



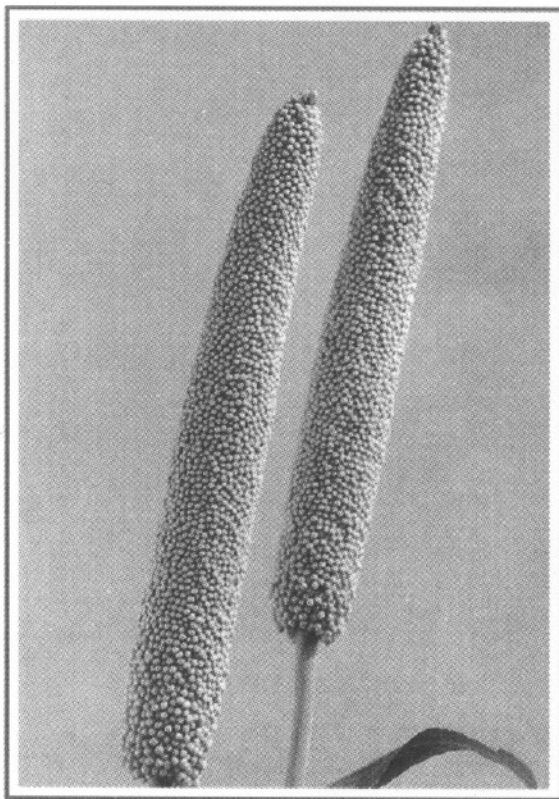
IPM PACKAGE NO. 5



INTEGRATED PEST MANAGEMENT PACKAGE

FOR

PEARL MILLET



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

May, 2001

IPM PACKAGE FOR PEARL MILLET

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Government of India
Ministry of Agriculture
(Department of Agriculture & Cooperation)
DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE
NH IV, FARIDABAD - 121 001 (Haryana)

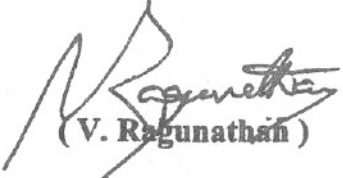
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To the Government of India

FORWARD

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. Raghunathan)

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 (AESA), 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.



(A.D. Pawar)
Director (IPM)

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IPM PACKAGE FOR PEARL MILLET

I. Major Pests

A. Pests of National significance.

1. Insect pests

- 1.1 Cutworms (*Agrotis ipsilon*)
- 1.2 White grub (*Holotrichia consanguinea.*)

2. Diseases

- 2.1 Downy mildew (*Peronosclerospora graminicola*)

B. Pests of Regional significance

1. Insect Pests

- 1.1 Shoot fly (*Atherigona sp.*)
- 1.2 Grasshopper (*Hieroglyphus sp., Chrotogonus sp.*)
- 1.3 White ant (*Chrotogonus sp., odontotermes obesus*)
- 1.4 Grey weevil (*Mylogerus sp.*)
- 1.5 Earhead bug (*Calocoris angustatus*)
- 1.6 Stem borer (*Chilo parpellus*)
- 1.7 Hairy caterpillar (*Spilosoma obliqua*)
- 1.8 Busles Beetle (*Amsacta moores Butles Mylabris sp.*)

2. Diseases

- 2.1 Ergot (*Claviceps fusiformis, C. microcephala*)
- 2.2 Smut (*Tolyposporium penicillariae*)
- 2.3 Rust (*Puccinia penniseti*)

3. Weeds

- 3.1 *Dactyloctenium aegyptium*
- 3.2 *Eleusine indica*
- 3.3 *Echinochloa spp.*
- 3.4 *Celosia argentea*
- 3.5 *Portulaca oleracea*
- 3.6 *Digera arvensis*
- 3.7 *Trianthema portulacastrum*

4. Nematodes

4.1 Reniform nematode (*Pratylenchus* spp)

5. Vertebrate pests

5.1 Rodents

5.2 Birds

II. Pest Monitoring

The objective of pest monitoring is to detect the initial development of pest and diseases and also biocontrol potential in the field situation for required plant protection measures.

1. Rapid Roving Survey

In the beginning of the crop season, survey routes are required to be identified in pest and disease endemic areas to articulate rapid roving surveys (RRS). During the surveys observations are made at 5-10 km distance in the pre-selected routes at 7-10 days intervals depending upon pest and disease situation. Record the incidence of pest, disease and defenders population at each spot in 5 plants at random.

2. Field scouting

Based on the observations of RRS the farmers at village level are to be mobilised to motivate for field scouting. During scouting farmers may record pest diseases and defenders population in 7-10 days in their own fields as per the Agro Eco system Analysis (AESA). The State Deptt. of Agriculture should make all possible efforts by different media and publicity to inform farmers need for field scouting in specific crop areas having indication of pest and diseases built up.

3. Agro Eco System Analysis (AESA)

AESA is an approach, which can be gainfully employed by extension functionaries & farmers to analyse field situations with regard to pests, defenders, soil condition, plant health, the influence of climatic factors and their inter-relationship 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 experience.

The details of AESA are given in Annexure I.

4. Use of Pheromone traps

Use pheromone traps for monitoring adults/moths etc of insects. Install traps at a distance of 50 mtrs, one trap for each insect plant. Specific lure should be used for each insect pest and should be changed after every 15-20 days.

5. Economic Threshold Levels (ETLs)

Pest/disease	ETL
White grub	1 grub/m ² area
Stem borer	10% plants with damage symptoms
Downy mildew	10% incidence at 30 DAP
Rodents	15 live burrows/ha
Nematodes	1-2 nematode/gm soil.

III. INTEGRATED PEST MANAGEMENT PRACTICES

A. Cultural Practices:

1. Deep summer ploughing helps in exposing resting stages of pests and destruction of crop residues.
2. Use of resistant varieties viz; Hybrid Pusa 23, ICMH 451, 423 Tap 155, Race 75, ICMS 7703 against downy mildew, ICMU 155, ICTP 8203, MP 155, WC-C75.
3. Timely sowing helps minimizing the pest population.
4. Growing open pollinated cultivars.
5. Wider spacing.
6. Balanced use of fertilizers & micronutrients.

B. Mechanical Practices:

1. Rouging of infected plants 15-20 days after emergence to reduce downy mildew.
2. Removal of dead hearts.
3. Use pheromone traps for monitoring.
4. Collect mechanically and destroy white grub beetles during adult emergence period to reduce the pest population.
5. Use bird scarers for the control of birds.

C. Biological Control Practices:

1. Conservation

- 1.1 Conserve biocontrol agents like *Trichogramma*, *Apanteles*, *Eriborus*, Carabids, lady bird beetles, *Chrysopa*, spiders, etc.

2. Augmentation

- 2.1 Seed treatment with *Trichoderma harzianum*, *T. viride* @ 4 g/ha seed against soil borne diseases.
- 2.2 Release of *Trichogramma chilonis* @ 75,000 adults/ha/week starting with first appearance of eggs.

D. Botanical pesticides:

1. NSKE @ 5% reduces the pest population.
2. Neem cake @ 200 g/kg for nematode control.

E. 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 development of IPM skill to play safe with environment by proper crop health, monitoring, observing ETL and conserving natural biocontrol population before deciding in favour of use of chemical pesticides as a last resort.

1. Treatment with Carbofuran 3g @ 8-12 kg in furrows to control shoot fly.
2. Spray Endosulfan 35 EC @ 0.1% for cutworms.
3. Application of Carbaryl 50 SP @ 3 kg in 500 ltr. Water/ha or Endosulfan 4 D @ 20 kg/ha to panicle to control earhead bug.
4. Spray Mancozeb 0.2% on the crop of 30 days to control downy mildew.

5. Application of Thiram 0.2% or Copper Oxychloride 0.25% thrice starting from 50% flowering.
6. Pre-emergence application of Atrazine 0.5% per ha. followed by one manual weeding to control weed.

F. Weed Management Practices:

1. Summer ploughing for destroying stubbles and perennial weeds.
2. Timely sowing of crop to minimise crop weed competition.
3. Proper spacing to facilitate interweeding operation.
4. Two manual weeding 2-3 & 6 weeks after sowing.

G. Nematodes Management Practices

1. Deep ploughing followed by fallowing in summer.
2. Rotation of crop with non host crops
3. Destruction of crop stubbles and residues.
4. Soil treatment with carbofuran granules.

H. Rodent Management Practices

1. Plough fields to demolish burrows
2. Bund trimming to minimise rodent harbourage.
3. Use of indigenous traps.
4. Apply 2.25(1:40) zinc phosphide bait preceded by one day prebaiting followed by bromodiolone (0.005%).

IV. Crop Stage-wise IPM Practices:

Stage	Pest	Practices
Pre-sowing	Resting stage of Insects, diseases causing spores, Nematode	<ul style="list-style-type: none"> - Deep summer ploughing followed by fallowing. - Adoption of crop rotation - Application of neem cake @ 200 kg/ha for Nematode control - Destruction of crop residues - Collection and destruction of white grub stages - Selection of tolerant varieties - Seed treatment with <i>Trichoderma viride</i>, <i>T. harzianum</i> @ 4 g/Kg.
	Ergot	<ul style="list-style-type: none"> - Destruction of collateral host plant <i>Pennisium typhoides</i>, <i>Ischaemum pretosum</i> and <i>Panicum maximum</i> on the field bunds. - Mechanical removal of sclerotia from seed and washing of seed in 2% salt water. - Application of Thiram 02% starting from 50% flowering. - Use of Copper Oxychloride 0.25%.
Seedling	Shoot fly	<ul style="list-style-type: none"> - Adjustment of sowing dates. - Increase seed rate. - Uprooting and destroying the infested seedlings. - Treatment with Carbofuran 3G @ 8-12 kg/ha in furrows.
Vegetative	Cutworm	<ul style="list-style-type: none"> - Release of <i>Trichogramma chilonis</i> @ 75,000/ha/week. - Spray of Endosulfan 35 EC 0.1%.
Flowering to earhead	Earhead bug	<ul style="list-style-type: none"> - Early planting reduces the chances of bug damage. - Application of Carbaryl 50 SP @ 3 kg in 500 litre water/ha or Endosulfan 4 D @ 20 kg/ha on panicles.

Midge

- Removal of Johnson grass weed.
- Application of Carbaryl 50 SP or Endosulfan 4 D prior to flower opening.

Downy mildew

- To grow resistant varieties.
- Spray Mancozeb 0.2% on the crop of 30 days old.

Birds

- Use of bird scarer.

V. 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. 	

CARBAMATES							
2.	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 was with soap and water (eyes – wash with isotonic saline). Wear rubber gloves while washing contact area.
3.	Carbaryl	Highly toxic	Yellow	Class II – Moderately hazardous			<ul style="list-style-type: none"> - 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							
4.	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.
5.	Thiram	Moderately toxic	Blue	Class III – Slightly hazardous			
6.	Copper oxychlorid e	Moderately toxic	Blue	Class III – Slightly hazardous			
HERBICIDES							
7.	Atrazine	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.

Agro Eco System Analysis (AESA)

AESA is an approach, which can be gainfully employed by extension functionaries & farmers to analysis field situations with regard to pests, defenders, soil condition, plant health, the influence of climatic factors and their inter-relationship 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 experience.

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 observations in following sequence:-
 - i) Flying insects (both pests & 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 parameters like number of leaves, branches, plant height and reproductive parts of the selected plants which 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) Record soil conditions viz. flooded, wet or dry.
- f) Observe rodent live burrows.

- g) Repeat the step (a) to (f) in four sites randomly selected.
- h) Record the climatic factors viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

B. Drawing:

First draw the plant with actual number of branches/leaves etc. at the center on a chart. Then draw pest 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 and their population count should also be given along with diagram. The weather factor should be reflected in 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 stage, 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 ration and take judicious decision for specific pest management practices.

AESA BY EXTENSION FUNCTIONARIES:

The extension functionaries during their regular visit to the village mobilise the farmers, conduct AESA and critically analyze 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, 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.

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 experience could be utilised in training their fellow farmers in their own villages. There is 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 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.

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.
