



IPM PACKAGE NO. 64



# INTEGRATED PEST MANAGEMENT PACKAGE

FOR  
**STRAWBERRY**



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 STRAWBERRY

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Government of India  
Ministry of Agriculture  
Department of Agriculture & Cooperation

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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)  
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## 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, Cucurbitaceous 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



(A. D. Pawar)  
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| (ii) Co-Chairman<br>Tech. Session   | Dr. Raj Singh, JD(Bio)<br>Dte. of P.P.Q. & S., Faridabad                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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# IPM PACKAGE FOR STRAWBERRY

## I. MAJOR PESTS:

### A. Pests of National Significance

#### 1. Insect Pests :

- |                     |                                   |
|---------------------|-----------------------------------|
| 1.1 Red spider mite | ( <i>Tetranychus urticae</i> )    |
| 1.2 Blossom weevil  | ( <i>Anthonomus rubi</i> )        |
| 1.3 Vine weevil     | ( <i>Otiorhynchus sulcatus</i> )  |
| 1.4 Leaf roller     | ( <i>Ctenopsestis obliquana</i> ) |
| 1.5 Thrips          | ( <i>Thrips atratus</i> )         |
| 1.6 White grubs     |                                   |

#### 2. Diseases :

- |                     |                                                                      |
|---------------------|----------------------------------------------------------------------|
| 2.1 Leaf spots      | ( <i>Mycosphaerella fragariae</i> )<br>( <i>Ramularia tulasnii</i> ) |
| 2.2 Grey mold       | ( <i>Botrytis cinerea</i> )                                          |
| 2.3 Red core        | ( <i>Phytophthora fragariae</i> )                                    |
| 2.4 Wilt            | ( <i>Verticillium albo-atrum</i> )                                   |
| 2.5 Powdery mildew  | ( <i>Sphaerotheca macularis</i> )                                    |
| 2.6 Alternaria spot | ( <i>Alternaria</i> sp.)                                             |

## B. PESTS OF REGIONAL SIGNIFICANCE

### 1. Insect Pests:

- 1.1 Cutworms
- 1.2 Hairy caterpillars
- 1.3 Aphids
- 1.4 Root louse

### 2. Diseases

- |                      |                                     |
|----------------------|-------------------------------------|
| 2.1 Anthracnose      | ( <i>Colletotrichum fragariae</i> ) |
| 2.2 Wilt             | ( <i>Fusarium</i> spp.)             |
| 2.3 Post harvest rot | ( <i>Rhizopus nigricans</i> )       |

### 3. Nematodes :

- |                    |                                     |
|--------------------|-------------------------------------|
| 3.1 Leaf nematodes | ( <i>Aphelenchoides fragariae</i> ) |
| 3.2 Stem nematodes | ( <i>Ditylenchus dipsaci</i> )      |

3.3 Root knot nematodes (*Meloidogyne spp.*)

4. **Rodent :**

4.1 Soft Furred Field Rat (*Melardia meltada*)

5. **Weeds :**

A. Monocot Weeds:

1) Burmuda grass (*Cynadom dactylon*)

2) Goose grass (*Eleusine indica*)

3) Signal grass (*Brachiaria romosa*)

4) Crab grass (*Digitaria spp.*)

5) Couch grass (*Elymus repens*)

B. Dicot weeds:

1) Sorrel (*Oxalis latifolia*)

2) Burclover (*Medicago dexticulata*)

3) Carpet weed (*Trianthema portulacastrum*)

4) Corn spray (*Spengula arvensis*)

## II. VARIETIES / CULTIVARS OF STRAWBERRY RECOMMENDED FOR CULTIVATION

1. Cavalier
2. Senga sengana
3. Chandler
4. Tioga
5. Torrey
6. Arking
7. Belrubi
8. Cambridge favourite
9. Cambridge vigour
10. Canoga
11. Domanil
12. Framura
13. Gilbert
14. Gorella
15. Haruyoi
16. Honeoye
17. Polka
18. Redgauntlet
19. Saladin
20. Sumas
21. Terunoka
22. Tyee
23. Vantage
24. Venta
25. Vesper



### **III. 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.

The details of the AESA are given in Annexure -I.

#### **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 February / March survey routes based upon the endemic areas are required to be identified to undertake roving surveys from Bud / Prebloom stage. Based upon the results of 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 for the presence of various pests. Therefore, for field scouting, farmers should be mobilized to observe the pest / disease occurrence at the intervals as stipulated under different fruit developmental stages. The plant protection measures are required to be taken only when pest / diseases cross ETL as per the results of field scouting.

## 1. Roving Survey :

Undertake roving survey after every 2 fields depending upon the plantation stretch both in linear and deep horizontal magnitudes, initially at 10 days interval and thereafter at weekly intervals. At fruit maturation stage it should be done on daily basis, depending again on pest population. Observe 5 plants at each spot selected randomly in zig zag fashion in the field for identifying and recording the intensity / population of the sucking pests and defoliators at the later growth stages i.e. from petal fall to harvesting. Record population of different potential biocontrol fauna to arrive at a decision making stage. Record the major diseases and their intensity along with deficiency related diseases exhibited during the course of fruit development.

## 2. Field Scouting :

Field scouting for pests / diseases and biocontrol fauna / flora by extension agencies and farmers should be undertaken once in a week to assess increasing / decreasing trend in the pest / disease incidence and availability of bio-control potential. This should be done soon after the resumption of growth i.e. early spring when the pests / diseases get activated on improvement in temperatures and appearance of new flush. The State Department 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.

## C. Pest Monitoring through Traps :

3.1 Through yellow sticky traps : Setup yellow fast coloured sticky traps, for monitoring the sucking pests @ 5-10 traps / ha. especially on the peripheries of the field. Locally available empty yellow palmolive tins coated with grease / vasline / castor oil on outer surface may also be used.

3.2 Through light traps : Most of the moths of defoliators get attracted towards light during night. Therefore, installation of light traps @ 5 traps/ha in the fields helps in monitoring of initial build-up of pest population.

#### **IV. INTEGRATED PEST MANAGEMENT STRATEGIES**

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

- Proper selection of cultivars, having commercial value and suitable for altitude and other geographical factors of the place.
- Heavy clay to light sandy and well drained soils slightly acidic (5.5-6.5 pH) are suitable for cultivation.
- Thorough land preparation be made by repeated ploughing and removal of weeds, stubbles etc.
- Plant material for laying quality fruit orchard should be obtained from registered nursery or imported from authorized source approved by PPA.
- Avoid planting of infested plants.
- For raising of nurseries soils should be well drained, not water lodged and without a hard soil pan.
- Places having warm summer and mild autumn is desirable and frost pockets should be avoided for its cultivation. Day temperature between 22.0°C to 23. °C should be preferred.
- Make use of recommended quantum of FYM and balanced dose of chemical fertilizers before planting.
- Avoid excessive use of nitrogen fertilizers and apply it in 2 split doses.

- Irrigate the beds timely at regular intervals of time and avoid drying of beds. During irrigation less amount of water should be used. Irrigate the crop in furrows between the rows. Water should not wet the leaves.
- Runners should be detached seasonally and planted a fresh for maintaining the space between the rows.
- Deweeding of the beds should be done.
- Hoeing should be adopted in the beds.
- Mulching of the beds should be done, with pine needles / grain straw/saw dust/polythene sheet etc.
- Avoid contact of berries with soil.
- Crop rotation should be adopted to avoid the pest infestation, especially with legumes and cow pea.
- Destroy refuse from the old fields after harvest to reduce pest infestation.
- Don't establish plantings next to hedge rows or overgrown fences.
- In hill system, renew the beds after harvesting of first fruiting season if pest population is there. If no problem is there maintain the field for 4-6 years old depending on profitability of crop.
- Keep 2-4 Nos. of bee hives / ha. in crop fields or nearby to enhance pollination.

**B. Mechanical Practices :**

- Hand picking of caterpillars and egg masses of insect pests.
- Raising of bird perches.
- Clipping of heavily aphid infested tips and their destruction.
- The white grub infested fields should be thoroughly deep ploughed for their exposure to birds or may be collected physically for their subsequent destruction.
- Install a light trap near the field, to collect and kill the adults of white grubs and cutworm.
- Mechanical collection and destruction of beetles from the plants to be done.

### C. Biological Practices :

- Before laying or raising of plant nursery make use of *Trichoderma viride* & *Trichoderma harzianum* to control soil borne disease.
- Make use of neem cakes while raising plant nurseries to ward off the soil pests @ 2.5 tonnes/ha.
- Conservation of predators, like Green lace wings, Lady bird beetles, Hover flies, Anthocorids, Spiders, Predatory ants, Carabirds and parasitic wasps .
- Growing of flowering plants and maize as a trap crop on the peripheries and legumes as inter cropping helps in conservation of natural enemies.
- Clip off twigs having mummies (aphid) without exit holes before spraying and tie such twigs with unsprayed plants supporting the aphid population to enhance the parasitoid activity.

#### Augmentation :

Monitor the incidence of sucking pests, defoliators, cutworms and white grubs and make releases of :

- a) Predators : Lady bird beetles, @ 10-15 adults / bed, Green lace wings & Hover flies @ 5-10 1st instar larvae / bed.
- b) Parasitoids : *Trichogramma spp.* @ 50000/hac.

### D. Chemical Control Measures :

1. Need based, judicious and safe application of pesticides is 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, if necessary use pesticides as per the list in annexure II.
2. Following suggestions have important bearing for success of control measures in the context of IPM strategy :

- 2.1 The number of fungicidal and insecticidal sprays recommended in Annexure II can be minimised as per need after proper surveillance and pest intensity considering both biotic and abiotic factors.
- 2.2 Avoid mixing of two or more insecticides/tank mixing.
- 2.3 Repeated application of same pesticides should be avoided.
- 2.4 Avoid using the synthetic pyrethroids which cause resurgence of sucking pests.
- 2.5 Use selective insecticides during early fruiting phase of crop growth.
- 2.6 Encourage use of biopesticides and neem based formulations as per the recommendations of SAU.
- 2.7 Proper spray equipments should be used.
- 2.8 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.
- 3.4 Spraying should be carried out either in the morning or in the evening.

### 4. Rodent Management :

- 4.1 Adopt orchard / field sanitation.
- 4.2 Make use of Bromodiolon concentrate in bait @ 0.005% a.i. in 2 applications at the interval of 1 week.
- 4.4 Adoption of community approach may be taken.
- 4.5 Use sticky traps.

## 5. Integrated Weed Management Practices

### 1. Preventive measures:

- Follow the recommended agronomic management practices of land preparation, planting distance, fertilizer and irrigation etc. to have healthy plants stand.

### 2. Control measures:

- Smothering of weeds by using mulching with straw/hay/plastic sheets etc.
- Follow hoeing and weeding for controlling weeds as and when needed.

## **V. STAGEWISE INTEGRATED PEST MANAGEMENT PRACTICES**

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
1.	Bud / Pre Bloom	Red Spider Mite	Monitoring	Regular field scouting be conducted.
			Biological	i) Conduct surveys for conservation of natural enemies (predators) like LLB, green lace wings, phytoseiid mites, syrphid and observe P.D. ratio. ii) Make release of LLB, G.L. wings @ 2/plant
			Chemical	Conduct sprays (need based) as per recommendations only after determining ETL. (Ref. annexure II).
		Blossom Weevil	Cultural	Beds should not be planted near woods.
			Mechanical	i) Destroy all possible winter quarters. ii) Destroy trash above beds. iii) Plant one row of staminate variety to each 5 rows of pistillate variety.
			Monitoring	Regular field scouting.
			Biological	Conduct surveys for conservation of natural enemies.
			Chemical	Conduct sprays (need based) as per recommendations only after determining ETL. (Ref annexure II)
		Vine Weevil	Biocontrol	Apply <i>Heterorhabditis heliothidis</i> nematode @ 0.05 or 1.0 million/m <sup>2</sup> in moist soils and temp > 12.0°C.



S.No	Crop Stage	Pest	Stage-wise IPM Practices	
			Chemical	Apply carbofuran @ 1.0kg/acre in soil 2.3cm deep or in case of heavy / severe infestation repeat the application after 60 days.
		Alternaria Leaf spot	Monitoring	Go for field scouting/vigilance regularly.
			Chemical	Go for the application of recommended fungicides only. (Ref. annexure II)
		Powdery Mildew	Cultural	Go for cultivating resistant cultivars. (As per SAUs recommended)
			Mechanical	Clip off the mildewed foliage/plant materials and destroy the same.
			Chemical	Go for the application of recommended chemicals. (Ref annexure II)
		Leaf Scorch	Chemical	i) Go for the application of bordeaux mixture during spring. ii) Repeat application if needed.
2.	Bloom	Red Spider Mite	Monitoring	Regular field scouting be conducted.
			Biological	Conduct surveys for conservation of natural enemies (predators) like LLB, green lace wings, phytoseiid mites, syrphids and observe P.D. ratio.
		Blossom Weevil	Monitoring	Regular field scouting to be done.
			Biological	Conduct surveys for conservation of natural enemies.

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
		Vine Weevil	Biocontrol	Apply <i>Heterorhabditis heliothidis</i> nematode @ 0.05 or 1.0 million/m <sup>2</sup> in moist soils and temp > 12.0°C. If not adopted at S.No. 1 above.
		Leaf Roller	Mechanical	Go for hand clipping of rolled leaves in trails.
			Monitoring	Regular monitoring be conducted.
			Chemical	Go for the application of chemical as recommended. (Ref. annexure II)
		Root Louse	Monitoring	Regular monitoring be conducted.
		Wilt	Monitoring	Regular monitoring advocated.
		Alternaria Leaf Spot	Cultural	i) Go for the cultivation of resistant cultivars as per SAUs recommendations. ii) Adopt clean cultivation. iii) Plant in well drained soils iv) Maintain optimum spacing.
			Monitoring	Scouting during humid weather with frequent showers be conducted.
			Chemical	Go for the application or recommended chemicals (Ref. annexure II).
		P. Mildew	Cultural	Go for cultivating resistant cultivars as per SAUs recommendations.
			Mechanical	Clip off the mildewed foliage/plant materials and destroy the same.
			Chemical	Go for the application of recommended chemicals. (Ref annexure II).
3.	Petalfall/Fruit Set	Red Spider Mite	Monitoring	Regular field scouting be conduction.
			Biological	Conduct surveys for conservation of natural enemies (predators) like LLB, green lace wings, phytosecid mites, syrphids & observe P.D. ratio.

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
			Chemical	Conduct sprays (need based) as per recommendations only after determining ETL. (Ref. annexure II).
		Blossom Weevil	Monitoring	Regular field scouting to be done.
			Biological	Conduct surveys for conservation of natural enemies like spiders.
			Chemical	Conduct sprays (need based) as per recommendations only after determining ETL. (Ref annexure II).
		Vine Weevil	Biological	Apply <i>Heterorhabditis heliothidis</i> nematode @0.05 or 1.0 million/m <sup>2</sup> in moist soils & temp >2.0°C. If not adopted earlier.
		Leaf Roller	Mechanical	Go for hand clipping of rolled leaves in trails.
			Monitoring	Regular monitoring be conducted.
			Chemical	Go for the application of chemical as recommended. (Ref. annexure II).
		Wilt	Monitoring	Regular monitoring and surveillance advocated.
		Alternaria Leaf Spot	Mechanical	Older leaves of the runner plants should be removed before fruit set.
			Monitoring	Scouting during humid weather with frequent showers be conducted.
			Chemical	Go for the application or recommended insecticides (Ref. annexure II).
4.	Fruit Development	Red Spider Mite	Monitoring	Regular field scouting be conduction.
			Biological	Conduct surveys for conservation of natural enemies (predators) like LLB, green lace wings, phytosecid mites, syrphids & observe P.D. ratio.

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
			Chemical	Conduct sprays (need based) as per recommendations only after determining ETL. (Ref. annexure II).
		Vine Weevil	Monitoring	Regular monitoring and surveillance advocated.
			Biological	Apply <i>Heterorhabditis heliothidis</i> nematode @ 0.05 or 1.0 million/m <sup>2</sup> in moist soils and temp > 12.0°C. If not applied earlier.
		Leaf Roller	Monitoring	Regular monitoring be conducted.
			Mechanical	Go for hand clipping of rolled leaves in trails.
			Chemical	Go for the application of chemical as recommended. (Ref. annexure II).
		Root Louse	Monitoring	Regular monitoring be done.
		Thrips	Monitoring	Regular monitoring be done.
			Biological	Conduct surveys for the conservation of enemies.
			Chemical	Go for the application or recommended pesticides. (Ref. annexure II).
		White Grubs	Mechanical	Mechanical collection of beetles should be done.
		Wilt	Monitoring	Regular monitoring and surveillance advocated.
		Alternaria Spot/Leaf Spot	Mechanical	Older leaves of the runner plants should be removed/destroyed before fruit set.
			Monitoring	Scouting during humid weather with frequent showers be conducted.
			Chemical	Go for the application of recommended fungicide (Ref. annexure II). If not undertaken at earlier stages (Need based).

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
		P. Mildew	Cultural	Go for cultivating resistant cultivars as per SAUs recommendations.
			Mechanical	Clip off the mildewed foliage/plant materials and destroy the same.
			Chemical	Go for the application of recommended chemicals. (Ref annexure II).
		Gray Mold	Cultural	i) Avoid excessive use of nitrogen. ii) Avoid touching of berries with soil.
			Monitoring	Regular scouting be done.
			Chemical	Go for the application of recommended fungicides. (Ref. annexure II).
		Red Core	Cultural	i) Avoid cultivation at poor drainage sites. ii) Avoid contamination of clean land to be contaminated by fungus through irrigation, infected soil implements, and infected runners. iii) Grow resistant cultivars.
			Monitoring	Regular field scouting be undertaken during wet autumn and winter.
			Chemical	i) Go for soil drenching with the recommended fungicides. (Ref. annexure II). ii) Go for foliar sprays as recommended. (Ref. annexure II).
		Leaf scorch	Chemical	i) Go for the application of bordeaux mixture during spring. ii) Repeat the applications if needed.
		White Buds	Cultural	Discard cultivating of all suspected plants and only healthy ones be used for cultivation.

S.No	Crop Stage	Pest	Stage-wise IPM Practices	
5.	Post Harvest / Dormant	White Grubs	Cultural	Cultivation of strawberries in sod land should be avoided. Avoid cultivation of strawberry beds near the trees as adults feed on them and near which they usually lay eggs.
			Biological	Go for the soil application of neem cakes.
			Chemical	i) Go for the application of carbaryl (0.2%) or Monocrotophos (0.05%). ii) Go for the soil application of Phorate 10 G or Quinolphos 5G@25.0kg /ha. iii) Standing crops can be sprayed with Chloropyriphos @ 4 ltrs./ha.
		Root Louse	Cultural	i) Go for crop rotation in infested soils. ii) Secure plants free from infestation. iii) Dip plants for few minutes in strong solutions made by boiling tobacco stems or leaves in water.
			Monitoring	Regular monitoring be conducted.
			Biological	Go for the soil application of Neem cakes.
			Chemical	Go for soil application of carbofuran or parathion. (Ref. annexure II).
		Nematode	Cultural	i) Starve the land for 2-3 years of any cultivation. ii) Grow nematode resistant cultivars. iii) Grow crops like oats, mustard, Peanut, Corn, Cow pea, Velvet beans to reduce nematode population.
			Chemical	i) Soil application of nemacur @ 13.5kg/ha.

				<p>ii) At transplanting give runners 5 minutes dip in 2.0% aqueous emulsion of thionazin 20E .</p> <p>iii) Apply <i>Thionazin</i> 20E @ 5L/ha. or <i>Isazophos</i> 50 @ 3L/ha. as foliar sprays during September / October or in February March.</p>
		Wilt	Cultural	<p>Go for the cultivation of wilt resistant cultivars as per SAUs recommendations.</p> <p>Avoid plantation of Tomato, Potato, Pepper, Brinjal and Raspberry as crop rotation crops.</p>
			Monitoring	<p>Regular monitoring advocated.</p>
			Biological	<p>Go for the application of <i>Trichoderma viride</i> &amp; <i>T. herzianum</i> before planting.</p>

**VI. DO'S & DON'T'S IN STRAWBERRY PEST  
MANAGEMENT**

<b>DO'S</b>	<b>DONT'S</b>
<b>A. Agronomical Practices :</b>	
1. Grow only recommended cultivars.	Don't grow under script material which vary greatly in fruiting pattern and pest susceptibility.
2. Light soil should be preferred. Soil should be slightly acidic having pH 5.5 to 6.5. Top soil should be porous and rich in humus content.	Don't establish the orchards either in high acidic or high alkaline soils.
3. For laying quality orchard, soils having adequate/well drainage facility be preferred.	Don't lay orchard in soils having poor drainage facility.
4. Sites having day temperatures from 22-23°C should be preferred for obtaining maximum yield.	
5. Thorough preparation of soil should be made by repeated ploughing and removal of weeds, stubbles etc.	Don't go for random preparation of soils.
6. Propagate through runners from stolons of healthy plants.	
7. Avoid damage and drying of roots of runners.	Don't keep runners unplanted for more time after removing from nursery beds.
8. After withdrawal of runners from storage, the material should be planted as soon as possible.	
9. Remove soil from the roots of runners	



before packing in bundles.

10. Plant the runners on a cloudy day or in late afternoon.

11. Spread out well the roots while planting.

12. Set the plants so that crowns are even with the surface of the ground after packing of the soil.

13. Planting distance should be maintained in relation to cultivar system of planting, growing conditions etc. However 72,000 plants to 87000 plants/ha has been found profitable at 10x40cm spacing.

14. Balanced dose of NPK with manuring/ FYM is essential and also apply micronutrients if deficiency is exhibited by the plants.

15. Mulching should be done at proper time to minimize freezing injury to plants, weed growth and soil erosion by making use of white straw, marsh hay, peavines, ground corn cobs, sawdust etc.

16. Irrigate the orchards at regular intervals, with optimum amount of water in each irrigation to reduce water stress in leaf, particularly in the 1st year after transplanting and rooting of runners during 1st maturation.

17. Adopt crop rotation, preferably with legumes and cowpea.

18. Keep 2-4 2 Nos. of beehives/ha in crop fields or nearby to enhance pollination.

Don't plant during mid day / noon hours.

Don't twist or cramp the roots while planting.

Don't set the plant too deep to cover the bud with soil or too high to expose the roots.

Don't give heavy irrigation at a time.

<b>B. Pest Management :</b>	
<ol style="list-style-type: none"> <li>1. Diseased/insect infested plant material should be removed and destroyed.</li> <li>2. Have regular monitoring for the pest / disease infestation and surveillance during the excessive rainfall or prolonged wet periods.</li> <li>3. Use only recommended pesticides at the recommended dosages for the control of various pests / diseases.</li> <li>4. Encourage the cultivation of flowering plants and maize crop on the peripheries of the field to enhance the population of natural enemies.</li> </ol>	<p>Don't go for blanket spray without field roving.</p> <p>Don't make use of spurious chemicals / sub doses or over dosages.</p>
<b>C. Harvesting and Post Harvesting :</b>	
<ol style="list-style-type: none"> <li>1. Harvesting of fruits should be done when half to three quarter of the skin develops colour, however, for shipments green or white hard fruits should be harvested.</li> <li>2. Harvesting should be done daily during hot weather and peak season.</li> <li>3. Berries should be picked by nipping off the stalk.</li> <li>4. Separate the berries from the leaves and foreign material after harvest.</li> <li>5. Place the berries in well cushioned containers at the time of harvesting and keep them at cool shaded place, protected from birds / ants.</li> </ol>	<p>Don't hold the fruit while harvesting.</p> <p>Don't leave any foreign material stuck to the berries.</p>

## **AGRO ECO SYSTEM ANALYSIS (AESA)**

The methodology of AESA is an under :

### **A. Field observations :**

- a) Enter the field atleast 10 feet away from road/bund. Select one metre square randomly.
- b) Record the visual observations on the following parameters :
  - i) Flying insects (both pests & defenders).
  - ii) Close observation on pest and defenders which remain on the plant.
  - iii) Observe the pests like leaf rollers, thrips and defender like LBB, Green Lace Wings, Spiders, Predatory Ants, Anthocorids and Syrphids.
  - iv) Record various diseases and their intensities.
  - v) Record insect damage in percentage or otherwise in case of non uniform pests like Aphids.
- c) The number of sample squares selected for sampling would depend largely on the size of the field. The predators population is surveyed within the  $m^2$  and is accomplished by slowly walking and observing keenly from the periphery towards the centre and recording the number of adults and larvae visually. The predator surveys should be done before samples are collected/observed for determining the pest population or extent of damage. Similarly at least  $5m^2$  sample areas should be observed in a field depending on the size of the field and the average assessment of all the sample areas should be made to have an overall pest/disease situation of the crop in a particular field.
- d) Record soil conditions viz dry, wet or water lodged.
- e) Observe rodent live burrows.

- f) Record the climatic factors like sunny, partially sunny, cloudy, rainy etc. for the proceeding week.

B. **Drawing :**

First draw the plant with average number of shoots / branches in the centre of the chart. Then draw pests on left side and defender 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 defenders 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 :**

- i) The group members may closely observe the representative sampling area for the fruit trees for the prominent / characteristic symptoms of various diseases and their extent along with prevailing weather conditions and may accordingly suggest for sprays or no sprays.

- ii) In case of sucking pests like mite and aphids if 2-3 LBB or 1-2 instar larvae of Green Lace Wings or Syrphid grubs are present per infested plant then there is no need of any chemical spray.
  
- iii) When it is hot and dry without any rains, group may suggest for no sprays, otherwise recommend spray against disease or can suggest for monitoring and surveillance.

### **AESA BY EXTENSION FUNCTIONARIES :**

The extension functionaries during the regular visit to the village should mobilize the farmers, 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 condition/soil conditions on the likely build up of defender/pest population. They may also take the decision based on the AESA, with IPM components like release of defenders, application of neem formulations/safe pesticides are to be used for specific pest situation. Such an exercise may be repeated by the extension functionaries during every visit to the village and motivate the farmers to adopt AESA in their orchards.

### **AESA BY FARMERS :**

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

**PESTICIDES RECOMMENDED FOR STRABERRY PEST  
MANAGEMENT**

S.No.	Crop Stage	Name of the Pesticides	Dosage	Target Pest	Pest Remarks		
1.	Bud / Pre Bloom	a) Pesticides :	Chloropyrifos 20EC or	0.1%	Red spider mite, Blossom weevil	Need based	
			Fenvalerate or	0.25%			
			Deltamethrin	0.05%			
			Carbofuran or	1kg/acre	Vine Weevil		
			Parathion		Root Louse		
		Thionazin 20 E or	0.1%	Nematode	Soil application		
		Isazophos 50					
		b) Fungicides :					
		Captan 50 wp or	0.2%			Leaf spot	First spray in spring when leaves are about Half grown
		Carbendazim 50 wp or	0.03%			Alternaria Spot	
Thiophanate methyl	0.03%						
Bordeaux mixture	0.03%	Leaf Scorch					
Triadimefon or	0.05%	Powdery Mildew					
Topsin -M	0.1%						
2.	Petalfall / Fruit set	a) Insecticides :	Chloropyrifos 20EC or	0.1%	Red spider, mite	Need based	
			Fenvalerate or	0.025%			
			Deltamethrin	0.05%	Leaf roller		
			Carbofuran or		Blossom weevil		
			Parathion	0.1%	Vine Weevil		
		b) Fungicides :					
		Captan 50 wp or	0.2%	Alternaria Spot	Conduct sprays as need based		
		Carbendazim 50 wp or	0.03%	Leaf spot			
		Thiophenate Phenyl	0.03%				
		Bordeaux mixture		Leaf Scorch			
Triadimefon or	0.05%						
Topsin-M	0.1%						
3.	Fruit Development	a) Insecticides :	Chloropyrifos 20EC or	0.1%	Red spider, mite	Need based	
			Fenvalerate or	0.025%			
			Deltamethrin	0.05%	Leaf roller		
			Carbofuran or		Thrips		
			Parathion	0.1%	Vine Weevil		
		b) Fungicides :					
		Chloropyrifos	0.1%	White grub	Soil application		
		Carbaryl or	0.2%				
		Phorate 10 G or	0.5%				
		Quinolphos					

S.No.	Crop Stage	Name of the Pesticides	Dosage	Target Pest	Pest Remarks
		b) Fungicides :			
		Captan 50 wp or	0.2%	Alternaria Spot	Need based
		Carbendazim 50 wp or	0.03%	Leaf spot	
		Thiophenate Phenyl	0.03%	Gray mold	
		Difolatan	0.25%	Red core	
		Bordeaux mixture	0.3%	Leaf Scorch	Need based
		Triadimefon or	0.05%	P. Mildew	Need based
		Topsin-M	0.1%		
4.	Post Harvest/ Dormant	Carbaryl	0.2%	White grub	Need based
		Phorate 10 G	25 kg/ha		Soil application
		Quinalphos 5 G	25kg/ha.		Soil application
		Chloropyrifos 20 EC	0.1%		Foliar application
		Nemacur	13.5kg/ha.		Soil application
		Thionazim 20 E or	5L/ha.	Nematode	Foliar application
		Isazophos 50	3L/ha.		Foliar application

**NB :** *However Azadirachtin formulations as per the recommendations of concerned S.A.Us may be preferred over synthetic insecticides being safe in use.*

## **BASIC PRECAUTIONS IN PESTICIDE USAGE**

### **A. Purchase :**

1. Purchase only just required e.g. 100, 250, 500 or 1000 g/l for single application in specified area.
2. Do not purchase leaking containers, loose unsealed or torn bags.
3. Do not purchase pesticides without proper / approved labels.

### **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.
4. Never keep them together with food or feed/fodder.
5. Keep away from reach of children and livestock.
6. Do not expose to sun-light or rain water.
7. Do not store weedicides along with other pesticides.

### **C. Handling :**

1. Never carry/transport pesticides along with food materials.
2. Avoid carrying bulk-pesticides (dusts/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 polyethylene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (do not use polyethylene bag contaminated with pesticides).
5. Read the label on the container before preparing spray solution.



6. Prepare spray solution as per requirement.
7. Do not mix granules with water.
8. Concentrated pesticides must not fall on hands etc. while opening sealed containers. Do not smell the pesticides.
9. Avoid spilling of pesticide solution while filling the sprayer tank.
10. Do not eat, drink, smoke or chew while preparing solution.
11. The operator should protect his bare feet and hands with polyethylene bags.

E. **Equipments** :

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
4. Do not 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.
3. Do not apply just before the rains and also after the rains.
4. Do not apply against the wind direction.
5. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer.
6. Wash the sprayer and buckets etc. with soap water after spraying.
7. Containers, buckets etc. used for mixing pesticides should not be used for domestic purposes.
8. Avoid entry of animals and workers in the fields immediately after the spraying.

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 re-use empty pesticides container for any purpose.