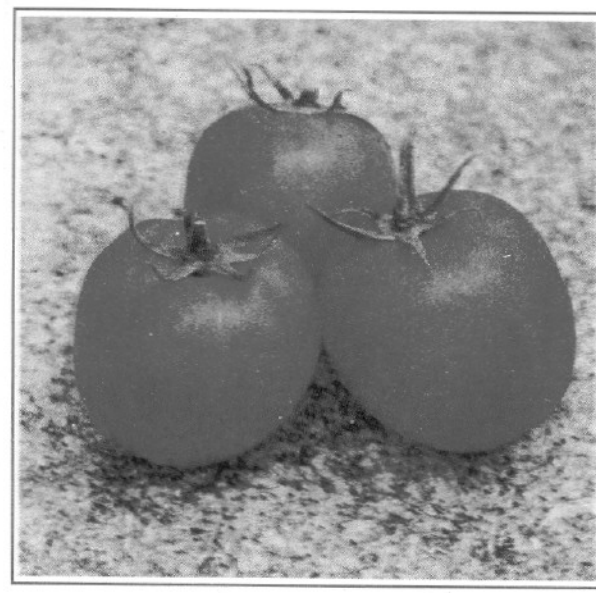
सत्यमेव जयते

IPM PACKAGE NO. 18

INTEGRATED PEST MANAGEMENT PACKAGE

FOR

TOMATO



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 TOMATO

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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

FOR EWARD

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 Progamme 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. Ragunathan)

PREFACE

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 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, Cucurbitacious vegatables), 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.

April 1, 2002

(A.D. Pawar)
Director (IPM)

ACKNOWLEDGEMENTS

The IPM Package of Practices for **Tomato** crop was discussed and finalised in the National Workshop on IPM held at National Plant Protection Training Institute (NPPTI), Hyderabad during May 14-17, 2001. The technical input received from the following experts is thankfully acknowledged.

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IPM PACKAGE FOR TOMATO

I. MAJOR PESTS

A. Pests of National Significance

1. Insect Pests

1.1 Fruit borer

1.2 White fly

1.3 Serpentine leaf miner

2. Diseases

2.1 Damping off

2.2 Tomato leaf curl virus

Gemini plant virus transmitted by white fly

2.3 Early blight

2.4 Late blight

2.5 Bacterial wilt

2.6 *Fusarium* wilt

3. Nematodes

3.1 Root-knot Nematode

3.2 Reniform Nematode

4. Weeds

Major Weeds

4.1 Lamb squire (*Chenopodium album*)

4.2 Pimpernel (*Anagallis arvensis*)

4.3 Sweet clover (*Melilotus* spp.)

4.4 Swine cress (*Coronopus didymus*)

4.5 Fumetry ((*Fumaria indica*)

4.6 Corn spurry (*Spergula arvensis*)

4.7 Blue grass (*Poa annua*)

4.8 Canary grass (*Phalaris minor*)

4.9 Rabbit foot grass (*Dactyloctenium aegyptium*)

5. Rodent pests

5.1 Smaller Bandicoot

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B. Pest of Regional Significance

1. **Insect Pests**
   - 1.1 Leaf hopper
   - 1.2 Cut worm
   - 1.3 Aphid
   - 1.4 Mites

2. **Diseases**
   - 2.1 Tomato spotted wilt transmitted by Thrips virus
   - 2.2 Buck eye spot
   - 2.3 Stem and fruit canker
   - 2.4 Powdery mildew

3. **Rodents**
   - 3.1 Tur House rat
   - 3.2 Indian gerbil

II. PEST MONITORING

A. AGRO ECO SYSTEM ANALYSIS

Agro Eco System Analysis (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 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. Farmer's past experience

B. Field Scouting

AESA requires skill. So only the trained farmers can undertake their exercise. However, other farmers also can do field scouting in their own fields at regular intervals to monitor the major pest situation. Simple field scouting on pest situation by the farmers helps to minimize pesticide usage to a large extent.

C. Pheromones

Pheromone traps with lures are commercially available for pests like Fruit borer and Tobacco caterpillar. Install 12 traps per hectare with lures for each pest. Traps should be installed in the field in such a way that the position of lure is always 2-3 feet above the crop canopy. Replace the lures once in 15-25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for Fruit borer is 2 moths per day per trap.

D. Yellow pan water trap/sticky traps

Set up yellow pan water trap/sticky traps 15 cm above the canopy for monitoring whitefly, thrips etc. @ 10 traps per ha. Locally available empty tins can be painted yellow/coated with grease/vaseline/caster oil on outer surface may also be used as yellow sticky trap.

E. Nematode sampling

Root knot nematodes cause galls and reniform causes "dirty roots". Their presence can be detected by "trypan blue" strain which turns nematode eggs sac dark blue whereas, roots stay uncoloured.

F. Economic threshold level (ETL)

The Economic threshold level (ETL) is an attempt to improve decision making practices by using partial economic analysis on the impact of the control practices such as spraying a pesticide. At the ETL, the benefit of spraying is equal to the losses caused by the insects in the field. The farmers are advised to take appropriate control measures when the incidence crosses ETL. The ETL for some of the major pests are listed below :

Pests	Economic Threshold Levels
Tomato fruit borer	one larva/one damaged fruit per plant
Whitefly (as a sucking pest)	4 adults/leaf
Root-knot and reniform nematode	1-2 larvae/g soil

III. IPM STRATEGIES:

A. Cultural Practices

1. Crop rotation with french beans reduces the bacterial wilt disease incidence. Crop rotation with cereals, sesame, mustard and marigold to reduce nematode infestation.
2. Adopt raised nursery beds (10 cms) for good drainage thereby avoid damping off in solanaceous nurseries by preventing soil borne fungi viz.,*Pythium, Phytophthora, Rhizoctonia*, etc.
3. Soil solarization using transparent polythene sheets (160-100 gauge thick) on nursery beds for about 15-21 days, which helps in killing weed seeds, nematodes and resting stages in insects and diseases.
4. Summer ploughing also helps in exposing resting stages of pests and nematodes to sunlight.
5. Destruction of crop residues/debris and alternate hosts material reduces the inoculum load of many foliar diseases and nematodes.
6. Barrier crop of pearl millet and sorghum reduces the incidence of TLCV.
7. Trimming of field bunds will destroy the existing rodent burrows.

B. Mechanical Control

1. Collection and destruction of eggmasses, larvae of fruit borer and tobacco cutworm etc. collection and destruction of crop debris of previous harvested crop.
2. Use of 100 mesh nylon net in nursery beds to avoid entry of whitefly *Bemisia tabaci* and transmission of leaf curl disease in tomato.
3. Use of yellow water pan/sticky traps for sucking pests @ 10 per ha.
4. Regular destruction of damaged fruits at each harvest.
5. Installation of Pheromone traps @ 12 per ha. for monitoring *H. armigera* and *S. litura.*
6. **Trap Crop Technology**: Tomato fruit borer is the major pest on developing fruits and is responsible for major yield loss in tomato. The IPM practices for tomato fruit borer includes inter croping a tall variety of marigold as trap crop in a row after every 16 rows of tomato. Raising of marigold nursery should be 15 days prior to tomato nursery, so that, 25 and 40 days old tomato and marigold seedlings are planted. Maximum egg laying is observed on marigold flowers and the movement of larvae from marigold to tomato is not significant. Eggs and larvae are removed from field alongwith the flowers. This trap cropping system also helps in reducing the rootknot nematode infestation.

C. Biological Control

1. **Conservation**

(a) Some parasites are very active in the field against serious pests of vegetable crop eg. *Trichogramma prateosum, Trichogrammatoidae armigera, Campoletis chlorideae, Carcella illota, Eriborus argenteopilosus, Hyposoter didyanator, Palexorista laxa, Goniopthalmus halli* on *H. armigera, Telenomus remus, Chelonus heliopae, C. formosanus, C. blackburni, Eriborus sp., Cotesia colemani, Cotesia marginiventris, Microplitis sp., Charops obtusa, Euplectrus sp., Peribae orbata* against *S. litura, Pristomerus testaceous, Cremastus flavoorbitalis, Barcon greeni, Phanerotema sp.,*

Campyloneura sp. on *Lorbanalis ; Pristomerus euzopherae* against *E. perticella ; Microbracon psarae* against *Psra bipunctalis ; Chrysonotomyia appannai, Chrysocharia johnsoni, Elasmus sp., Pediobius foveolatus, Tetrastichus ovulorum* against *Epilachna sp.; Aphidius sp., Aphelinus sp.* on aphids ; *Eurytoma* sp. on *Asphondylia* sp.

(b) In addition to these parasites, general predators like Coccinellids, Syrphids, Spiders, Carabids, Staphylinids, Dragonfly, Damselfly, predatory miridbugs, predatory pentatomids, Nabid bugs, Reduvid bugs, Anthocorid bugs, Geocorid bugs, predatory mite, predatory thrips are also actively suppress the pest population. *Stethorus apuperculus* is active predator on red spider mite.

(c) Since these natural enemies are highly prone for pesticides, avoiding unnecessary sprays are the best way to conserve them.

(d) Grow cowpea or pulses on the bunds to build up natural enemy fauna.

2. Augmentation

1. Inundative release of *T. priteosum* @ 50,000 per ha. starting from flower formation stage for 6 times at weekly interval.
2. Spray *Bacillus thuringiensis* var *kurstaki*, the commercial preparation @ 0.5 kg/ha against lepidopteran pests.
3. Spray HaNPV @ 250 LE per ha ($6x10^9$ PIB/ha) twice during evening hours at 10 days interval.
4. Seed treatment with *Trichoderma viride/T. harzianum* @ 2 gm./ kg of seeds to prevent seed and soil born infection of fungal diseases.

D. Chemical Control

1. Application of bleaching powder @ 15 kg/ha before planting against Bacterial wilt infection in tomato in endemic areas.
2. Treat nursery belt with 100 g per sq m of *Carbofuran 3 G for nematode management.

3. Spray 40-100 ppm Streptocycline sulphate on unriped fruits of tomato to control bacterial spot *Xanthomonas compestris* pv *vesicatoria* or dipping seedlings in 100 ppm streptocycline sulphate before transplanting.
4. Application of *carbofuran 1 kg. a.i. per ha during early stages of crop to avoid sucking pests and also nematodes.
5. Spray *Endosulfan @ 0.07% (2ml/lit water) to control *H. armigera*.
6. Apply Metribuzion @ 0.525 kg a.i./ha as pre-emergence herbicide for weed management.
7. Bromadiolone CB should be mixed in locally available grains in the ratio of 1:49 and inserted @ 15 g/burrow for rodent management.

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*Not approved as per usage under Insecticides.Act, 1968.

IV. CROP STAGE -WISE IPM PRACTICES:

	Stage	Pest	Practices
1.	**PRE-SOWING**	Soil borne fungus Nematodes Resting stages of Insect pests Nematode	Deep summer ploughing and soil solarization Application of Neemcake @ 200 kg per ha. Raising African marigold nursery 15 days prior to tomato nursery against *H. armigera* as a trap crop. If nematode is severe in the area, apply *carbofuran granules @ 1 kg a.i./ha.for main field. For weed control, use Fluchloralin @ 0.67 to 0.9 kg a.i./ha as preplanting soil incorporation.
2.	**SEED SEEDLING**	Early blight Damping off	Seed treatment with *T. viride* 4 g. or *carbendazim 2 g/1000 g seed. Raise Nursery beds at least 10 cm. high. Thin sowing with proper drainage facilities. Transplanting 25 days old healthy tomato seedlings and 40 days old marigold seedlings on every 16th row as a trap crop for *H. armigera* management.
		Serpentine	Avoid excess dose of Nitrogen.
		Leaf miner	5 per cent NSKE (50 g per lit.) commercially available neem

			formulation. Interplanting with beans reduces the attack of serpentine leaf miner.
			Spray *Endosulfan at the rate of 0.07% (2 ml/lit of water)
		Whitefly	Use 100 mesh nylon net to avoid entry of whitefly into the nursery in the beginning. Install yellow water pan/sticky traps @ 10 per ha for monitoring.
3.	**VEGETATIVE**	*Alternaria* blight (early blight)	Field sanitation. Destruction of alternate weed hosts.
			Spray 0.02 percent Mancozeb @ 1500-2000 g a.i. in 750 lit. water/ha
		Late blight	Destruction of affected plant/plant parts. Light irrigation. Spray Mancozeb as given above.
		Leaf curl diseases	Roguing of affected plants. Install bird perchers @ 50/ha to encourage birds to feed on pests.
4.	**REPRODUCTIVE**		Early Blight Field sanitation.
		and others	Spray captan 50% WP @ 2500 g a.i./ha in 750 to 1000 litres of water.

Tomato Fruit Borer	Install Pheromone traps with replacement of lures once in 15 days. Release *T. priteosum @ 50,000/ha* for 6 times at weekly interval. Hand collection of larvae of *Helicoverpa* on marigold trap crops. Spray HaNPV @ 250 LE per ha ($6x10^9$ PIB/ha) twice during evening hours at 10 days interval. Spray 5 per cent NSKE or *Bacillus thuringiensis* var kurstaki 500 g/ha.
Leaf curl disease	As shown in vegetative stage.
Mosaic	Rouging of affected plants. Careful inter cultivation operation.
Rodents	Bromadiolone CB should mixed in locally available grains in the ratio on 1:49 and inserted @ 15 g/burrow.

CROP: TOMATO

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	Remove the person from the contaminated environment. 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. Medical aid: Take the patient to the docotr/Primary Health Centre immediately along with the original container, leaflet and label.	Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death	- 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) intra-venously 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,	- Atropine injection 1 to 4 mg. Repeat 2 mg when toxic symptoms begin to recur (15-60 minute intervals).	

						diarrhoea, epigastric pain, tightness in chest.	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. Avoid theophyllin and aminophyllin or barbiturates. 2-PAM and other oximes are not harmful and in fact contra indicated for routine usatge. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.	
FUNGICIDES								
3.	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.	
4.	Captan	Slightly toxic	Green	Table 5 – Unlikely to present acute hazard in normal use				

5.	Carbendazim	Slightly toxic	Green	-do-				
6.	Streptocyclin sulphate	-do-	-do-	-do-				
HERBICIDES								
7.	Metribuzin	Moderately toxic	Blue	Class III – Slightly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.	
OTHERS								
8.	Bromodiolon	Extremely toxic	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.	
9.	Fluchloralin	Moderately toxic	Blue	Class III – Slighly hazardous				
10.	Bleaching powder							

ANNEXURE -I

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 burried deep into soil away from water source.
3. Never re-use empty pesticide container for any purpose.

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