



IPM PACKAGE NO. 26



INTEGRATED PEST MANAGEMENT PACKAGE

FOR

SUGARCANE



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 SUGARCANE

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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 sensitize extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, gathering of the scattered information on various components of this eco-friendly approach in the form of package is basic necessity. In this direction, initial attempts were made in 1992 to harmonize 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. Keeping in view, the development of resistance and attainment of pest status by certain insects, updating of IPM modules in five crops (Cotton, Rice, Sugarcane, Groundnut & Coconut) was done in 9th National Workshop held at CIL, Faridabad during 22nd-23rd December, 2003.

(P. S. Chandurkar)

31st December, 2003

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 May 14-17, 2001 and February 20-22, 2002 respectively to update 20 available IPM Packages and developed 31 new IPM Packages especially for horticultural crops. Sixth and Seventh National Workshops held at Central Insecticides Laboratory, Faridabad on 4th-5th July, 2002 and 9th-10th January, 2003 respectively for 18 IPM Packages and Eighth National Workshop was held at NPPTI, Hyderabad on 28th-29th 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, Peas, 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. Moreover, 9th National Workshop for Review/Upgradation of IPM Package of Rice, Cotton, Sugarcane, Coconut and Groundnut crops was held during 22nd -23rd Decembe, 2003 at CIL, Faridabad. Latest research developments, pest problems and their management practices have been incorporated in these IPM packages.

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 the various Institutes of 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.

31st December, 2003



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IPM PACKAGE FOR - SUGARCANE

I. MAJOR PESTS

A. Pests of National Significance :

1. Insect Pests:

(a) **BORERS:**

- 1.1 Shoot borer (*Chilo infuscatellus*)
- 1.2 Pink borer (*Sesamia inferens*)
- 1.3 Top Shoot borer (*Scirpophaga excerptalis*)
- 1.4 Root borer (*Emmalocera depressella*)
- 1.5 Internode borer (*Chilo sacchariphagus indicus*)
- 1.6 Stalk borer (*Chilo auricilius*)

(b) **SUCKING PESTS:**

- 1.7 White woolly aphid (*Ceratovacuna lanigera*)
- 1.8 Black bug (*Cavelerius sweeti*)
- 1.9 White fly (*Aleurolobus barodensis*)
- 1.10 Pyrilla (*Pyrilla perpusilla*)
- 1.11 Mealy bugs (*Saccharicoccus sacchari*, *Kiritschenkella sacchari*)
- 1.12 Thrips (*Fulmekiola saccharicila*)
- 1.13 Grasshoppers (*Hieroglyphus sp.*, *Acrotylus sp.*, *Spherigonotus sp.*)

(c) **SUBTERRANEAN PESTS:**

- 1.13 Termites (*Odontotermes spp.*)

2. **Diseases:**

- 2.1 Red Rot (*Colletotrichum falcatum*)
- 2.2 Wilt (*Acremonium implicatum*, *Fusarium moniliforme* var *subglutinans*)
- 2.3 Grassy shoot
- 2.4 Smut
- 2.5 Scald
- 2.6 Red stripped disease

3. **Weeds:**

- 3.1 Purple nut sedge (*Cyperus rotundus*)
- 3.2 Burmuda grass (*Cynodon dactylon*)
- 3.3 Johnson grass (*Sorghum halepense*)
- 3.4 Crab grass (*Digitaria sanguinalis*)
- 3.5 Tiger grass (*Saccharum spontaneum*)
- 3.6 Carpet weed (*Trianthema portulacastrum*)

- 3.7 Bull goat weed (*Ageratum conyzoides*)
- 3.8 Day flower (*Commelina benghalensis*)
- 3.9 Field bind weed (*Convolvulus arvensis*)

4. Rodents :

- 4.1 Lesser bandicoot (*Bandicota benghalensis*)
- 4.2 Soft furred fieldrat (*Millardia melitana*)

5. Nematodes :

- 5.1 *Pratylenchus* spp.
- 5.2 *Hoplaimus* spp.
- 5.3 *Tylenchorhynchus* spp.

6. Non-Insect Pests :

- 6.1 Mites (*Oligonychus indicus, O. sacchari*)
- 6.2 Jackals (*Canis aureus*)

B. Pest of Regional Significance :

1. Insect pest:

- 1.1 Plassy borer (*Chilo tumidicostatis*) - Assam, Bihar, West Bengal.
- 1.2 Scale insect (*Melanospis glomerata*) - A.P., Karnataka, Tamil Nadu, M.S.
- 1.3 White grub (*Holotrichia consanguinea*)- Karnataka, A.P., Tamil Nadu.
(*Holotrichia serrata*) - U. P.
- 1.4 Gurdaspur borer (*Acigona steniellus*)- Haryana, Punjab, UP
- 1.5 Green borer (*Rophimetopus ablutellus*)- Uttaranchal, UP.

2. Diseases:

- 2.1 Whip smut (*Ustilago scitaminea*) - Tamil Nadu, A. P., Karnataka, Kerala
- 2.2 Phoka boeing - Throughout the country
- 2.3 Mosaic - Throughout the country

3. Weeds :

- 3.1 Crow foot grass (*Dactyloctenium aegyptium*)
- 3.2 Goose grass (*Eleusine indica*)
- 3.3 Purselane (*Portulaca oleracea*)
- 3.4 Mukand (*Eclipta alba*)
- 3.5 Prickly chofflower (*Achyranthus aspera*)
- 3.6 Bathua (*Chenopodium album*)
- 3.7 Morning glory (*Ipomoea* spp.)
- 3.8 Nightshade (*Solanum nigrum*)
- 3.9 Ground cherry (*Physalis minima*)
- 3.10 Niruri (*Phyllanthus niruri*)

- 3.11 Pimpernel (*Anagallis arvensis*)
- 3.12 Rumitory (*Fumaria pusviflora*)
- 3.13 *Parthenium hysterophorus*
- 3.14 *Trianthema portulacastrum*
- 3.15 *Brachiaria reptans*
- 3.16 *Gynandropsis pentaphylla*

II. PEST MONITORING:

The objective of the pest monitoring is to detect the initial development of pests and diseases and also the bio-control potentials in the field situation.

1. **Rapid Roving surveys:** Undertake regular roving surveys at 10 days interval for monitoring pests/diseases and assess biocontrol potential. Select randomly five observation plots at 5 to 10 Km. distance and examine thoroughly 25 clumps (i.e. 5 clumps at five spots) diagonally or zig-zag manner. Record data from sowing to cane formation.

2. Pest scouting:

1. **Pyrilla** : Count eggmasses, nymphs and adults of pyrilla and *Epiricania* cocoons. Record egg parasitism.
2. **White woolly aphid**: Count nymphs of adults on 159 inch area alongwith midrib and *Dipha* larvae & pupae on a whole leaf.
3. **Top shoot borer**: Count top shoot borer affected shoots and workout the % damage.
4. **Stalk borer**: Count stalk borer affected shoots/canes and workout the % damage.
5. **Internode borer**: Count the affected canes and workout the % damage.
6. **Rodent pests**: 25 live burrows/ha.

3. Field scouting:

Based on the observation of Rapid Roving Survey the farmers at village level are to be mobilized to undertake field scouting. During field scouting farmers may record pest, disease and defenders population once in 7 to 10 days in their own fields as per Agro Eco-System Analysis (AESA) approach. The State Departments of Agriculture should make all possible efforts by using different media mode and publicity to inform the farmers about the field scouting in the specific crop areas having indication of pest or disease build up.

4 Agro Eco System Analysis (AESA):

AESA is an approach which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pest, defenders, soil conditions, plant health, the influence of climatic factors and their inter-relationship for growing healthy crop. Such a critical analysis of the field situation 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 defenders population dynamics
4. Soil conditions
5. Climatic factors
6. Farmers' past experience

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

5 Economic Threshold Levels (ETLs)

PEST	ETL
1. Pyrilla	3-5 individuals (eggs, nymphs & adults) per leaf.
2. Early shoot borer	15-22% incidence
3. Top shoot borer	5% dead hearts in 2 nd brood (June end)
4. Internode borer	6.2 to 28.5 larvae per row of 6 m. length.
	17.15 to 28.39 bored canes per row of 6 m. length.
5. Stalk borer	17 bored internodes per row of 6 m. length
6. Rodents (working index)	25 live burrows/ha.

III. INTEGRATED PEST MANAGEMENT (IPM) STRATEGIES

A. Cultural Practices:

1. Deep summer ploughing to expose soil inhibiting/resting stages of insects. pathogens, nematode population and perennial weeds.
2. Adopt proper crop rotation like sugarcane followed by paddy, wheat, maize, jowar, potato, vegetables, pulses, oilseeds etc.
3. Resistant/tolerant varieties : Grow pest resistant/tolerant varieties, CO-86032, CO-7705, CO-8013, CO-6249, COS-8436, CO-8021 (for red rot), CO-7706, CO-7005, CO-527 (for smut), CO-7219 (for wilt), CO-6907 (for grassy shoot)
4. Select healthy setts for planting.
5. Sowing should be done timely. Late planting should be avoided in Northern region to minimise the early shoot borer incidence.

6. Planting in deep furrows of 20 cm depth.
7. Always use well rotten Farm Yard Manure (FYM) to avoid the damage by termites.
8. Avoid untimely high nitrogenous fertilizers to minimise the pyrilla, white woolly aphid and stalk borer attack.
9. Irrigation at closer intervals for managing early shoot borer.
10. Rouging of diseases infected clumps soon after detection.
11. Detrashing of canes in the scale insect, mealy bugs, white woolly aphid and stalk borers prone areas.
12. Removal of water shoots to destroy scale insect stages, stalk borers and white woolly aphid.
13. Practice deep harvesting to destroy stubbles.
14. Take green manuring crops.
15. Avoid trash burning which will be helpful to conserve moisture, predators and parasitoids and minimise the weeds growth except in black bug endemic pockets.
16. Trash mulching at the rate of 3 tons per ha immediately after planting for early shoot borer.
17. Propping the canes to prevent lodging to reduce the damage by stalk borer and rodents.

B. Mechanical Control Practices & Physical Control methods:

1. Clipping of leaves bearing egg masses of top borer, Gurdaspur borer and pyrilla.
2. Removal of dead hearts of early shoot borer and top borer.
3. Removal of Gurdaspur and Plassey borer infested canes with borers in gregarious phase of feeding during July to October as campaign basis.
4. Uproot and destroy red rot & GSD and wilt infected plants and maintain high bunds around such fields to avoid run out of infected water to other healthy fields.
5. Clipping of leaves bearing of top borer signs (mid-rib tunnels).
6. Sett treatment with moist hot air at 54⁰ C for 2-2.5 hours for the control of RSD&GSD.
7. Snap traps made of bamboo may be employed for rodent management in sugarcane, rice, wheat-based cropping system.
8. Growing of arhar around the fields to prevent root borer attack.
9. Collection of white grub adults from favoured host plant and grubs behind the ploughing operation.
10. Avoid the planting of sugarcane under and around trees in order to prevent the perpetuation of white woolly aphid.
11. Use blind hoeing at 7-10 days after planting. After that use power/bullock/hand operated implements at 20-25 days interval for 3-4 times.

C. Biocontrol Practices:

1. Conservation:

- 1.1 Conservation of biocontrol agents like various species of *Sturmiopsis*, *Stenobracon*, *Isotima*, *Rhaconotus*, *Telenomus*, *Trichogramma*, *Beauveria*, *Metarhizium*, *Bacillus*, *Tetrastichus*, *Apanteles*, *Bracon*, *Adelenchyrtus*, *Epiricania*, *Encarsia*, *Brumus*, *Menochilus*, *Pharoscymnus*, *Chilocorus*, *Chrysopa*, *Dipha*, *Micromus*, *Coccinellids*, *Syrphids* and *Spiders*.
- 1.2 Paired or wider row planting of sugarcane with inter-cropping of crops like wheat, chickpea, mustard, lentil, pea, onion, winter vegetables in October-November planted sugarcane and lady finger, green gram, black gram, soybean, groundnut, sunflower, maize, French bean, cowpea, Dolichus etc. in February-March planted sugarcane should be promoted to conserve predators and parasitoids of white woolly aphid and other pests.
- 1.3 Avoid unwanted chemical sprays to conserve natural enemies.
- 1.4 Avoid trash burning to prevent destruction of hibernating *Epiricania* eggs on dry leaves, alternatively collect it and staple it in pyrilla infested field in February so also to prevent destruction of *Dipha*, *Micromus* and other predators of white woolly aphid.
- 1.5 Settle treatment with *Trichoderma viride* and *T. harzianum* before planting against wilt and red rot.

2. Augmentation:

- 2.1 Release 50,000 *Trichogramma sp.*/ha at 10 days interval for 10 times from July onwards upto October against cane borer complex.
- 2.2 Release 8-10 lakh eggs of *Epiricania*/ha when 3-5 pyrilla individuals per leaf are seen.
- 2.3 Introduction and colonization of *Isotima javensis* in northern parts of the country in the endemic areas for top borer.
- 2.4 Colonisation of egg parasitoids of top borer & pyrilla.
- 2.5 Release *Dipha* @ 2000 larvae or pupae/ha or *Micromus* @ 2000 larvae or *Chrsoperla carnae*, 2500 eggs or 1000 larvae/ha in white woolly aphid infested areas.

3. Pest Defenders Ratio (2:1): For pyrilla one viable cocoon of *Epiricania*/10 leaves and for white woolly aphid, one larvae of *Dipha*/leaf does not warrant any chemical pesticide application.

- D. Chemical Control Measures: 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.

- i) Application of Chlorpyrifos 20 EC @ 5 ltr/ha at planting or at 35-40 days after planting along the furrows followed by irrigation gives excellent control of early shoot borer, termites and white grubs.
- ii) Application of Carbofuran 3 G @ or phorate 10 G @ 25 kg/ha in the last week of June along the furrows near the root zone will give excellent control of third brood of top borer in Sub-tropical region. Insecticide application should be mixed in soil followed by light irrigation.
- iii) Spraying of Endosulfan (0.07%) mixed with 2% Urea give good control of black bug in ratoon crops. While spraying insecticides, the nozzle of sprayer should be directed towards whorl.
- iv) Apply Phorate 10 G @ 20-25 kg/ha or Carbofuran 3 G 33kg/ha for the control of white grub.
- v) Spraying of malathion 0.1% at 4-6 internode stage in ratoon crop against scale insect.
- vi) Soil application of phorate 10 G @ 20 kg/ha upto 6 months old crop or one spray of methyl demeton or dimethoate at 0.05% for the control of white woolly aphid.

(E) Weed Management Practices:

Pre-emergence herbicides like Atrazine @ 0.5-2.0 Kg a.i./ha., Simazine @ 1.5-2.0 kg/ha, Diuron @ 1.6-3.2 kg a.i./ha Metribuzin @ 1.05-2.0 kg a.i./ha would provide effective weed control for a period of 5-6 weeks and thereafter the dense crop canopy will suppress weed vegetation.

(F) Nematode Management Practices:

1. Deep summer ploughing.
2. Removal of weeds.
3. Destruction of crop residue.
4. Application of neem cake.

(G) Rodent Management Practices:

1. In case of heavy rodent infestation (more than 50 live burrows/ha, apply Zinc Phosphide (1 : 40) baits preceded by 1-2 days pre-baiting.
2. Apply Bromodialone (0.005%) baits either freshly made from Bromodialone 'C' or ready to use form Bromodialone 'CB'. Repeat the application after 10 days.

IV. STAGewise IPM PRACTICES TO BE ADOPTED IN SUGARCANE CULTIVATION.

CROP STAGE/PESTS	IPM PRACTICES TO BE ADOPTED
1. Pre-sowing	<ol style="list-style-type: none"> 1. Deep ploughing in summer. 2. Removal of weeds. 3. Adopt proper crop rotation. 4. Avoid mono cropping. 5. Application of neem cake @ 1 Tonne/ha
2. At planting.	
(i). Soil & seed born diseases	<ol style="list-style-type: none"> 1. Select tolerant/resistant varieties. 2. Select the seed cane from aerated steam treated nurseries. 3. Seed treatment with carbendanzim (0.1%) or <i>Trichoderma spp.</i> @ 4-6 g/ litre of water. 4. Crops like potato, mustard, lentil, pulses and winter vegetables can be grown as inter-crop during autumn planted sugarcane i.e. Oct-Nov. & Lady finger, sunflower, soybean, green gram, groundnut etc. during Feb-March planted sugarcane to reduce the weed and pest population and to conserve bioagents of white woolly aphid and other pests.
(ii) Termite & white grub	<ol style="list-style-type: none"> 1. Remove stubble and debris of previous crops. 2. Digging of termatoria and destruction of queen be done around sugarcane field. 3. Apply Endosulphan dust 25 kg/ha for termites or Chlorpyrifos 20 EC @ 5 lit/ha for termites and white grubs on seed setts in furrows.
(iii) Weeds	<ol style="list-style-type: none"> 1. Use pre-emergence herbicides like Atrazine @ 1.5 - 2.0 kg/ha.
3. Tillering stage	
(i) Weeds	<ol style="list-style-type: none"> 1. Inter-culture and handweeding.
(ii) Early shoot borer	<ol style="list-style-type: none"> 1. Collection and destruction of dead hearts. 2. Timely irrigation from April-June for early shoot borer. 3. In ratton crop, mulching with trash

	<p>reduces shoot borer attack.</p> <ol style="list-style-type: none"> 4. Use of pheromone traps @ 5/ha for monitoring. 5. Apply granulosis virus @ 250 LE/ha 6. Release of <i>Trichogramma chilonis</i> @50,000 /ha 6 times, 10 days interval in May-June. 7. If needed use Chlorpyrifos 5 lit./ha 35-40 days after planting followed by irrigation.
(iii) White grubs	<ol style="list-style-type: none"> 1. Application of <i>Beauveria brongniartii</i> @ 4 kg/ha (2×10^7 CFU/g) in 60-70 kg Farm Yard Manure (FYM) at the base of clumps covering with soil followed by irrigation.
(iv) Top shoot borer	<ol style="list-style-type: none"> 1 Collection and destruction of dead hearts. 2. Collection and destruction of egg masses. 3. Use of pheromone traps @ 5/ha for monitoring coincing with brood emergence. 4. Release of <i>Trichogramma japonicum</i> @ 50,000/ha. 2-3 times at 10 days interval 5. Apply Carbofuran 3 G @ 25 kg/ha or phorate 10 G @ 25 kg/ha.in the last week of June to control 3rd brood of top borer.
(v) Black bug	<p>Apply Endosulfan (0.07%) in April- May in ratoon crops.</p>
(vi) Scale insect	<ol style="list-style-type: none"> 1.Drench spraying with malathion 0.1% at 4-6 internode stage of the crop in scale insect endemic pocket in ratoon crop.
(vii) White woolly aphids	<p>Soil application of phorate 10 G @ 20 kg/ha.</p>
5. Cane formation stage	<ol style="list-style-type: none"> 1. Avoid late application of nitrogenous fertilizers. 2. Collection and destruction of egg masses.
(i) Pyrilla	

	<ol style="list-style-type: none"> 3. Conservation of nymphal and adult parasite, <i>Epiricania melanoleuca</i>. 4. Release of 8,000 to 10,000 cocoons or 8-10 lakh eggs of <i>E. melanoleuca</i> per ha. when 3-5 pyrilla individuals per leaf are seen. 5. Spray Dichlorvos (0.1%) or endosulphan (0.05%) or malathion (0.1%) in case <i>Epiricania</i> is not seen.
<p>ii) Stalk borer, internode borer and plossy borer</p>	<ol style="list-style-type: none"> 1. Proper water management to avoid lodging. 2. Detrash once in month from September to October. 3. Balanced dose of fertilizers. 4. Removal of water and late shoots. 5. Spray granulosis virus @ 250 LE/ha 6. Release of <i>Trichogramma chilonis</i> @ 50,000/ha 10 times at 10 days interval from July to October. 7. Use of pheromone traps @ 5/ha for monitoring.
<p>iii) Scale insect and mealy bug</p>	<ol style="list-style-type: none"> 1. Detrashing at 30 days interval.
<p>iv) White fly</p>	<ol style="list-style-type: none"> 1. Clipping of infested leaves. 2. Spray <i>verticillium leconii</i> @ 2 g/lit of water (2×10^7 CFU/g) 3. Spray NSKE (5%) or neem oil (0.2%). 4. Spray Endosulfan (0.07%) or Monocrotophos (0.05%).
<p>v) Red rot and wilt</p>	<ol style="list-style-type: none"> 1. Roguing of infected plants.
<p>vi) Rodent</p>	<ol style="list-style-type: none"> 1. Resort to baiting with zinc phosphide (2%) in May and November followed by Bromadilone baiting.
<p>5. Harvesting</p>	<ol style="list-style-type: none"> 1. Deep harvesting. 2. Removal of late shoots and water shoots.

V. DO's AND DON't's IN SUGARCANE I.P.M.

Do's

1. Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be exposed to sun light at least for 2-3 weeks.

2. Grow only recommended varieties for a particular region.

3. Plant the varieties which are recommended for early sowing or late planting or water logging conditions at proper time.

4. Always use recommended doses of NPK fertilizers as per the soil testing recommendations.

5. Use Micronutrients mixture at the time of planting.

6. Hot water and hot air treatment should be given to check the seed borne diseases.

7. Always treat the setts with approved chemicals/bio products for the control of seed borne diseases.

8. Plant in rows (east-west direction) at optimum depths under proper moisture conditions for better establishment.

9. Pre emergence herbicides should be applied immediately after sowing before the emergence of weeds and crops.

10. Apply only recommended herbicides at recommended dose at

Don't's

Do not plank or irrigate the field after ploughing at least 2-3 weeks to allow desiccation of weeds' bulb and rhizomes of perennial weeds.

Do not grow varieties which are not recommended for a particular area or which have become susceptible to diseases/pests in general.

Do not grow varieties which are not recommended for that particular time or situation.

Avoid imbalanced use of fertilizers.

Do not mix micronutrients with fertilizers.

During the treatment, temperature and humidity should be maintained very carefully, otherwise it may effect on germination.

Do not use seeds without seed treatment with biopesticides/chemicals.

Do not plant setts beyond 20 cm depth.

Pre emergence herbicides should not be applied after emergence of crop or weeds, as they may cause phytotoxicity to the crop.

Pre emergence as well as soil incorporated herbicides should not be

- proper time and appropriate spray solution with standard equipment alongwith flat fan or flat get nozzles. applied in dry soils. Do not apply herbicides alongwith irrigation water or by mixing with soil, sand or urea.
11. Conduct AESA weekly in the morning preferably before 9.00 am. Take decision on management practice based on AESA, ETL and P:D ratio only. Do not apply chemical pesticides on calendar basis.
12. Release parasites only after noticing adult moths or as per field observation. Do not apply chemical pesticides within 7 days of release of parasitoids.
13. Spray pesticides thoroughly to treat the undersurface of the leaves. Do not spray at mid day since, most of the insects are not active during this period.
14. Dry trash containing egg masses of *Epiricania* should be spread thoroughly in thin layers in ratoon crops. Do not burn the dry trashes because it preserves moisture and conserve parasites/predators and minimise weeds growth.

VI SAFETY PARAMETERS IN PESTICIDES USAGE

Classification per WHO 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning	Waiting period (No. of days)
PESTICIDES						
Toxic	Yellow	Class II - Moderately Hazardous	<p>Remove the person from the contaminated environment.</p> <p>In case of (a) Skin contact - Remove all contaminated clothings and immediately wash with lot of water and soap; (b) Eye contamination - Wash the eyes with plenty of cool and clean water; (c) Inhalation - Carry the person to the open fresh air, loosen the clothings around neck and chest, and (d) Ingestion - If the victim is fully conscious, induce vomiting by tickling back of the throat. Do not administer milk, alcohol and fatty substances. In case the person is unconscious make sure the breathing passage is kept clear without any obstruction. Victim's head should be little lowered and face should be turned to one side in the lying down position. In case of breathing difficulty, give mouth to mouth or mouth to nose breathing.</p> <p>Medical aid: Take the patient to the doctor/Primary Health Centre immediately along with the original container, leaflet and label.</p>	Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death	<ul style="list-style-type: none"> - Gastric lavage with 2-4 L. tap water - Catharsis with 30 gm. (10 oz) sodium sulphate in one cup of water - Barbiturates in appropriate dosages repeated as necessary for restlessness or convulsions - Watch breathing closely, aspirate, oxygen and/or artificial respiration, if needed. - Avoid oils, oil laxatives and epinephrine (Adrenalin) - do not give stimulants. - Give calcium gluconate (10% in 10 ml. Ampules) intravenously every four hours. 	

ORGANOPHOSPHATE PESTICIDES

2.	Chlorpyrifos	Highly toxic	Yellow	Class II Moderately Hazardous	Mild - anorexia, headache, dizziness, weakness, anxiety, tremors of tongue and eyelids, impairment of visual acuity.	For extreme symptoms of O.P poisoning, injection of atropine (2-4 mg., for adults, 0.5-1.0 mg for children) is recommended, repeated at 5-10 minute intervals until signs of atropinization occur.
3.	Phorate	Extremely toxic	Bright red	Class I a Extremely hazardous		
4.	Dichlorvos	Highly toxic	Yellow	Class II Moderately hazardous	Moderate- nausea, salivation, lacrimation, abdominal cramp, vomiting, sweating, slow pulse, muscular tremors, miosis.	Speed is imperative - Atropine injection - 1 to 4 mg. Repeat 2 mg. when toxic symptoms begin to recur (15-16 minute intervals), Excessive salivation - good sign, more atropine needed; - Keep airways open, Aspirate, use oxygen, insert endotracheal tube. Do tracheotomy and give artificial respiration as needed. - 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.
5.	Malathion	Moderately toxic	Blue	Class II Moderately Hazardous		
6.	Fenitrothion	Moderately toxic	Blue	Class II Moderately hazardous	Severe - diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	
						In addition to atropine give 2-PAM (2-pyridine aldoxime methiodide). 1 g and 0.25 g for infants

		toxic	Red				intravenously at a slow rate over a period of 5 minutes and administer again periodically as indicated. More than one injection may be required.
		toxic	Red				Avoid morphine, theophyllin, aminophyllin, barbiturates or phenothiazines.
		toxic	Red				Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.

CARBAMATES

7.	Carbofuran	Extremely toxic	Red	Class I b - Highly hazardous		Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhoea, epigastric pain, tightness in chest.	<ul style="list-style-type: none"> - Atropine injection 1 to 4 mg. Repeat 2 mg when toxic symptoms begin to recur (15-60 minute intervals). Excessive salivation – good sign, more atropine needed. - Keep airway open. Aspirate, use oxygen, insert endotracheal tube. Do tracheotomy and give artificial respiration as needed. - 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
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							<p>area.</p> <ul style="list-style-type: none"> - Oxygen - Morphine, if needed. <p>Avoid theophyllin and aminophyllin or barbiturates.</p> <p>2-PAM and other oximes are not harmful and in fact contra indicated for routine usatge.</p> <p>Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.</p>
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HERBICIDES

8.	Metribuzin	Moderately toxic	Blue	Table 5 – Unlikely to present acute hazard in normal use		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.
9.	Pendimethalin	Moderately toxic	Blue	Class III – Slightly hazardous			
10.	Diuron	Moderately toxic	Blue	Table 5 – Unlikely to present acute hazard in normal use			
11	Atrazine	Moderately toxic	Blue	-do-			
12.	Simazine	Moderately toxic	Blue	-do-			

RODENTICIDES

13.	Bromodiolo ne	Extremely toxic	Bright red	Class I a - Extremely hazardous	Bleeding from nose, gums and into conjunctiva, urine and stool & coma	<ul style="list-style-type: none"> - Give Vitamin K1 15-25 mg for adults; 5-10 mg. for children orally; - Transfuse with fresh blood if bleeding is severe or until anemia is corrected. - Iron (Ferros sulfate) by mouth for correction of secondary anemia, 0.3 gm t.i.d.
					Possible polar and petechial rash, late-massive echymoses or hematoma of skin, joints, brain hemorrhage	

AGRO-ECOSYSTEM ANALYSIS (AESA)

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. Plants 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 experiences.

The methodology of AESA is as under :-

A. Field Observations :

- a) Enter the field at least 5 ft. away from the bund. Select a site with a dimension of 1 sq. mt. Randomly.
- b) Record the visual observation in following sequence :-
 - i) Flying insects (both pests & defenders)
 - ii) Close observation on pest and defenders which remain on the plants

- iii) Observe various pests like pyrilla, black bugs, mealy bugs, scales, white woolly aphid, etc. and defenders like *Epiricania*, coccinellids, *Chrysopa*, ground beetles/rove beetle, *Dipha*, *Micromus*, *Syrphids* and earwigs etc., by scrapping the soil surface and the plants.
- iv) Record disease and its intensity.
- v) Record insect and rodent damage and disease incidence in percentage.
- c) Record parameters like number of leaves, plant height and vigour of the selected plants for making observation in the following weeks. Observe nematode damage symptoms.
- d) Record the types of weeds, their size and population density in relation to crop plant.
- e) Record soil conditions viz., flooded, wet or dry.
- f) Observe rodent live burrows.
- g) Record the climatic factors viz., sunny, partially sunny, cloudy, rainy etc. for the preceeding week.

B. Drawing

First draw the plant at the centre on a chart. Then draw pests on left side and defender on the right side. Indicate the soil condition, weed population, rodent damage etc. Give natural colours to all the drawing, 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 pest and defenders are their population count

should also be given alongwith diagram. The weather factors should be reflected inn the chart by drawing the diagram of sun just above the plant if the attribute is sunny. If cloudy, the clouds may be drawn in place of sun. In the 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 by raising questions relating to change in pest and defender population in relation to crop stages, soil condition, 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 : (Examples)

- i) When large number of egg masses and early instar larvae/nymphs of borers and pyrilla are observed, the group may initiate release/conserved natural enemy.
- ii) Some of the defenders like lady beetles, groundnut beetles, rove beetles, wasps *Dipha*, *Micromus*, *Chrysopa*, *Syrphids*, *Spiders*, etc. play useful role in arriving at P : D ratio.

E. AESA by Extension functionaries :

The extension functionaries during their regular visit to the village mobilise the farmers, conduct AESA and critically analyse the various factors such as the pests population vis-a-vis 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, which 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 fields.

F. AESA by farmers :

After a brief exposure during IPM demonstrations/field training, farmers can practice AESA in their own fields. Wherever trained farmers are available, their experiences could be utilized in training their fellow farmers in their own villages. Thus, a large group of farmers could be made proficiently 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.

BASIC PRECAUTIONS IN PESTICIDE USAGE**A. Purchase**

1. Purchase only JUST required quantity e.g. 100, 250, 500 or 1000 g/ml 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 alongwith 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 polythin bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover head (Do not use polythin 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 polythene bags.

E. Equipment

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
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.
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 purpose.
8. Avoid entry of animals and workers in the fields immediately after the spraying.
9. Anti-cogulant rodenticide should be applied deep inside the rat holes to prevent their intake by non-target animals.

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 pesticide container for any purpose.
4. Dead rodents should be buried in the soil.