



IPM PACKAGE NO. 16



INTEGRATED PEST MANAGEMENT PACKAGE

FOR

POTATO



Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation
Directorate of Plant Protection, Quarantine & Storage
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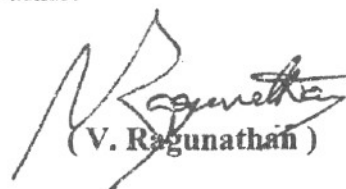
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FOR E W A R D

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 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 and 2002 to update and develop IPM package of practices for agricultural and horticultural crops. Presently, IPM package of practices for 51 crops have been finalised to help the extension workers and farmers to manage the pests/ diseases and to minimise 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. 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.

April 1, 2002


(V. Raguathan)

P R E F A C E

In order to minimise 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 harmonisation of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized from April 15-17, 1998 and Nov. 5-6, 1998 at Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM package of practices for 20 crops were evolved 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 Feb. 20-22, 2002 respectively to update 20 available IPM Packages and develop 31 new IPM Packages specially for Horticultural crops. In these workshops, 51 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), commercial crops (Cotton, Sugarcane, Tobacco, Tea), pulse crops (Pigeonpea, Gram, Black gram/Green gram, Pea, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitaceous vegetables), fruit crops (Citrus, Banana, Apple, Mango, Guava, Grapes, Pineapple, Sapota, Pomegranate, Litchi), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalised.

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 encompasses various management strategies for containing the pest and disease problems. Pest monitoring is also one of the important component 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 Agriculture 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 Indian Agriculture and Horticulture. These will also be useful in reducing the pesticide residues in exportable 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 packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

April 1, 2002



(A.D. Pawar)
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IPM PACKAGE FOR POTATO

1. MAJOR PESTS:

A. Pests of National Significance

1. INSECT PESTS

- 1.1 Aphids
- 1.2 Potato tuber moth

2. DISEASES

- 2.1 Late blight
- 2.2 Viruses (Potato virus x, s & y)
- 2.3 Black scurf
- 2.4 Common scab
- 2.5 Bacterial wilt
- 2.6 Leaf spot complex (*Alternaria*, phoma leaf spot)

3. WEEDS

Broad Leaved Weeds

- 3.1 Lamb square (*Chenopodium album*)
- 3.2 Swine cress (*Coronopus didymus*)
- 3.3 Corn spurry (*Spergula arvensis*)
- 3.4 Sweet clover (*Melilotus spp.*)
- 3.5 Primpernel (*Anagallis arvensis*)

Grassy Weeds

- 3.6 Canary grass (*Phalaris minor*)
- 3.7 Blue grass (*Poa annua*)
- 3.8 Rabbit foot grass (*Dactyloctenium aegyptium*)

4. NEMATODE

- 4.1 Potato cyst nematode (PCN)

5. RODENT

- 5.1 Smaller bandicoot

B. Pests of Regional Significance:

1. INSECT PEST

- | | | |
|-----|--------------|-----------------------------|
| 1.1 | Cut worms | Throughout plains and hills |
| 1.2 | White grubs | Hills |
| 1.3 | Leaf hoppers | Plains |
| 1.4 | Mites | Plains and plateau region |
| 1.5 | Thrips | Plains and hills |

2. DISEASES

- | | | |
|-----|--|------------------------------|
| 2.1 | Stem necrosis
(tomato spotted wilt virus) | Gujarat, M.P. and Rajasthan |
| 2.2 | Charcoal rot | Bihar, M.P. and Eastern U.P. |
| 2.3 | Potato Spindle Tuber viroid (PST vd) | |
| 2.4 | Pink rot | Shimla, Darjeeling hills |
| 2.5 | Early blight | |

3. RODENT

- | | | |
|-----|------------------|--|
| 3.1 | Indian Porcupine | Himachal Pradesh, J & K Upper
Parts of U.P. and Bihar |
|-----|------------------|--|

4. NEMATODE

- | | | |
|-----|--------------------|-----------------|
| 4.1 | Root-knot nematode | Plain and hills |
| 4.2 | Golden nematode | Ooty hills. |

II. PEST MONITORING

The objective of pest monitoring is to detect the initial development of pests and diseases and also the biocontrol potential in the field situations.

1. Rapid Roving Survey (RRS)

Survey teams should undertake regular insect pests and disease monitoring on pre-selected routes at seven days interval and assess biocontrol potential in addition to insect pest and disease situation to give early fore-warnings. Records should be kept about insect pest and disease incidence and biocontrol fauna. Aphids population should

be recorded on 34 plants (100 leaves) and leaf hoppers population by sweep method and plant count. The fields should be selected randomly after every 10 km. distance. The working index for rodent pests is 25 live burrows per hectare.

2. Field Scouting

Field scouting should be undertaken by the farmers/extension functionaries to keep a close watch on the appearance of insect pests, diseases and biocontrol fauna, once in seven days to work out the ETL. For sucking pests, population should be counted on three leaves (top, middle and lower) per plant. Cut worms and white grub percent damage assessment can be made by counting total number of plants and affected plants.

When the weather conditions become congenial (overcast sky, high humidity or intermittent rains) the fields should be monitored on alternate days for occurrence of late blight.

3. Agro Eco System Analysis (AESAs)

Based upon weekly AESA, Economic Threshold Level (ETL) and corresponding change in pest defender ratio, the extension functionaries have to take judicious decision in advising farmers for specific pest management practices. Detailed methodology for undertaking AESA exercise is given in Annexure. I .

4. Pest Monitoring Through Pheromones/Yellow Pan/Sticky Traps

i. Pheromone traps - Monitoring

The pheromone traps may be placed in the field @ 20 traps per ha. for potato tuber moth for mass trapping the field and @ 4 traps per 100 m³ area of the stores.

ii. Yellow pan/sticky traps

Set up yellow pan/sticky traps for monitoring aphids @ 10 yellow pans/sticky traps per ha. Locally available empty yellow palmoline tins coated with grease/vaseline/castor oil on outer surface may also be used.

5. Economic threshold levels (ETLs)

Pest/ Disease	ETL
1. Aphids	20 aphids/100 leaves
2. Potato tuber moth	15-20 moth/trap consecutive for 3 nights
3. Golden nematode	1-2 larvae/gram soil
4. Late blight	Not more than 1% leaf area affected
5. Bacterial wilt	1% of plants population
6. Potato viruses	1% of plants population
7. Soil and tuber borne disease	5% potato tubers

III. INTEGRATED PEST MANAGEMENT

A. Cultural Practices

1. Summer deep ploughing to expose soil inhabiting/resting stages of insects, pathogens and nematode population.
2. Trimming of the field bunds to destroy the existing rodent burrows.
3. Plant disease free whole tubers at optimum date(s) of planting -15th October to 30th October in Western and Central plains and from 1st November to 15th November in Eastern plains.
4. Apply recommended doses of NPK.
5. Prepare high ridges to avoid exposure of seed tubers.
6. Grow resistant varieties as under:

For late blight: Kufri Badshah, Kufri Jyoti, Kufri Satlej, Kufri Anand, Kufri Giriraj, Kufri Megha, Kufri Kanchan, Kufri Thanamalai.

For cyst nematode: Kufri Swarna and Kufri Thanamalai.

For wart : Kufri Jyoti, Kufri Kanchan and Pimpernel.

7. Adjustment of planting and harvesting time for avoidance of pests and diseases.
8. Follow crop rotation with non solanaceous crops.

9. Seed treatment with Mancozeb for 20 minutes before storage for the control of soil and tuber borne diseases.
10. The crop should be sown timely at proper moisture by using recommended seed rate, balanced doses of fertilizers for achieving optimum plant population and healthy crop stand which would be capable of competing with weeds at initial stages of crop growth.
11. The crop should be maintained weed free initially up to six weeks after planting by resorting two hand hoeing/earthing up operation at 3rd and 6th weeks of planting.

B. Mechanical Practices

1. Collect and destroy larvae, pupae and adults of white grubs.
2. Sort out late blight infected tubers, cut worms and white grubs damage tubers to avoid secondary infection in the stores.

C. Biocontrol Practices

1. Conserve predators like lady bird beetles, predatory wasps, surface bugs, spiders and parasitoids like *Apanteles*, *Bracon* and *Telenomus*.

D. Chemical Practices

1. Apply Phorate 10% CG @ 1.0 kg. a.i. per ha. as soil application/earthing up application followed by one spray of Oxydemeton methyl 25 E.C. @ 250 gram a.i. per ha. for aphids and thrips control in the seed crops only.
2. Apply carbofuran 3% CG @ 1.0 and 2.6 kg. a.i. per ha. against white grubs and potato cysts nematodes respectively.
3. Strict domestic quarantine regulations to be implemented against PCN and potato wart in Tamil Nadu and West Bengal.
4. Use chlorpyrifos 20 E.C. @ 500 gms. a.i. per ha. against cut worms.
5. Apply mancozeb 75% WP @ 1.5-2.0 kg/ha for the control of late blight and early blight diseases or copper-oxy-chloride 50% WP @ 2.5 kg/ha. or clorothalonil 75% WP @ 1.25 Kg/ha.

6. Apply metalaxyl 8%+mancozeb 64% WP combination formulation @ 1.8-2.5 kg/ha. for the control of the late blight after one spray of above fungicides in cases when the disease has established and the weather is congenial for further build up of the disease.
7. Apply stable bleaching power @ 12 kg/ha. in soil at planting for the control of bacterial wilt.
8. If the rodent infestation is less than 25 live burrows/ha., use bromadiolone 0.005% bait (10-15 gram per burrow inside the live burrows). However, if the rodent infestation is high (more than 25 live burrows per ha.), use Zinc Phosphide 2-2.5% baits @ 10 gram per burrow to be placed inside the live burrows after prebaiting with plain bait. The control operations may be started during first week of June in the hills.

IV. CROP STAGES VIS-A-VIS IPM PRACTICES

Sr. No.	Crop Stage	IPM Practices	Pest Type	Applicable to Location	
1.	Planting	- Clean cultivation and deep ploughing	All	All	
		- Avoid collateral host	All	All	
		- Soil application of Carbofuran 3G @ 1.0 kg. and 2.6 kg. a.i./ha respectively	White grub & Nematodes	All	All
		- Deep planting	PTM	All	All
		- Select resistant varieties - Kufri Swarna & Kufri Thanamalaj	PCN	All	Nilgiris
		- Crop rotation	PCN	All	Nilgiris
2.	Emergence	- Spray with chlorpyrifos 20 EC	Cut worms	All	All
3.	Tuber initiation	- Carbofuran 3G @ 1.0 kg. and 2.6 kg a.i./ha. respectively	White grub Nematodes	All/Seed	All
		- Apply mancozeb 75% WP @ 1.5-2.0 kg. a.i./ha. for the control of late blight and early blight	Late blight/Early blight		Hills
		- Apply metalaxyl 8% + mancozeb 64% combination @ 1.8-2.5 kg/ha formulation when the weather is congenial for further buildup of the disease.	Late blight and early blight	All	Hills
		- Rogue out off types and virus infected plants	Virus	All	All
		- Irrigate the crop when the night temperature drops below 4 ⁰ C.	Blight	All	All
4.	Bulking	- Removal of collateral host and spraying them with endosulfan 35 EC or quinalphos 25 EC @ 0.005% a.i.	White grub	All	Hills
		- Light traps during initial showers	White grub	All	All

- Prophylactic application of mancozeb 75% WP @ 0.25% against late blight. Subsequent application of metalaxyl 8% + mancozeb 64% combination formulation (0.25%) in alternation with mancozeb at 8 and 14 days interval respectively.

Late blight All Hills

- Apply metalaxyl 8% + mancozeb 64% when weather conditions for disease buildup are favourable. (continuous overcast sky and intermittent rains)

Late blight All Plains

- Rogue out off types and virus infected plants

Virus All All

- Irrigate the crop when the night temperature drops below 4^o C.

Blight All All

5. Leaf- senescence - Haulm cutting for vector control
- Pheromone traps for mass trapping of PTM.

Aphids Seeds All
PTM All All

- Cut haulms when the late blight infection crosses 80%

Late blight All All

6. Harvesting- Early harvest and disposal/storage

All All All

- Collection and destruction of pest/disease damaged tubers.

All All All

- Cut the haulms and stop irrigation one week before the harvest.

Blight All All

- Curing of potatoes in heaps for 7-10 days.

Blight All All

- Sorting out of cut/bruised tubers before storage.

Blight & other diseases All All

- Seed tuber treatment with boric acid (3%) for 20 minutes before storage.

Blight & other diseases All All

7. Storage - Preferably store potatoes in cold stores in country stores
- Clean the store before placing material.
 - Pheromone trap @ 4 traps/ 100m³ of storage space.

PTM

Mid hills

All

V. DO'S AND DON'TS IN POTATO IPM

Do's	Don'ts
1. Grown only recommended varieties/ hybrid. formation	Do not grow the underscrip material which vary greatly in tuber and pest susceptibility.
2. Agronomic practices	
a) Timely sowing	
b) Judicious use of fertilizers	
Always use recommended NPK fertilizers in balanced proportion based on soil testing reports	Do not use under, over or imbalanced fertilizers application which might result in poor plant health and reduce resistance to various insect pests and diseases.
c) Rogue the plants infected with viruses regularly during vegetative phase.	
3. Pest management	
a) Ensure regular surveillance for timely detection of economic threshold values which are required for need based application of control measures against different insect pests and potato cyst nematodes.	Do not keep the virus infected plant in the field to check the further spread of the diseases.

- | | |
|---|---|
| b) Selection of effective pesticides and its doses at right stage. | Do not go for blanket sprays without field roving. |
| c) Use only recommended pesticides of the recommended doses for control of various pests. | Do not use mixture of various insecticides which are not recommended in any case.
Do not use the insecticide at lesser/over dosages than the recommendations. |
| d) Always follow the recommended spray technology using adequate spray of material. | Do not use substandard nozzles with high discharge rate which lead to poor coverage of the target site. |
| e) Use recommended pesticides | Do not use those pesticides which are not recommended. The date expired pesticides should not be used.
Do not purchase insecticides without bills and the information on batch number. |
| 4. Weed management | |
| a) Deep ploughing is to be done on bright sunny days during the months of May or June. The field should be kept exposed to sunlight at least 2-3 weeks. | Do not plank or irrigate the field after ploughing, at least for 2-3 weeks to allow desiccation of weed's bulbs and/or rhizomes of perennial weeds. |
| b) Maintain optimum and healthy crop stand which would be capable of competing with weeds at critical stages of crops-weed competition. | Less seed rate of crops should not be used. |
| c) Pre-emergence herbicides should be applied immediately after sowing before emergence of weeds and crops. | Pre-emergence herbicides should not be applied after emergence of crop or weeds as they will not control the germinated weeds as well as may cause phytotoxicity to the crop. |

d) Apply only recommended herbicides at recommended dose, proper time, appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.

Pre-emergence as well as soil incorporated herbicides should not be applied in dry soils.

Herbicides should not be applied along with irrigation water or by mixing the soil, sand or urea.

The spray equipment including nozzles used for herbicides application should not be used for insecticides or fungicides application to avoid possible phytotoxicity to crops.

5. Rodent control

Pre-baiting for one day should be done before applying zinc phosphide baiting.

Do not use zinc phosphide baiting more than once.

SAFETY PARAMETERS IN PESTICIDES USAGE

S. No	Name of pesticide	Classification as per Insecticides Rules, 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning	Waiting period (No. of days)
INSECTICIDES								
ORGANOCHLORINE PESTICIDES								
1.	Endosulfan	Highly 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 docotr/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.	Quinalphos	Highly toxic	Yellow	Class II – Moderately Hazardous		Mild – anorexia, headache, dizziness, weakness, anxiety, tremors of tongue and	For extreme symptoms of O.P poisoning, injection of atropine (2-4 mg., for adults, 0.5-1.0 mg for	

3.	Oxydemeton methyl	Highly toxic	Yellow	-do-		eyelids, miosis, impairment of visual acuity.	children) is recommended, repeated at 5-10 minute intervals until signs of atropinization occur.
4.	Chlorpyrifos	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;
5.	Phorate	Extremely toxic	Bright red	Class I a – Extremely Hazardous		Severe – diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	- 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. In addition to atropine give 2-PAM (2-pyridine aldoxime methiodide). 1 g and 0.25 g for infants intravenously at a slow rate over a period of 5 minutes and administer again periodically as indicated. More than one injection may be required. Avoid morphine, theophyllin, aminophyllin, barbiturates or phenothiazines.

							Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.
CARBAMATES							
6.	Carbofuran	Extremely toxic	Red	Class I b - Highly hazardous		<p>Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhoea, epigastric pain, tightness in chest.</p>	<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 was with soap and water (eyes – wash with isotonic saline). Wear rubber gloves while washing contact area. - Oxygen - Morphine, if needed. <p>Avoid theophyllin and aminophyllin or barbiturates. 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>

FUNGICIDES

7.	Mancozeb	Slightly toxic	Green	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.
8.	Copper Oxychloride	Moderately toxic	Blue	Class III – Slightly hazardous			
9.	Metalaxyl	-do-	-do-	-do-			
10.	Chlorothalonil	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use.			
11.	Boric Acid	-do-	-do-	-do-			

RODENTICIDES

12.	Bromodiolone	Extremely toxic	Bright red	Class I a – Extremely hazardous		Bleeding from nose, gums and into conjunctiva, urine and stool & coma Possible polar and petechial rash, late-massive echymoses or hematoma of skin, joints, brain hemorrhage	<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 (Ferrous sulfate) by mouth for correction of secondary anemia, 0.3 gm t.i.d.
13.	Zinc phosphide	Extremely toxic	Bright red	Class I b – Highly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and Skin etc.	No specific antidote. Treatment is essentially symptomatic.

AGRO-ECO-SYSTEM ANALYSIS (AESA)

Agro-eco-system analysis (AESA) is a process which involves periodical (weekly) observations of plant health, plant compensation abilities, ETL, climatic factors, change of pest and defenders population and their inter-relationship. AESA can be practiced by more than one group of trained farmers in a village. AESA helps in decision making on management practice required to be adopted at each crop growth stage. AESA technique may be useful in farmer to farmer IPM training programme also.

Method:

A. Field Observations

- a) Enter the field at least 5 lt. away from the bund. Select a site with a dimension of one sq. m randomly.
- b) Record the observations in following sequence :
 - i) Flying insects (both pests and defenders)
 - ii) Close observation on pests and defenders which remain on the plants.
 - iii) Observe pests like *S litura* and defenders like ground beetle/rove beetle/earwigs by scrapping the soil surface around the plants.
 - iv) Record disease and its intensity.
 - v) Record insect damage in percentage.
- c) Record in one of the selected plants, parameters like number of leaves, branches, plant height and reproductive parts (plant should be flagged for making observation in the following weeks).
- d) Record the types of weeds, their size and population density in relation to crop plant.
- e) Observe the live burrows of rodents.
- f) Repeat the step (a) to (e) for other randomly selected four sites.
- g) Repeat the climate factors viz. sunny, cloudy, partly cloudy, rainy etc. for the preceding week.

B. Drawing

Draw the entire observations in a chart paper with the plant at the centre ; pests on the left side and defenders on the right side. Use natural colours for the drawing. Indicate common names and population of pest and defenders per plant.

C. Group Discussion and Decision Making

The observation using the previous and current charts should be discussed among the group members by raising relating to change in pest and defenders population, crop stage, etc. The group may evolve a strategy based up on weekly AESA, ETL and corresponding change in P:D ration and take judicious decision for specific pest management practices.

D. Strategy for Decision Making : (Example)

- i) When large number of egg masses and early instar larvae of *Spodoptera* are observed, the groups may conclude NPV application.
- ii) 25 per cent defoliation up to 30 DAS or after 60 DAS will not affect the yield. Such information may be useful to decide management practice for defoliators.
- iii) Some of the defenders like lady beetles, ground beetles, rove beetles, wasps play useful role in arriving at P:D ratio.

AESA BY EXTENSION FUNCTIONARIES :

The extension functionaries during their regular visit to the village mobilise the farmer, conduct AESA and critically analyse the various factors such as the pest population vis-à-vis 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, which IPM components like release of defenders, application of 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.

AESA BY FARMERS :

After a brief exposure during IPM demonstrations/field trainings, 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. Farmer-to-farmer 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 the house premises.
2. Keep only in original container with intact seal.
3. Do not transfer pesticides to other container.
4. Never keep them together with food or feed/ fodder.
5. Keep away from the 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 sprayer tank.
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. **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 some 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 bucket 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 pesticide container for any purpose.
