



IPM PACKAGE NO. 62



INTEGRATED PEST MANAGEMENT PACKAGE

FOR
BROCCOLI



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 BROCOLLI

CONTENTS

Subject	Page No.
Foreward	i
Preface	ii
Acknowledgements	iii
I. MAJOR PESTS	1-2
A. Insect pests	
B. Diseases	
C. Weeds	
D. Nematodes	
E. Rodents	
II. PEST MONITORING	2-4
A. Agro Eco- System Analysis (AESA)	
B. Field scouting	
C. Pheromones	
D. Yellow water pan/sticky traps	
E. Nematode	
F. Rodents	
G. Economic threshold levels (ETL)	
III. IPM STRATEGIES	4-7
A. Cultural practices	
B. Mechanical control	
C. Trap crop technology	
D. Biological control	
E. Chemical control	
F. Integrated Weed Management	
IV. STAGE WISE IPM PRACTICES	8-9
V. DO'S AND DONT'S	10-11
VI. Annexure-I & II	12-16



Government of India
Ministry of Agriculture

Department of Agriculture & Cooperation

DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE

N. H. IV, FARIDABAD - 121 001 (HARYANA)

DR. P. S. CHANDURKAR
Plant Protection Adviser
to the Government of India

FOREWARD

Integrated Pest Management (IPM) approach has been globally accepted for achieving sustainability in agriculture. It has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities, low input cost based Crop Production Programme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitise extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, the scattered information on various components of this eco-friendly approach forms basic necessity. In this direction, initial attempts were made in 1992 to harmonise the IPM Package of Practices of various crops. Subsequently, concerted efforts were made in 1998, 2001, 2002 and 2003 to update and develop IPM Package of Practices for agricultural and horticultural crops. Presently, IPM Package of Practices for 77 crops have been finalized to help the extension workers and farmers to manage the pests and diseases and to minimize the over use/misuse of chemical pesticides. Efforts have been made to incorporate the relevant available technical input provided by the scientists of ICAR Institutes/ SAUs and State Departments of Agriculture/Horticulture. However, suggestions for further improvement in future publication/ revision will be of immense help. Hopefully, these IPM Package of Practices will be useful for the Researchers, Plant Protection Workers and Farmers alike.


(P. S. CHANDURKAR) 14/8/03

P R E F A C E

In order to minimize the indiscriminate and injudicious use of chemical pesticides, INTEGRATED PEST MANAGEMENT (IPM) has been enshrined as cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM is an eco-friendly approach for managing pest and disease problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. The greater emphasis has been given on biological control including use of biopesticides.

With a view to provide technical knowledge to the extension functionaries and farmers in the States, first National Workshop on IPM for harmonization of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized on April 15-17, 1998 and Nov. 5-6, 1998 at the Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM Package of Practices for 20 crops were finalized on rice, cotton, vegetables, pulses and oilseeds. In this series, two National Workshops on IPM have been conducted at NPPTI, Hyderabad and Dte. of PPQ&S, Faridabad during 14-17, 2001 and Feb. 20-22, 2002 respectively to update 20 available IPM Packages and develop 31 new IPM Packages especially for horticultural crops. Sixth and Seventh National Workshop held at Central Insecticides Laboratory, Faridabad on 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, Pea, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Olive, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitacious vegetables, Broccoli, Spinach, Lablab bean, Garlic), fruits (Citrus, Banana, Apple, Mango, Guava, Grapes, Jackfruit, Pineapple, Sapota, Pomegranate, Litchi, Papaya, Apricot, Peach, Pear, Cherry, Walnut, Ber, Amla, Loquat, Strawberry, Watermelon, Fig, Phalsa, Persimmon, Custard apple, Raspberry, Kiwi, Passion fruit), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalized.

IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. The IPM packages encompass various management strategies for containing the pest and disease problems. Pest monitoring is one of the important components of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (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 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.

7th October, 2003



(A. D. Pawar)
Addl. PPA-cum-Director(IPM)

ACKNOWLEDGEMENTS

The IPM Package of Practices for Broccoli crop was discussed and finalized in the National Workshop on IPM held at CIL, Faridabad during 9-10 January, 2003. The input received from the following experts is thankfully acknowledged :

- | | |
|-------------------------------------|--|
| (i) Chairman | Dr. A.D. Pawar, Director (IPM)
Dte. of P.P.Q. & S., Faridabad |
| (ii) Co-Chairman
Tech. Session | Dr. Raj Singh, JD(Bio)
Dte. of P.P.Q. & S., Faridabad |
| (iii) Coordinator-
Tech. Session | Sh. K.K. Singh, Asstt. Director (Ent)
Dte. of P.P.Q. & S., Faridabad |
| (iv) Expert Inputs | <ol style="list-style-type: none">1. Dr. U.S. Singh, Nematologist, IICRP on Betelvine, RAU, Pusa, Bihar2. Dr. N.L.M. Tripathy, Sr. S.M.S., UPDASP., Deptt. of Horticulture, Lucknow3. Sh. Ashok Shukla, PPO(PP), CIPMC, Baroda4. Dr. R.P. Misra, PPO(E), CIPMC, Lucknow5. Sh. P. Manickam, PPO(PP), CIPMC, Bangalore,6. Sh. A..P. Sinha, APPO, CIPMC, Kolkata7. Sh. Dinesh Sachan, PPO, Deptt. of Hort., Lucknow8. Sh. C. Elangowan, PPO(E), CIPMC, Trichy9. Dr. S.K. Verma, PPO, CIPMC, Patna |
| (v) Technical Input | <ol style="list-style-type: none">1. Sh.S.P.Singh, APPO, IPM Div., Dte. of PPQ&S, Fbd.2. Sh. K.S. Sharma, SSA-III, IPM Div., Dte. of PPQ&S, Fbd3. Sh. Yogesh Kunwar, SSA-III, IPM Div., Dte. of PPQ&S, Fbd4. Sh. R.S. Tomer, SSA-III, IPM Div., Dte. of PPQ&S, Fbd5. Sh. M.C. Sharma SSA-III, IPM Div. Dte. of PPQ&S, Fbd6. Sh. Laxmi Chand, TO-II, IPM Div., Dte. of PPQ&S, Fbd7. Mohd. Abrar Alam, Steno, IPM Div., Dte. of PPQ&S, Fbd8. Sh. N.K. Mishra, LDC, IPM Div., Dte. of PPQ&S, Fbd |

IPM PACKAGE FOR BROCOLLI

(*Brassica oleracea italica*)

I. MAJOR PESTS

A. INSECT PESTS :

1. Diamond back moth (*Plutella xylostella*)
2. Leaf webber (*Crocidolomia binotalis*)
3. Cabbage butterfly (*Pieris brassicae*)
4. Mustard sawfly (*Athalia Lugens proxima*)
5. Aphid (*Aphis spp.*)
6. Painted bug (*Bagrada cruciferarum*)
7. Cabbage borer (*Hellula undalis*)
8. Termite (*Microtermus obesì*)
9. Cutworm (*Agrotis ipsilon*)
10. Leaf eating weevil (*Tanymecus circumdatus*)
11. Leaf eating caterpillar (*Trichoplusia ni*)
12. Leaf miner (*Phytomyza horticola*)
13. White fly (*Bemisia tabaci*)
14. Mites

B. DISEASES

1. White blister (*Albugo candida*)
2. Leaf blight (*Alternaria spp.*)
3. Damping off (*Pythium spp., Rhizoctonia spp.*)
4. Club rot (*Plasmodiophora brassicae*)
5. Black rot (*Xanthomonas spp.*)
6. Mosaic virus
7. Boron deficiency
8. Molybdenum deficiency
9. Root rot

C. WEEDS:

MONOCOT

1. Burmuda grass (*Cynodon dactylon*)
2. Nutgrass (*Cyperus rotundus*)
3. Canary grass (*Phalaris minor*)
4. Paraneal (*Lotium temulentum*)
5. Nutsedge (*Cyperus spp.*)

DICOT

1. Bathua (*Chenopodium album*)
2. Krishnaneel (*Anagallis arvensis*)
3. Sweet clover (*Melilotus spp.*)
4. Jangli chawlai (*Amaranthus viridis*)
5. Mahkua (*Ageratum conyzoides*)
6. Hiran khuri (*Convolvulus arvensis*)
7. Carpetweed (*Trianthema portulacastrum*)

D. NEMATODES

1. Root knot nematode (*Meloidogyne spp.*)
2. Reniform nematode (*Rotyienchulus reniformis*)

E. RODENTS

1. Bandicoot rat (*Bandicota bengalensis*)
2. Indian gerbil (*Tatera indica*)
3. Striped squirrel (*Funambulus spp.*)

II. PEST MONITORING

A. Agro Ecosystem Analysis (AESA)

Decision making in IPM requires an analysis of the ecosystem. IPM is based on ecological interaction between the environment, plants, herbivores (diseases, insects and rats) and natural enemies. The health of the plant is determined by the environment (weather, soil, nutrients) and the herbivores. The herbivores are balanced by the natural enemies.

The basic components of AESA are:

1. Plant health at different stages.
2. Built-in-compensation abilities of the plants.
3. Pest and defender population dynamics.
4. Plant and soil conditions.
5. Climatic factors.
6. Farmers' Past experience.

The details of AESA are given in Annexure 1.

B. Field scouting:

AESA requires skill. It is very important to make a representative survey of a field in the least amount of time and upon completion, have an accurate

indication of the numbers, kind and severity of pest problems present in the field.

C. Pheromones:

Pheromones traps with lures are commercially available for pests. Install 5-6 traps per ha. with lures for each pest. Traps should be installed in the field in such a way that the position of lure is always 6"-12" 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 H. armigera is 8 to 10 moths per day per ha.

D. Yellow Water Pan/ Sticky Traps:

Set up yellow pan/sticky traps for monitoring thrips, aphids, jassids, and whitefly @ 8 -10 traps per ha. Locally available empty yellow Palmolive tins coated with grease / Vaseline / castor oil on outer surface may also be used as yellow pan trap.

E. Nematodes:

Root knot nematodes cause gall formation and reniform nematodes cause "dirty root" symptom. Their presence can be detected by using " Trypan blue" stain in water which turns nematode egg sac dark blue in colour whereas roots remain uncoloured.

F. Rodents:

Rodents can be monitored by means of active burrows. The number of active burrows indicate the number of adults in the burrow.

Level of infestation:

Live Rodent burrows / ha.

- (i) 0 -25 Low
- (ii) 26 -50 Medium
- (iii) 51-100 Severe

G. Economic Threshold Levels (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 of pesticides. At the ETL, the benefit of spraying is equal to losses caused by the pests 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:

Diamond back moth	-	1 larva / plant
Leaf Webber	-	1 larva / metre row of length
Nematodes	-	1-2 juveniles / gm of soil
Spider mite	-	2-mites / leaf
Saw fly	-	1 larva / plant
White fly	-	4-6 adults per leaf

III. IPM STRATEGIES:

A. Cultural Practices:

1. Deep summer ploughing to expose immature stages of insects and micro organisms to unfavourable environmental conditions.
2. Removing and destroying of stubbles and other trashes helps in reducing pest incidence.
3. Follow crop rotation as recommended for different pests.
4. Select resistant and tolerant varieties and treat the seed before sowing with any fungicide to ward off seed borne diseases.
5. Seeds must be healthy, pure and free from all the inert materials and weed seeds.
6. Proper water management practices should be followed to avoid stagnation of water in the field.
7. Crop seedlings should be timely planted in well prepared field at recommended spacing and balanced doses of fertilizers be given.
8. Solarization of nursery bed by covering it with polythene transparent sheet (60-100 gauge) for 15-21 days is recommended to minimize soil infection by various pests and weed seeds.

B. Mechanical Control:

1. Collection of egg masses, larvae and pupae of pests and their placement in bamboo cages for conservation of bioagents and withholding of pest larvae.
2. Collection and destruction of infested and old leaves regularly.
3. Roguing of borer affected plants.

4. Crop should be maintained weed free for 4-6 weeks after planting by resorting to timely hand hoeing/hand weedings.
5. Use light traps for monitoring and trapping of insects pests.

C. Trap Crop Technology:

- Two rows of mustard are sown at the beginning and then after every 25 Broccoli rows. Bold seeded mustard is more suited. Mustard is to be sown twice; first is at 15 days prior to Broccoli transplanting, while the second one is at 25 days after Broccoli planting. Thick sowing of mustard i.e. 50-60 plants per metre row is recommended. Usually, the inter-cropped Broccoli is free from infection during early stages. However, there may be some incidence at later stages. For this, apply either 5% NSKE or cartaphydrochloride 2g. per litre of water.

D. Biological control:

1. Before sowing seeds treat seed beds with *Trichoderma viride* and *T. harzianum* for control of soil borne fungal pathogens.
2. Avoid spraying of broad spectrum pesticides to conserve the natural enemies.
3. Erecting bird perches @ of 50/ha help the birds to come and eat the insects at their larvae.
4. Growing of flowering Plants especially marigold and sunflower on the peripheries of fields helps in attracting pest species like *H. armigera* and *Spodoptera spp.* and subsequent building up population of biocontrol agents.
5. Collection of egg masses and larvae of various lepidopteran pests and putting them in fine meshed cage for emergence of egg parasitoids (*Trichogramma spp.*) and larval parasitoids (species of *Apanteles*, *Bracon*, *Euplectrus* etc.) protect them from predation and pesticide spray.
6. Monitor the incidence of sucking pests and make release of predators like *Coccinella septempunctata*, *Epysirphus spp.*, *Metasyrphus confrator*, *Chrysopa scelestes*, *Nabis spp.* and parasitoids like *Aphelinus* and *Aphidius spp.*
7. Seed treatment with *Trichoderma viride* or *T. harzianum* @ 2g per 100 g of seed.

8. Release of *Trichogramma* spp like *T. Chilonis* or *T. pretiosum* (egg parasites) @50000 per ha. 4-5 times with interval of 5-7 days helps in controlling DBM and other lepidopteran pests.
9. Make inoculative release of *Cotesia plutellae* @ 5000/ha. at 10-15 days interval after planting to control diamond back moth (DBM).
10. Spray commercial preparation of *Bacillus thuringiensis* var. *kurstaki* @ 500gm/ha. after 15 days planting and should be repeated after every 15 days to control DBM and other lepidopteran pests.
11. Spray *Beauveria bassiana* (1×10^6 cfu/g) @ 2g/litre of water every 20 days to control lepidopteran pests.
12. Spray *Entomophthora* sp. (2×10^7 cfu/g) @ 2 g./litre of water after every 20 days to control lepidopteran pests.
13. Apply twice at 15 days interval of 5% NSK beginning from head initiation stage.
14. Since all natural enemies are highly sensitive to pesticides avoiding unnecessary sprays of pesticides is the best way to conserve them.

E. Chemical Control:

1. Treat one Kg of seed with 100mg of streptocyclin antibiotic solution for 15 minutes before sowing for controlling black rot infection.
2. Treat the seed with 1 gm carbendazim and 2gm of captan per 100gm of seeds for the control of seed and soil borne fungal pathogens
3. Apply malathion (0.05%) or endosulfan (0.07%) or carbaryl (0.1%) (2g./litre water) whenever population exceeds ETL.
4. Apply Mancozeb 75% WP @ 1500-2000 g. per ha. for black rot disease management whenever disease inoculum and favourable climatic conditions are noticed.
5. Treat the nursery bed with carbofuran 3 G @ 0.3 to 0.6 g a. i. /sq.m. for control of soil borne fungal pathogens.
6. Always observe economic threshold levels (ETLs) and pest defender ratio before deciding in favour of use of chemical pesticides.

7. Encourage the use of neem based formulation which are comparatively safe.
8. Repeated use of synthetic pyrethroids should be avoided, which are responsible for development of resistance in pest species.
9. Only recommended chemical in recommended doses should be applied where needed.
10. Application of carbofuran (3kga.i) plus neem cake (400kg) plus Urea (24 kg) per ha. is an effective method in reducing nematode infection in the soil of main field.
11. Nursery bed treatment with carbofuran at 0.3g. a.i./m², root dip in 0.2% solution of Carbofuran or phorate for 12 hrs. effectively controlled nemotode infection,
12. For rodents control, make use of Bromodiolon CB mixed with locally available grains in the ratio of 1:49 and insert 15 g. per live burrow after pre-baiting with grains only. Remaining burrows can be fumigated with Aluminium phosphide tablets.

F. Integrated Weed Management

I. Preventive Measures:

1. Summer deep ploughing to expose and destroy the underground vegetative parts of the rooted perennial weeds.
2. Follow the recommended agronomic management practices of land preparation, planting distance, fertilizer and irrigation etc. to have healthy plants stand.

II. Control measures:

1. Smoothing of weeds by using mulching with straw/ hay/ plastic sheets etc.
2. Hoeing and weeding by hand operated implement for controlling weeds as and when needed.

IV. STAGE WISE IPM PRACTICES

S.No.	Stage	Pest	Practices
1.	Pre-sowing	Resting stages of insect pests	<ul style="list-style-type: none"> - Deep summer ploughing - Raised nursery beds - Soil solarization for 15-21 days.
		Nematodes	<ul style="list-style-type: none"> - Treat the nursery bed with Carbofuran 3 g @ 0.3 to 0.6 g a.i. per sq.m.
		DBM and other pests.	<ul style="list-style-type: none"> - After land preparation leave two ridges at the beginning and then after every 25 rows and at the end. - Sow bold mustard seeds densely in one of the ridges 15 days before brocolli planting as a trap crop.
		Weeds	<ul style="list-style-type: none"> - Apply Fluchloralin @ 0.2 to 0.67 kg a.k./ha as preplanting soil incorporation.
2.	Sowing/planting	Black rot and other soil borne pathogens	<ul style="list-style-type: none"> - Seed treatment with Carbendazim 0.01%+ 100 ppm Streptocycline sulphate. - Seed treatment with <i>T. viride</i> @ 2 gm per 100 g. of seed. - Apply optimum dose of Nitrogen and Phosphorus fertilizer as basal dose. - Adopt optimum irrigation.
		Weeds`	<ul style="list-style-type: none"> - Apply Alachlor 10 gm @ 2.5 kg a.i/ha as pre-emergence herbicide. - Timely planting, optimum spacing and balanced use of fertilizer.
3.	Vegetative growth	DBM and other Lepidopteran pests.	<ul style="list-style-type: none"> - 25 days after transplanting, sow bold mustard seeds densely in the second ridge at the beginning and then after every 25 rows and at the end as a trap crop - Application of <i>B. thuringiensis</i> var <i>Kurstaki</i> 500 gm/ha - Release <i>T. chilonis</i>,

			<p><i>T. priteosum</i> @ 50000/ha 4-5 times at weekly intervals</p> <ul style="list-style-type: none"> - Release <i>Cotesia plutellae</i> @ 5000/ha three times at weekly intervals.
		Black rot and leaf spots.	- Spray mancozeb 75% WP @ 1500-2000 gm/ha (0.3%-0.4%).
4.	Head Development	DBM and other lepidopteron pests.	<ul style="list-style-type: none"> - Application of <i>B. thuringiensis</i> var <i>kurstaki</i> @ 500 gm/ha - Release <i>T. chilonis</i> <i>T. priteosum</i> @ 50000/ha 4-5 times at weekly intervals. - Release <i>Cotesia plutellae</i> @ 5000/ha 4-6 times at weekly interval. - Spray 5% NSKE. - Erect bird perches - Spray cartap hydrochloride or Dichlorvos 2 gm/litre of water on the trap crop when DBM population is recorded. - Spray malathion 50 EC or methyl demeton (0.025%) 1 ml/litre of water.

V. DO's AND DON'Ts

Do's	Don'ts
1. Deep ploughing is to be done on bright sunny days. The field should be kept exposed to sun light at least for 2-3 weeks.	Do not plough or irrigate the field after ploughing at least for 2-3 weeks to allow desiccation of weeds, bulbs seeds or rhizomes of perennial weeds.
2. Grow only recommended varieties.	Do not grow varieties not suitable for the season or the region.
3. Sow early in the season.	Avoid late sowing as this may lead to reduced yields and incidence of white grubs and diseases.
4. Always treat the seeds with approved chemicals/bio products for the control of seed borne diseases/pests.	Do not use seeds without seed treatment with biocides/chemicals.
5. Sow in rows at optimum depths under proper moisture conditions for better establishment.	Do not sow seeds beyond 5-7 cm. depth.
6. Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stages of crop weed competition.	Crop should not be exposed to moisture deficit stress at their critical growth stages.
7. Use NPK fertilizers as per the soil test recommendations.	Avoid imbalanced use of fertilizers.
8. Use micronutrient mixture after sowing as top dressing separately.	Do not mix micronutrients with fertilizers and incorporate into the soil.
9. Conduct AESA weekly in the morning preferably before 9 am, take decision on management, practice based on AESA, ETL and P:D ration only.	Do not apply chemical pesticides on calendar basis.
10. Install pheromone traps at appropriate period for monitoring and mass trapping of insects.	Do not store the pheromone lures at normal room temperature (keep them in refrigerator).
11. Release parasites only after noticing adult moth catches in the pheromone trap or eggs in field observation.	Do not apply chemical pesticides within seven days of release of parasitoids.

12. Apply HaNPV, SINPV at recommended dose when a large number of egg masses and early instars larvae are noticed. Apply NPV only in the evening hours after 5PM.	Do not use the same sprayer for application of chemical pesticides and biocides. The same sprayer should be used after thorough cleaning with soap.
13. Spray pesticides thoroughly to treat the under surface of the leaves, particularly for mites, <i>Spodoptera</i> and <i>Epilachna</i> grubs etc.	Do not spray pesticides at midday. Since most of the insects are not active during this period.
14. Apply short persistent pesticides to avoid pesticide residue in the solid and produce.	Do not apply pesticides during preceding 10 days before harvest.
15. Spray pesticides during the dusky hours to avoid the killing of pollinators.	Do not spray insecticides during flowering season to protect the pollinators, which helps in cross pollination.
16. Follow the recommended procedure of trap crop technology for higher yield.	Do not apply long persistent pesticide on trap crop, otherwise it may not attract the pests and natural enemies.
17. Where the pests/diseases are present only in strips or at certain spots, apply the pesticides to these affected areas only, to conserve natural enemies in the field.	Do not go for blanket spray without field roving.
18. In rich soils, fertilizer doses should be given on the basis of soil analysis.	Do not make use of raw cow dung or raw FYM which increases pest incidence.
19. Ensure complete destruction of pest/disease infested plants in the fields.	Do not leave infested plants in the field for longer time.
20. Ensure complete collection and destruction of foliage and plant residues in the field at the end of season by decomposition.	Do not burn collected plant debris to avoid air pollution.
21. Make the use of stickers (adjuvants) for better efficacy of pesticides during spray.	Do not use unrecommended mixture of various insecticides in any case.

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 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 dynamic.
4. Soil conditions.
5. Climatic factors.
6. Farmers past experience.

The methodology of AESA is as under :-

A. Field Observation:-

- a) Enter the field at least 5ft. 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. litrura* 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 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, White 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 pests and defenders and their population count should also be given alongwith diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant if 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, whether 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) If during bud/flowering initiation stage, 2 to 3 eggs/plant or one larva/10 plants are observed, apply 250 L.E. NPV/ha or NSKE 5%.

- ii) Some of the defenders like lady bird beetles, spiders, lacewing, reduviid bug, Campoletis sp., wasps play useful role in arriving at P:D ration i.e. 1:1.

AESA BY EXTENSION FUNCTIONARIES :

The extension functionaries during their regular visit to the village should mobilise the farmers, 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 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 experiences could be utilised 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 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.