pruning should be done close to the branches leaving no stubs.</p> <p>2. Cut wounds should be painted thoroughly.</p> <p>3. Remove dead and dying trees to ward off borer infestation.</p>	<p>Don't prune the tree in haphazard / carelessly.</p> <p>Don't leave cut / pruned portions unpainted.</p> <p>Avoid planting of saplings having borer infestation.</p>

4. Remove and destroy the die back / canker infested twigs and destroy the same.
5. Complete collection and destruction of foliage after leaf fall / Autumn by decomposition.
6. Ensure regular scouting / monitoring for timely detection of ETL's required for need based application of the chemical sprays.
7. Conduct the sprays during mornings and evenings only.

Avoid sprays during hot days

## **VIII. INTEGRATED CONTROL OF CODDLING MOTH, CYDIA** **POMONELLA**

Codling moth is a seasonal pest of apple confined to Ladakh region (Leh and Kargil District) of the State of J&K. This pest also attacks other fruits like, Pear, Apricots and Walnut .

### **Life and Seasonal History :**

There is one complete generation each year with a larval diapause during late August to mid of May next. There is however, a partial 2nd generation also, adults of which are seen in August. Thus, some times broods overlap and caterpillars of both generations are found between 3rd week of August to late September. The adults of 1st generation are seen from late May or early June depending on earliness or lateness of the season.

### **Integrated Control Measures :**

The integrated control of codling moth is affected by adopting the following methods :

- A
1. All loose bark of trees should be scraped off to remove overwintering sites for the caterpillars. Vicinity of trees should be kept clean of packing cases and all other debris which are likely to shelter the overwintering caterpillars during August to mid October,
  2. Bands of sacking (gunny bags) or corrugated cardboard about 150 mm. to 240mm. wide, can be tied round the tree trunks by late July till end of October to provide alternative over wintering sites for the caterpillars. These bands should be removed during the first week of November and either burnt or immersed in a pail of boiling water or kerosenised water.
  3. Fallen fruits should be collected throughout the season and buried deep in the soil.
- B. **Biological :**
1. Release of exotic egg parasites like *Trichogramma embryophagum* Htg., *Trichogramma cacoeciae pallidum* Meir and *Trichogramma chilonis (minutum)* at the rate of 20,000 adults per tree per/week should be undertaken from first fortnight of June to end of August.
  2. Birds, especially tits feeding on overwintering caterpillars play an important roles in pest suppression.

### **Sex Pheromone Traps :**

Use sticky traps (Delta traps) baited with the synthetic Codling moth pheromone/lure to monitor the flight of male moth as :

- i) An aid to the timing of chemical sprays. If fewer than five moths are caught per trap per week, it is not necessary to spray. Thus it can improve spray timings and leads to judicious use of spray.
- ii) For suppression of codling moth by male removal through mass trapping.

### **Chemical :**

Well timed sprays of relatively safer insecticides are effective in controlling Codling moth. Spray timings should be related to moth catches in sex pheromone traps or as per surveillance data.

Apply two sprays - one in the 2nd half of June coinciding with hatching of 1st generation larvae and another two to three weeks later where regular infestation by Codling moth occur depending on altitude.

The pesticides which can be used for chemical are Chlorpyrifos and Fenitrothion, (0.02%), Ethion (0.05%), Diazinon (0.045), Malathion (0.05%).