

FOREWORDS

In order to promote sustainable agriculture for the generations to come, indiscriminate use of chemical pesticides must be checked and thereby its ill effects which may manifest in the form of environmental pollution, resistance to pesticides, depletion of soil fertility, resurgence of pests and diseases and more importantly health hazard to human beings and animals.

Present day farmer's attitude of relying on single tactic of chemical control has to be changed and replaced by suitable mix of different pest control methods in an integrated manner. This is a challenge before the field functionaries of the department of Agriculture, Assam. I.P.M. is dynamic and problem oriented. For this, our field officers have to know all the technologies available and update knowledge on the changes.

I.P.M. package of practices for field crop is a long felt need for the field functionaries and farmers. There is no crop wise guide book on I.P.M. practices for taking up suitable field activities as well as planning I.P.M. relevant to crop, pest, location and cropping pattern.

I hope, this book on package of practices for different crops will certainly help the field functionaries in guiding the farmers for adoption of I.P.M. practices in the years to come.

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Preface

Integrated Pest Management (IPM) package of practices on different crops have been prepared and published by the Directorate of Plant Protection, Quarantine and Storage, Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India with the technical inputs from experts of Indian Council of Agricultural Research, State Agricultural Universities, Central Directorate of Plant Protection, Pesticide Industries and State Departments of Agriculture/Horticulture in the management of pests, diseases, weeds, nematodes and rodents.

Fine tuning of the IPM packages of some of the field crops, spices included in this booklet had been done having interfaces with scientists of Assam Agricultural University and concerned officers of the State Department of Agriculture, Assam to make it relevant to the pests and diseases scenario of the state.

IPM is a dynamic and constantly evolving approach, its components as well as tactics should change as the situation warrants. As such transfer of technology to the farmers is a challenging task before the field functionaries. Training of farmers in crop production and protection methods, identifying pests, their natural enemies, concept of damage on economic injury levels, knowing agro-ecosystem and its analysis are very important which empower the farmers to take their own decisions.

It is hoped that these packages of IPM practices on important crops shall help the field level extension workers in guiding the farmers towards achieving that goal.

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IPM PACKAGE FOR RICE

I. Major Pests

A. Pest of National Significance :

1. Insect Pests :

- 1.1. Yellow stem borer (*Scirpophaga insertulas*)
- 1.2. Brown planthopper (*Nilaparvata lugens*)
- 1.3. Gall midge (*Orseolia aryzae*)
- 1.4. Leaf folder (*Cnaphalocrosis medinalis*)
- 1.5. White backed planthopper (*Sogatella furcifera*)

2. Diseases :

- 2.1. Rice blast (*Pyricularia oryzae*)
- 2.2. Sheath blight (*Rhizoctonia solani*)
- 2.3. Bacterial leaf blight
(*Xanthomonas compestris* pv *oryzac*)

3. Weeds :

- 3.1. Panicum spp
- 3.2. Echinochloa spp
- 3.3. Cyperus spp

4. Rodents :

- 4.1. Smaller bandicoot (*Bandicota bengalensis*)
- 4.2. Soft furred field rat (*Millardia melitada*)
- 4.3. Field mice (*Mus spp.*)

B. Pest Regional Significance :

1. Insect Pests :

- 1.1 Rice hispa (*Dicladispa armigera*) – Low lying area in Assam, Bihar, West Bengal, Orissa, Meghalaya, Mizoram and Tripura.
- 1.2 Stripped, darkheaded and white stemborer – Assam.
- 1.3 Gundhi bug (*Leptocorisa spp*) – Mainly in upland rice in Assam, Bihar, West Bengal, Uttar Pradesh, Orissa, Madhya Pradesh.
- 1.4 Caseworm (*Nymphula depunctalis*) – In low lying and water logged areas.

- 1.5 Green leaf hopper (*Nephotettix virescense*, *N. nigropictus*) Bihar, West Bengal, Assam, Madhya Pradesh, Andhra Pradesh and Tamil Nadu.
- 1.6 Whorl maggot (*Hydrellia spp*)
- 1.7 Swarming caterpillar (*Spodoptera mauritia*)
- 1.8 Thrips (*Baltothrips biformis*) in upland rice in Assam, Uttar Pradesh and Madhya Pradesh and Tamil Nadu.
- 1.9 Climbing cutworm (*Mythimna separata*)
- 1.10 Mealy bug (*Ripersia aryzae*) – In upland rice in Assam, Uttar Pradesh, Bihar, Orissa, West Bengal and Madhya Pradesh.
- 1.11 Root weevil (*Echinochemus oryzae*) – In upland rice.
- 1.12 Root aphid – Assam.

2. Diseases :

- 2.1 Rice blast
- 2.2 Sheath blight
- 2.3 Bacterial leaf blight
- 2.4 Sheath rot
- 2.5 Brown spot
- 2.6 False smut
- 2.7 Tungro
- 2.8 Yellowing
- 2.9 Bakanae

3. Weeds :

3.1 Direct seeded upland rice :

	Local Name
1 <i>Cynodon dactylon</i>	Dubori
2 <i>Digitaria setigera</i>	Sirabon
3 <i>Paspalum conjugatum</i>	Lokosha-bon
4 <i>Eleusine indica</i>	Bodosa-bon
5 <i>Mimosa pudica</i>	Nilajibon

- | | | |
|---|--------------------------------|--------------|
| 6 | <i>Melochia conchiorifolia</i> | Bon-mora |
| 7 | <i>Fimbristylis littoralis</i> | Murphula-bon |
| 8 | <i>Ageratum houstonianum</i> | Gondhoa-bon |

3.2 Transplanted rice :

- | | | Local Name |
|---|------------------------------------|-------------------|
| 1 | <i>Cyperus iria</i> | Murphula-bon |
| 2 | <i>Monochoria vaginalis</i> | Bhat-meteka |
| 3 | <i>Scirpus juncooides</i> | Junga-bon |
| 4 | <i>Sacciolepis interrupta</i> | Dol |
| 5 | <i>Commelina diffusa</i> | Kona-simolu |
| 6 | <i>Rottboellia Cochinchinensis</i> | Lokosha-bon |
| 7 | <i>Paspalum scrobiculatum</i> | Kododhan |
| 8 | <i>Marsilea minuta</i> | Pani-tengeshi |

4. Rodent :

1. Indian mole rat (*Bandicota bengalensis*)
2. Indian field mouse (*Mus booduga*)

5. Nematodes :

- 5.1 Root knot nematodes (*Meloidogyne graminicola*) Assam, West Bengal, Orissa and Tripura.
- 5.2 Ufra (*Ditylenchus angustus*) – Assam, West Bengal.
- 5.3 Rice root nematodes (*Hirschmanniella oryzae*) – Assam.

II. Pest Monitoring :

a. Agro Ecosystem Analysis (AESA) :

AESA is an approach which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in situations will help in taking appropriate decision on management practices. The basic components of AESA are :

- i. Plants health at different stages. Monitor symptoms of diseases and nematodes.
- ii. Built-in-compensation abilities of the plants.
- iii. Pest and defender population dynamics.
- iv. Soil conditions.
- v. Climatic factors.
- vi. Farmers past experience.

The methodology of AESA is as under :

b. Field Observations :

- i. Enter the field at least 5 ft. away from the bund. Select a site with a dimension of 1 sq mt. randomly.
- ii. Record the visual observation in following sequence:
 - a. Flying insects (both pests & defenders)
 - b. Close observation on pests and defenders which remain on the plants.
 - c. Observe pests like borer, BPH etc. and defenders like cooccinellid, chrysopa, ground beetle/rove beetle and earwigs etc, by scrapping the soil surface around the plants.
 - d. Record disease and its intensity.
 - e. Record insects damage and disease incidence in percentage.
- iii. Record parameters like number of leaves, plant height and reproductive parts of the selected plants for making observation in the following weeks. Observe nematode damage symptoms.
- iv. Record the types of weeds, their size and population density in relation to crop plant.
- v. Record soil conditions viz flooded, wet or dry.
- vi. Observe rodent live burrows.
- vii. Record the climatic factors viz sunny, partially sunny, cloudy, rainy etc. for the preceding week.

c. Drawing :

First draw the plant at the centre on a chart. Then draw pests on left side and defender on the right side. Indicate the soil condition, weed population, rodent damage etc. Give natural colours to all the drawing, for instance, draw healthy plant with green colour, diseased plant/leaves with yellow colour. While drawing the pests and the defenders on the chart care should be taken to draw them at appropriate part of the plant, where they are seen at the time of observation. The common name of pest and 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 case of partially sunny, the diagram of sun may be half masked with clouds.

d. Group Discussion and Decision making :

The observations recorded in the previous and current charts should be discussed among the farmers by raising questions relating to change in pest and defender population in relation to crop stages, soil condition, weather factors such as rainy, cloudy or sunny etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P.D. ratio and take judicious decision for specific post management practices.

e. Strategy for decision making :

Some of the defenders like lady beetles, groundnut beetles, rove beetles, wasps play useful role in arriving at P.D. ratio.

f. AESA by Extension Functionaries :

The extension functionaries during their regular visit to the village mobilize the farmers, conduct AESA and critically analyse the various factors such as the pest population vis-a-vis defender population and their role in natural suppression of the pest, the influence of per

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 need 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.

g. AESA by Farmers :

After a brief exposure during IPM demonstrations/ field trainings, farmers can practice AESA in their own field. Whenever trained farmers are available their experiences could be utilized in training their fellow farmers in their own villages. Thus a large group of farmers could be made proficiently competent in undertaking weekly AESA thereby empowering themselves in decision making on any specific pest situations. Farmers-to-farmers training approach will go a long way in practicing IPM on a large area on sustainable basis.

B. Survey/ Field Scouting :

The objective of surveys through roving surveys is to monitor the initial development of pest and diseases in endemic areas. Therefore, in the beginning of crop season survey routes based upon the endemic areas are required to be identified to undertake roving surveys. Based upon the results of the roving surveys, the state extension functionaries have to concentrate for grater efforts at block and village levels as well as through farmers to initiate field scouting. Therefore, for field scouting farmers should be mobilized to observe the pest and disease occurrence at the intervals as stipulated hereunder. The plant protection measures are required to be taken only when pests and diseases cross ETL as

results of field scouting.

1. Roving survey : Undertake roving at every 10 km.distance initially at weekly intervals and thereafter at 10 days intervals (depending upon pest population). Everyday at least 20 spots should be observe.
2. Field scouting : Field scouting for pests and bio-control fauns by extension agencies and farmers once in 3 – 5 days should be undertaken to workout ETL.

C. Pest Monitoring Through Pheromones/ Light Traps etc.

Certain pests required positioning of various kinds of traps like pheromones, light trap to monitor the initial pest build up. Therefore, the State Department of Agriculture is to initiate action for positioning of different kinds of traps at strategic locations at village level as per the following details.

1. Pheromone trap – 8 traps per ha. may be used to monitor stem borer moth population in Summer rice initiate in February to April (Boro & Early Ahu) trapping should be done from February to April and in Winter rice –(Sali rice), it should be done from July to September lures should be replaced at 10 days intervals.

2. Light trap - Chinsurah light trap or any other light trap with 200 watts mercury lamps can be operated for two hours in the evening to observe photo tropic insect pests. Traps should be placed away from other light sources.

3. Sweep-nets-water pans – Besides visual observations sweep-nets and water pans may also be used to assess the population of insect pests and bio-control agents.

D. Economic Threshold Levels (ETLs) :

Sl.	Crop Stage and Pest	Economic Threshold Levels (ETLs)
A. Nursery :		
	1. Green leafhopper	1-2 insects/ sq.m. in RTD endemic areas
	2. Gall midge	1 silver shoot (gall)/ sq.m.
	3. Stem borer	1 moth/ 1 egg mass/sq.m.
B. Planting to pre-tillering:		
	1. Leaf folder	1 freshly damaged leave/hill
	2. Yellow stemborer	5% dead – hearts or one egg mass or one moth/ sq.m.
	3. Gall midge	1 gaa/ sq.m. in endemic areas or 5% affected tillers in non-endemic areas.
	4. Brown Plant hopper	5 to 10 insects/ hill.
	5. Rice leaf hopper	10 or more insects/ hill (in RV endemic areas 2 insects/ hill)
	6. White backed plant hopper	10 or more insects/ hill.
	7. Rice hispa	2 adults or 2 damaged leaves/ hill.

Sl.	Crop Stage and Pest	Economic Threshold Levels (ETLs)
C	Mid tillering :	
	1. Leaf folder 2. Stem borer 3. Gall midge 4. Brown Planthopper 5. Green leafhopper 6. Hispa 7. Blast 8. Bacterial leaf blight 9. Sheath blight 10. Tungro	1-2 freshly damaged leaves/ hill 5% dead hearts or 1 egg mass or 1 adult / sq.m. 5% silver shoot 5 - 10 insects/ hill. 10-20 insects/ hill (2 insects/ hill in RTD endemic areas) 1 adults or 1-2 damaged leaves/ hill. Light (5-10% disease severity) Light (2 to 5% disease severity) 5% or more affected tillers 1 affected hill/ sq.m.
D.	Panicle initiation to booting :	
	1. Stem borer 2. Leaf folder 3. Green leafhopper 4. Brown Planthopper 5. White backed planthopper 6. Blast 7. Bacterial leaf blight 8. Sheath blight	1 egg mass/ moth/ sq.m. 1-2 freshly damaged leaves/ hill 20 insects/ hill 5 - 10 insects/ hill. 5 -10 insects/ hill. 2-5% leaf area damage Light to Moderate (2-5% disease severity) 5% or more tillers affected
E.	Flowering and after :	
	1. Brown Planthopper 2. Climbing cutworm 3. Gundhi bug 4. Blast 5. Sheath rot/ brown spot 6. Sheath blight	5 - 10 insects/ hill. 4-5 leaves/ sq.m. 1 or 2 bugs/ hill 5% leaf area damaged or 1 to 2% neck blast 2-5% tillers affected 5% or more tillers affected.

III. Integrated Pest Management Strategies

A. Cultural practices

1. Summer ploughing trimming of bunds and destruction of crop residues.
2. Selection of healthy seeds or resistant/tolerant varieties (Annexure II).
3. Seed treatment (for diseases).
4. Early and timely planting/ sowing.
5. Raising of healthy nursery.
6. Seedling root dip/ nursery treatment in gall midge stemborer endemic areas.
7. Destruction of left over nursery, removal of weeds from field and cleaning of bunds.
8. Normal spacing as per recommendations.
9. Clipping of rice seedling tips before planting. But this should be avoided in BLB endemic areas.
10. 30 cm. alley formation at every 2 to 3 m. distance in planthopper and sheath blight endemic area.
11. Balanced use of fertilizers and micro-nutrients as per local recommendations.
12. Proper water management (alternate wetting and drying to avoid water stagnation) in planthopper endemic areas.
13. Removal and destruction of affected plant or plant parts.
14. Destruction of alternate host in swampy areas during off season.
15. Avoid staggered planting.
16. In case of late planting during Sali use aged seedling (40-45 old)

B. Mechanical Practices

1. Collection of egg masses and leaves of pest and their placement cages for conservation of bio-control agents.
2. Use of coir rope soaked in one part of kerosene and one part of water in rice crop for dislodging case worm, leaf folder leave etc.

3. Paddy weeder should be used at 30-35 DAT to suppress weed population.

4. Hispa infested leaves should be clipped at 6th – 9th and destroyed by burning or burying. Alternately, leaves of infested plants may be beaten with thorny twigs like ber etc. to injure and expose the grubs and pupae.

C. Biological Control

1. Conservation :

1.1 Bio-control agents viz, spider, drynids, water bugs, mirid bugs, damsel flies, dragonflies, meadow grasshoppers, staphylinid beetles, carabids, coccinellide, Apanteles, Tetrastchus, Telenomus, Trichogramma, Bracon, Platygaster etc. should be conserved.

1.2 Root dip treatment of rice seedlings with chlorpyriphos is safe for the natural enemies i.e. gall midge endemic areas.

1.3 As an alternate to seedling root dip, apply 1.5 kg. a.i./ ha of carbofuran or phorate granules in nursery 5 days before uprooting the seedlings for control of insect pests in early transplanted crop.

1.4 Place bamboo tops or twigs for perching of predatory birds soon after planting. However these are to be remove at flowering stage of the crop.

1.5 Collection of egg masses of borers and putting them in a bamboo case cum-percher till flowering which will permit the escape of egg parasites and trap and kill the hatching larvae. Besides, these would allow perching of predatory birds.

2. Augmentation:

Augmentative release of *Trichogramma japonicum* or *T. Chilonis* @50,000/ha/week 6-8 release should be made starting from 30 days of transplanting for control of stem borer and leaf folder respectively.

3. Pest Defender ratio :

2.1 Ratio may be useful to avoid application of pesticides.

4. Spraying of *Beauveria bassiana* (at a concentration of 107 spores/ml @400-700 l/ha. In general 3 kg/ha of the medium impregnated with *B. bassiana* is required per hectare.

D. Behavioral Control :

Mass trapping of yellow stem borer male moths by installing pheromone traps at the rate of 20 traps/ha 10 days after transplanting. Lures containing 5 mg pheromone mixture of Z, 11 hexadecenal & 2-9 hexadecenal (at 3:1 ratio) should be replaced 3-5 times during crop season.

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 developing IPM skill to pay safe with environment by proper crop health monitoring observing ETC and conserving bio-control potential before deciding in favour of chemical pesticides as a last resort.

F. Weed Management Practices :

1.1 In Direct Sown Rice :

The problem of weeds under direct sown rice growing condition are more than in transplanted rice. This is particularly so when crop is sown by broad casting. Major weeds of these situations are panicum sp. *Echinochloa*

crusgalli, cyperus iria, Cyperous diformis, Commelina benghalenses, Eclipta alba, Ischaemum rugosum, Eleusine indica, Amaranthus spinosus.

1.2 Weed Management :

- a. By ensuring thorough land preparation, the weed can be minimized. Summer ploughing is generally recommended for facilitating stubble management as well as weed control. Rain water conservation, preparation of stale seed bed before sowing by way of providing one round harrowing and leveling after the land preparation to minimize weeds. The fields should be given summer ploughing to destroy perennial weeds. Stale seed bed should be prepared by thorough seed bed preparation.
- b. Timely sowing of crop may be encouraged to minimize crop weed competition.
- c. The crop should be sown in lines at recommended spacing to facilitate inter-weeding operation. The mechanical methods of weed management should be practiced after 2-3 weeks and second time if necessary after 4-6 weeks of sowing.
- d. Apply Butachlor 2 kg a.i./ha at 2-3 days after sowing following by 1 mechanical weeding at 30-35 days after sowing.
- e. 2-4 D @ 0.8 kg. a.i./ha as post emergence at 2-3 leaf stage of the dicot weeds and sedges or 25-30 days after emergence.

2. Under Low Land Rice :

- 2.1 Major weeds under these situations are *Echinochloa colomn, Echinochloa crusgalli, Cyperus iria, Monochoria vaginalis indica, Digitaria setigera, Ischaemum rugosum, Fimbristylis littoralis and Fiss endocarpa linifalia.*

2.2 Weed Management :

- a. Bunds and irrigation channels should be kept free from weeds.
- b. Summer ploughing should be practiced wherever possible to destroy perennial weed vegetation.
- c. Stale seed bed should be prepared wherever possible and puddling should be done immediately before transplanting of rice.
- d. As far as possible rice seedling should be free from weed seedling at the time of transplanting.
- e. Optimum plant population and application of recommended rate of nutrients would help to ensure adequate density of plant population which could minimize the competition from weeds.
- f. Maintain a thin layer of water on the soil surface to minimize weed growth under such conditions.
- g. Early weeding 3-4 weeks after transplanting in case where mechanical methods are to be used.
- h. One hand weeding may be given 4-6 weeks after transplanting if necessary.
- i. Apply *Butachlor, Pendimethalin* or *Thiobencarb* @ 1.5 kg. a.i./ha or *Pretilachlor* @ 0.5 to 0.75 kg.a.e./ha. Or *Loxadiargyl* @ 100 g.a.i./ha or *Chlorimuron ethyl* @ 6-8 g.a.e./ha or *Metsulfuron methyl* @ 4 g a.e./ha or *Anilophos* @ 0.4 g a.i./ha as pre-emergence within 4-6 days after transplanting.
- j. Apply *Metsulfuron methyl + Chlorifuran methyl* @ 4-6 g a.i./ha or *Anilophos + 2-4 D* @ 300-480 g a.i./ha at 3-10 days after transplanting.

G. Nematode Management Practices :

Nematode Management practices are essential for obtaining the desired yield potential of rice crop. Important nematodes and their management approaches are as under –

1. Write tip nematode (*Apheienchides bessryi*)

- 1.1 Hot water treatment of seed at 52°C for 10 minutes after a presoak for 6 hours.
- 1.2 Sun drying seeds for 6 hours for 4 days.
- 1.3 Burning stubbles to prevent any carryover infection.
- 1.4 Pre-sowing of nursery bed treatment with carbofurn 3G granules @ 33 kg./ha.
- 1.5 Pre-soaking resistant varieties like Ratna, Triveni, TMK, TMK 9 Surya, Kaveri, Indira.

2. Rice Root Nematode (*Hirschmanniella oryzae*)

- 2.1 Application of neem cake at 100-120 kg/ha.
- 2.2 Grow resistant varieties like TMK 9, Annapurna in endemic areas.
- 2.3 Pre-sowing treatment of nursery bed with Carbofurn 3G granules @ 33kg/ha.
- 2.4 Seed soaking with 0.2% solution of Monocrolophos for 6 hours.
- 2.5 Soil application of Carbofuran 3G @ 33 kg/ha.
- 2.6 Growing *Sesbania rostrata* as intercrop.
- 2.7 Growing potato or groundnut as rotation crops.

3. Ufra (*Ditylenchus angustus*) – Assam, West Bengal

- 3.1 Destruction of ratoon crops.
- 3.1 Summer ploughing.
- 3.2 Delayed planting.
- 3.3 Rotation with non-host crops like Jute or Sesamum.
- 3.4 Seed treatment with Carbosulfan 25 ST.
- 3.5 Soil application of Carbofuran 3G @ 33 kg/ha.
- 3.6 Growing an early variety like Padmapani, which can escape the nematode in endemic areas.

4. Root knot nematode (*Meloidogyne graminicola*)

- 4.1 Rotation with the crops like Sweet potato, Sunflower, Cowpea, Sesamuan, Onion.
- 4.2 Growing resistant varieties like TKM-6 Hamsa, IR64 and Ramakrishna in endemic areas.
- 4.3 Soil application of Carbofuran 3G @ 33 kg/ha.

5. Cyst Nematode (*Heterodera oryzae*) – Kerala only

- 5.1 Growing resistant varieties like Alaknanda-41, Hamsa, TKM 6, MTU-17, CR-143-2-2 in endemic areas.
- 5.2 Soil treatment with Carbofurn 3G @ 33 kg/ha.

H. Rodent Management Practices :

(Working Index (ETL : Fifteen live burrows per hectare)

1. Bund trimming specially to minimize rodent harbourage.
2. Weed management to reduce alternate source of food. Remove ulubon (*Eleusine indica*) from the bunds.
3. Employment of indigenous traps preferably one month after transplantation.
4. Six weeks after transplantation application of bromodiolone (0.005% a.i.) in baits.
5. The residual live burrows may be treated with second application of bromodiolone (0.005%).

6. The above operations with rodenticides except Zinc phosphide (as rodents develop bait shyness) may be repeated if the rodent population exceeds working index.

Important :

- i. Optimum period or undertaking control operation is six week after transplantation.
- ii. Zinc phosphide (2.5%) in baits may be applied in rodent outbreak situation.
- iii. For effective control, it is recommended that Zinc, Phosphide with ISI mark in 10 gm pouches preferably in manufacturers package should be procured.

iv. Safety parameter s in Pesticide Usage. (as in booklet)

Resistant / Tolerant Varieties :

Variety	SB	GM	Blast	BLB	SLB	Ufra	M. Graminicola
Ranjit	MR	MR	-	T	T	-	
Bahadur	MR	MR	R	T	T	-	
Kushal MR	MR	MR	R	T	T	-	
Plyolee	MR	MR	R	T	-	-	
Maniram	MR	MR	R	T	T	-	
Mahsuri	MR	MR	S	MR	MR	-	
Satyaranjan	MR	R	R	T	T	-	
Basundhara	MR	R	R	T	T	-	
Luit	MR	MR	R	T	-	-	
Kapilee	MR	MR	R	T	-	-	
Bishuprasad	MR	-	R	-	-	-	
Jyotiprasad	MR	-	R	-	-	-	
Gopinath	MR	-	MR	T	T	-	
Prafulla	-	-	R	T	T	-	
Aghoni	MR	MR	R	T	T	-	
Rangilee	MR	MR	R	T	T	-	
Bhugalee	MR	MR	R	T	T	-	
Ketaki	MR	MR	R	T	T	-	

Variety	SB	GM	Blast	BLB	SLB	Ufra	M. Graminicola
Lachit	MR	-	R	T	T	-	
Chilarai	MR	-	R	T	T	-	
Pankaj	MR	MR	R	T	T	-	
Joymati	MR	MR	R	T	T	-	
Rayada 16-06	-	-	-	-	-	R	
Rayada 133	-	-	-	-	-	R	
Brazil 65	-	-	-	-	-	MR	

SB : Stemborer

GM : Gallmidge

BLB : Bacterial

ShB : Sheath Blight Leaf Blight

MR : Moderately Resistant

R : Resistant

T : Tolerant

Procedure for Seedling Root Dip

A smooth area of 10x1 cm can be bounded strongly on all sides. A polythene sheet of 10.5x1.5 m is spread over the area touching the soils surface and extended along the bunds up to a height of 10-15 cm. Let it water to a depth of about 2 cm and add 200 ml of chlorpyrifos (20EC) and mix thoroughly. Uprooted rice seedlings required to plant one acre closely arranged immersing roots in insecticide solution (0.02%). All these operations are done towards evening and seedlings are allowed to remain in the insecticide solution over night (for 12 hours) and are transplanted next day morning. In case of time shortage, add 1% urea to insecticide emulsion in bounded area and mix thoroughly. Dip roots in this solution for 3 hours and plant.

INSECT-PESTS, THEIR THRESHOLD AND RECOMMENDED CHEMICAL CONTROL :-

Sl.	Crop stage & Pest	ETL	Insecticide (Technical name)	Dose
1	2	3	4	5
A. Nursery				
1	Thrips	At the appearance of damage symptom (curling and yellowing to reddish discoloration)	Quinalphos 25 EC Monocrotophos 40EC Chlorpyriphos 25 EC Fenitrothion 50 EC Dimethoate 30 EC	2 ml 1.2ml 2.5ml 1 ml 1.6ml
2	Green leaf hopper	1-2 insects/sqm in RTD endemic area	Monocrotophos 40EC Chlorpyriphos 20 EC Dimethoate 30 EC Quinalphos 25 EC Phosalone 35 EC	1.2ml 2.5ml 1.6ml 2 ml 1.4ml
3	Gallmidge	1 silver shoot/sqm	Chlorpyriphos 20 EC Monocrotophos 40EC	25 ml 1.2 ml
4	Stem borer	1 moth or 1 egg mass/sqm	Chlorpyriphos 20 EC Monocrotophos 40EC	25 ml 1.2 ml
5	Blast	Endemic 1-2 spots/sqm	Adopt seed dressing With tricyclazole 75 WP or pyroquilon 50 Wp Carbendazim 50 WP ediphenphos 50 EC Tricyclazole 75 WP	2gmkg Seed 4gmkg Seed 1g 1 ml 0.6gm
B Planting to pre-tillerin				
1.	Whorl maggot	20% of damaged hill upto 30 DAT	Carbofurn 3 G Chlorpyriphos 20 EC Monocrotophos 40 EC	30Kg/ha 2.5 ml 12 ml
2.	Case worm	1-2 barrel cases/hill	Quinalphos 25 EC Monocrotophos 40 EC	2 ml 1.2 ml
3.	Leaf folder	1-2 freshly damaged leaves / hill	Quinalphos 25 EC Monocrotophos 40 EC Chlorpyriphos 20 EC Fenitrothion 50 EC Dimethoate 30 EC	2 ml 1.2 ml 2.5 ml 1 ml 1.6 ml

4	Green leaf hopper (GLH)	10 or more insects/hill or 2 insects/hill in RTV endemic areas	Monocrotophos 40 EC Chlorpyriphos 20 EC Quinalphos 25 EC Dimethoate 30 EC Phosalone 35 EC	12 ml 25 ml 2 ml 16 ml 14 ml
5	White backed plant hopper (WBPH)	10 or more insects/hill	Monocrotophos 40 EC Chlorpyriphos 20 EC Quinalphos 25 EC Dimethoate 30 EC Phosalone 35 EC	12ml 2.5ml 2 ml 1.6ml 1.4ml
6	Brown plant hopper (BPH)	5-10 insects/hill	Monocrotophos 40 EC Chlorpyriphos 20 EC Quinalphos 25 EC Dimethoate 30 EC Phosalone 35 EC Carbofuran 3 G	1.2ml 2.5ml 2 ml 1.6ml 1.4ml 30kg/ha
7	Stem borer	1 egg mass or 1 moth/sqm or 5% dead hearts	Chlorpyriphos 20 EC Monocrotophos 40 EC Quinalphos 25 EC Phosphaomidon 100 EC Fenitrothion 50 EC Carbofurn 3 G Phorate 10 G	2.5ml 1.2ml 2 ml 0.5ml 1 ml 30kg/ha 10kg/ha
8	Rice hispa	2 adults or 2 damaged leaves/hill	Chlorpyriphos 20 EC Monocrotophos 40 EC Phosalone 35 EC Quinalphos 25 EC Carbofuran 3 G	2.5ml 1.2ml 1.4ml 2 ml 30kg/ha
9	Gall midge	1 gall/sqm in case of endemic area or 5% silver shoot in non-endemic area	Chlorpyriphos 20 EC Monocrotophos 40 EC Carbofurn 3 G Phorate 10 G	2.5 ml 1.2ml 30kg/ha 10kg/ha
10	Swarming Caterpillar	1 larva/hill	Chlorpyriphos 20 EC Monocrotophos 40 EC Quinalphos 25 EC Dichlorvos 70 EC	2.5ml 1.2ml 2 ml 0.7ml
11	Blast	5-10% disease servery	Carbendazim 50 WP Ediphenphos 50 EC Tricyclazole 75 WP Delay top dressing of N fertilizer when infection is seen	1g 1 ml 0.6gm
12	Bacterial leaf blight	2-5% disease servery	Skip top dressing of N fertilizer	

13	Sheath blight	5% affected tiller/sqm	Carbendazim 50 WP Mancozeb 45 WP Contaf 50 EC	1g 2.5 g 2 ml
C Mid tillering				
1	Rice hispa	2 adults or 2 damaged leaves/hill	Chlorpyrifos 20 EC Monocrotophos 40 EC Phosalone 35 EC Quinalphos 25 EC Carbofuran 3 G	2.5ml 1.2ml 1.4ml 2 ml 30kg/ha
2	Leaf folder	1-2 freshly damaged leaves / hill	Quinalphos 25 EC Monocrotophos 40 EC Chlorpyrifos 20 EC Fenitrothion 50 EC Demethoate 30 EC	2 ml 1.2 ml 2.5ml 1 ml 1.6 ml
3	Green leaf hopper (GLH)	10 or more insects/hill or 2 insects/hill in RTV endemic areas	Monocrotophos 40 EC Chlorpyrifos 20 EC Quinalphos 25 EC Dimethoate 30 EC Phosalone 35 EC	1.2ml 2.5ml 2 ml 1.6 ml 1.4 ml
4	Brown plant hopper	As mentioned under 'B' planting to pre tillering.		
5	White backed planthopper			
6	Stem borer			
7	Gallmidge			
8	Blast	5-10% disease serverity	As mentioned under 'B'	
9	Bacterial leaf blight	2-5% disease serverity	Stop top dressing of nitrogenous fertilizer	
10	Sheath blight	5% more affected tillers	As mentioned under 'B'	
11	Tungro	One affected hill/sqm	Remove and destroy affected plants and apply additional nitrogen for early recovery. Apply carbofuran granules @ 1 kg a.i/ha or spray monocrolophos 40 EC 1.2 ml/lit of water	

D Panicle initiation to booting stage				
1	Stem borer	1 egg mass/sqm		
2	Leaf folder	1-2 freshly damaged leaves / hill	As mentioned under 'B'	
3	Brown plant hopper	5-10 insects/hill		
4	Climbing cutworm	1 larvae/hill	-do-	
5	Rice bug	1-2 bugs/hill	Malathion 5% dust @ 20 kg/ha or endosulfan 4% dust @ 25 kg/ha	
6	Blast	5% leaf area damaged or 1-2% neck blast	As mentioned earlier	
7	Sheath rot	2-5% tillers affected	-do-	
8	Brown spot	2-5% tillers affected	-do-	
9	Sheath blight	5% of more tillers affected	-do-	

IPM PACKAGE FOR WHEAT

A. Pests of Major Importance :

1. Diseases :

1. Diseases :			
		Common Name	Distribution
	1.1	Leaf (brown) rust	Throughout the wheat growing zones.
	1.2	Stripe (Yellow) rust	Cooler regions of Northern India (Northern hill zone and NWPZ)
	1.3	Stem (black) rust	PZ, CZ & sometimes in NWPZ. Rarely in very late sown crop in NEPZ.
	1.4	Foliar blights	Major problem in NEPZ, moderate in CZ & PZ; newly emerging problem in NWPZ.
	1.5	Loose smut	Major problem in NWPZ; NHZ & NEPZ.
	1.6	Karnal bunt	Major (endemic) in NWPZ, minor in NEPZ & Northern parts of CZ.
	1.7	Powdery mildew	Disease of cooler and humid areas in NHZ & NWPZ.
	1.8	Flag smut	Minor problem in Western Haryana and Northern Rajasthan (NWPZ).
	1.9	Hill bunt	NHZ
	1.10	Foot rot	Low to moderate in CZ & PZ
	1.11	Head scab	Newly emerging problem in submountaneous parts of NWPZ
	1.12	Black point & discolouration	Black point throughout wheat growing areas under humid conditions at the time of harvest. Black discolouration in parts of CZ & NWPZ.

2. Nematodes :			
	2.1	Ear cockle (seed gall nematode)	Major problem in NWPZ, low to moderate in parts of NWPZ (Northern Rajasthan)
	2.2	Tundu disease	Western & Southern Haryana.
	2.3	Cereal cyst nematode	Moderate to high in drier areas of NWPZ (Northern Rajasthan and Haryana)
3. Insect Pests :			
	3.1	Termites	Major problem in dry areas of the wheat growing zones.
	3.2	Aphids wheat growing areas (Newly emerging problem).	Major problem in most of the
	3.3	American pod borer	Mostly low; sometimes moderate (especially under cotton-wheat & Rice-wheat rotations).
	3.4	Armyworm/Rice caterpillar	NWPZ, NEPZ and CZ, (especially in late sown crops)
	3.5	Brown mite	Normally low in NWPZ, CZ, NEPZ but rarely moderate to high in dry winter in isolated pockets.
	3.6	Shoot fly	Low in part of NWPZ.
	3.7	Root aphid	Low to moderate in parts of CZ (Central MP)
	3.8	Pink borer	Low in parts of NWPZ, CZ and NEPZ.
4. Rodents :			
	4.1	Smaller Bandicoot	Throughout wheat growing areas.
	4.2	Soft furred field rat	NWPZ, CZ.
	4.3	Indian gerbil	
5. Major weeds :			
	5.1	Lamb square	NWPZ, NEPZ & CZ
		Pimpernel	
		Fumitory	
		Lathyrus	
		Medic	
		Cluster weed	
		Corn spurry	
		Sweet clover	

	5.2	Grassy weeds	
		Canary grass* wild oat	*Major problem in NWPZ and NEPZ (especially in rice-wheat rotation). Absent or rare in CZ and PZ.
		Darnel	
		Blue grass	
		Rabbit foot grass	
B. Pests of regional significance :			
1. Inset Pests :			
	1.1.	Wheat aphid	<i>Sitobion miscanthi</i>
	1.2.	Pink borer	<i>Sesamia inferens</i>
	1.3.	Tarmite	<i>Mirotermes obesi, Odontotermes obesus</i>
	1.4.	Army Worm	<i>Mythimna separata</i>
	1.5.	Thrips	<i>Anaphothrips favicinctus</i>
	1.6.	Cut worm	<i>Agrotis ipsilon</i>
	1.7.	Ear head cutipillar	<i>Helicoverpa armigera</i>
	1.8.	Cricket	<i>Brachytryes achatinus</i>
2. Diseases :			
	2.1	Loose smut	
	2.2	Foliar blight	
	2.3	Foot rot	
	2.4	Brown rust	
	2.5	Stripe (Yellow) rust	
	2.6	Stem (Black) rust	
3. Weeds :			
	3.1	<i>Cyperus rotundus</i>	
	3.2	<i>Digitaria sanguinalis</i>	
	3.3	<i>Cyperus iria</i>	
	3.4	<i>Cynodon dactylon</i>	
	3.5	<i>Chenpodium album</i>	
	3.6	<i>Polygonum brubatum</i>	
	3.7	<i>Amaranthus viridis</i>	
	3.8	<i>Polygonum visosum</i>	
4. Rodents :			
	4.1	Lesser bandicoot	<i>Bandicota bangalensis</i>

II. Pest Monitoring :

The objective of surveys is to monitor the initial development of pests and diseases in endemic areas. In the beginning of crop season routes based upon the endemic areas are required to be identified to undertake roving survey. Based upon the results of the roving surveys, the extension functionaries have to concentrate for greater efforts at block and village levels as well as through farmers to initiate field scouting. Farmers should be mobilized to observe the pest and disease occurrence by field scouting at the intervals as stipulated here under. The plant protection measures are required to be taken only when pests and diseases cross ETL as per results of field scouting.

1. Rapid Roving Survey :

Undertake roving survey at every 10 km initially at weekly intervals and thereafter at 10 days intervals (depending upon the pest and disease incidence) in pre-fixed routes. Record incidence of pests/ diseases of the crop.

In case of nematodes, particularly in the month of February (ear head stage), special attention should be given to monitor incidence of cereal cyst nematode exhibiting symptoms like stunted growth, yellowing, less tillering and pearl like white females attached to the rootlets. For seed gall nematodes, field showing symptoms of curling, crinkling and twisting of leaves with spread out ones may be identified to avoid harvest of produce for the purpose of seed material.

2. Trap Plot Nurseries (TPN) :

Such nurseries are planted at various strategic locations and regular watch is kept for the occurrence of the pests. Such type of nurseries, usually contain varieties or entries with known genetic constitution so that occurrence or appearance of a new race or pest could be identified. The trap plot nurseries (TPN) is planted at multiplications including those all along the western border. It helps in knowing the first appearance of disease, disease progress, disease situation and appearance of new variants or races or resistant materials. This also helps in monitoring the entry of new races (pathotypes) from across the border, specially for the yellow rust. Distribution pattern of the rust virulence (races) provides much needed indications for executing the resistant gene deployment, thus helping in preparedness for the future.

3. Field Scouting :

Field scouting should be undertaken by the farmers and extension functionaries for keeping a close watch on the appearance of diseases, insect pests and bio-control fauna.

During the visit to the field, a diagonal path should be followed. During the first course through the field, only occurrence of pests is recorded whereas during the second course, quantitative information is also recorded on 5 randomly selected spots of one metre row length/5 plants.

- (a) First passage
- (b) Second passage showing five sites for date recording.

Pest infestation, resulting damage in scattered patches in the field like root diseases, termite and nematodes should be scouted.

4. Agro-Eco System Analysis (AESA) :

AESA is an approach which can be gainfully employed by extension functionaries and farmers to analysis 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 situation will help in taking appropriate decision on management practices. The basic components of AESA are :

- i) Plant health at different stages. Monitor symptoms of diseases and nematodes.
- ii) Built-in-compensation abilities of the plants.
- iii) Post and defender population dynamics.
- iv) Soil conditions.
- v) Climatic factors
- vi) Farmer's past experience.

III. Economic Threshold Level (ETL) :

1. Nematodes :

- 1.1. 2 eggs/larvae per gm of soil for cereal cyst nematode.
- 1.2. 1 percent mixture of seed galls with healthy seeds for seed gall nematodes.

2. Insect Pests :

2.1. Aphids

- i) Five aphids per ear head

Armyworm and American pod borer (*Helicotheris*) 4 to 5 larvae per metre row.

3. Rodents :

- i) 25 live burrows/hectare.
- ii) Damage index 2 percent tiller damage (diagonal method)

During AESA observations, small stem bits damaged by the rodents may be noted, which indicated the presence of reproducing/lactating females.

IV. Integrated Pest Management Strategies :

4.1. Cultural Practices :

1. Summer deep ploughing and burning of stubbles/residue of previous crop.
 2. Grow moderately aphid resistant/tolerant varieties-like UP-262 and WH-291.
- 4.2.3. Rogueing of 'dead heart' plants & loose smut infested plants at early stage of attack.
 - 4.1.4. Crop rotation with non host crops (other than maize, rice, fodder jawar etc.) against pink borer attack
 - 4.1.5. Collect seeds from disease free source.
 - 4.1.6. Use well rotten cowdung manure/compost to avoid termites.
 - 4.1.7. Avoid late sowing of wheat to save the crop from aphid and army worm.
 - 4.1.8. Use only recommended dose of nitrogenous fertilizer excess nitrogen attract insects and diseases.
 - 4.1.9. Maintain frequent surveillance of crop field for timely management of pests.
 - 4.1.10. In rodent infested fields trimming of field bunds should be done to destroy existing rodent burrows. Existing rodent burrows should be collapsed by flooding the field.
 - 4.1.11. Application of neem cake (250 kg/ha) suppress cutworm.
 - 4.1.12. Clean cultivation – one hand weeding at 45 days.
 - 4.1.13. Flooding against cricket and rodents.

4.2. Dismantle termataria (monde) around fields & kill the termite queen.

4.3. Biological Control :

4.3.1. Conservation and exploitation of biocontrol agents like coccinellid beetles, chrysopa, syrphid, Apanteles etc. by spot & strip application of insudae against aphid attack.

4.3.2. Fix bird perches of 5ft high to attract insectivorous birds like swallow, Mayana, rodentivorus birds like owls. After flowering of crop bird perches should be removed.

4.4. Chemical Control :

4.4.1. Seed Treatment :

For Termite : Treat seeds before sowing with any of the following insecticides. Chlorpyriphos @ 4 ml/kg of seeds. Endosulfan @ 7 ml/kg of seeds.

For Loose Snut : Treat seeds before sowing with arboxin/ arbandazim @ 1 gm/kg.

4.4.2. Soil treatment : For cutworm cricket or termite endemic field apply 25-30 kg of Malathion 5% dust or Endosulfan 4% dust at soil preparation.

4.4.3. Insecticide spray :

For Aphid & Thrips : Endosulfan 2 ml/lit of water

Or

Monocrotophos 1 ml/lit of water

Or

Oxydenmeton methyl 1 ml/lit of water

Or

Dimethoate 1 ml/lit of water.

For Army worm : Fenitrothion 2 ml/lit of water (Spray in evening hours for better control)

Or

Diclorvos 1 ml/lit of water

Or

Endosulfan 1 ml/lit of water

For Pink borer : Quinalphos 2 ml/lit of water

Or

Monocrotophos 1 ml/lit of water

Or

Dimethoate 1 ml/lit of water.

For Rodents : Place bromadiolone 0.005% bait (15 gm/furrow) is live when the infestation level Furrows is live burrow/ha.

V. Crop Stage wise IPM Practices :

Sl. No.	Crop Stage/pest	IPM Practices
1.	Presowing	i) Deep summer ploughing in May-June to expose soil borne diseases and nematodes to solar radiation.
		ii) Apply well rotten farm yard manure only.
		iii) Avoid late sowing of crop.
2.	Seed	iv) Use only certified seed, clean seed by sieving or by using 2.5 percent salt-water floatation to remove galls and prevent ear-cockle disease.
		i) Treat the seed with chlorpyriphos @ 4 ml/kg seed or endosulfan @ 7 ml/kg seed before sowing to control termite damage.
3.	Seedling stage	i) If termite damage is notices at seedling stage, apply treated soil by broadcasting @ 175 gm/a.i/ha of endosulfan.
		ii) Observe the damage by root aphid.
		iii) If the dead hearts inflicted by pink borer are noticed, rogue the dead heart plants and spray crop with any one of the recommended insecticides.
4.	Vegetative stage	i) Erect bird perches for insectiveorous & rodentivorous birds.
		ii) For army worm and pink borer control apply the recommended nematiodes in the evening hours.
5.	Ear head stage	i) To control aphids use the above mentioned pesticides.
		ii) For army worm and ear head caterpillar, spray, Endosulfan 1 ml/lit or dichlorvos 1 ml/lit or fentrothin 2 ml/lit.

Note 1. Insecticide should only be sprayed when pest population attain economic threshold level.

VI. Do's and Don'ts :

	DO'S	DON'TS
1.	Grow only recommended varieties	Do not grow varieties which are not recommended for a particular area or which have become susceptible to diseases or pests in general.
2.	Sow the varieties which are recommended for timely sown or late sown or rainfed conditions at proper time.	Do not grow varieties which are not recommended for that particular time or situation.
3.	Always use recommended doses of NPK fertilizers.	Do not use N fertilizers in excess.
4.	Regular surveillance/monitoring for timely detection of ETL which are must for undertaking chemical control measures.	Do not spray insecticides without detecting ETL of a pest.
5.	Use only recommended pesticide at the recommended dosages for control of various pests.	Do not use unrecommended pesticides or mixtures of various pesticides.
6.	Use certified, healthy clean seeds free of seed galls.	Do not use farm implements contaminated with soil to avoid spreading soil borne infestation from one field to another.
7.	Practice deep summer ploughing.	

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IPM PACKAGE FOR RAPSEED-MUSTARD

1. MAJOR PESTS

A. Pests of National significance :

1. Insect Pests :

- 1.1. Mustard aphid
- 1.2. Painted bug
- 1.3. Mustered sawfly

2. Disease :

- 2.1. White rust
- 2.2. Downy mildew
- 2.3. Alternaria blight

2. Weeds :

- 3.1. Lamb square
- 3.2. Wild onion.

B. Pests of Regional Significance :

1. Insect pests:

- 1.1. Flea beetle (*Phyllotreta cruciferae*)
- 1.2. Cabbage butterfly (*Pieris canidia P. brassicae*)
- 1.3. Diamond backmoth (*Plutella xylostella*)
- 1.4. Leaf webber (*Crocidolomia binotalis*)
- 1.5. Hairy caterpillar (*Euproctes sp.*)

2. Diseases :

- 2.1. White blight
- 2.2. White rust
- 2.3. Downy mildew
- 2.4. Alternaria blight.

3. Weeds :

- 3.1. *Polygonum visoerum*
- 3.2. *Oxilas corniculata*
- 3.3. *Oxalis dibilis*
- 3.4. *Eleusin indica*
- 3.5. *Cyperus rotundus*
- 3.6. *Cynodon dactylon*

3. Pest Monitoring :

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

1. Rapid Roving Survey (RRS) : Survey routes should be identified with the beginning of the crop season in the pest and disease endemic areas to undertake Rapid Roving Surveys (RRS). Monitoring and Surveillance of almost all the important pests should be done regularly i.e. weekly in general and twice a week during seeding/flowering/pod formation stage. During survey the observations are to be made at every 10 kms. distance in pre-selected routes. For mustard aphid, monitoring activities will have to be intensified from first week of December onwards. Record the incidence of pest, disease and defender populations in 30 to 40 randomly selected per ha.

2. Field Scouting : Based on the observation of RRS, the farmers at village level are to be mobilized to undertake field scouting. During field scouting, farmers may record pest, disease and defenders population twice a week in their own fields as per Agro-Eco-system Analysis (AESA) approach. (The State Department of Agriculture should make all possible efforts by using different media, mode and publicity to inform the farmers the need for field scouting in the specific crop areas having indication of pest or disease buildup.)

3. 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 situation will help in taking appropriate decision on management practices.

1. Plant health at different stages (Phenophases)
2. Built-in-compensation abilities of the plants.
3. Pest and defender population dynamics.
4. Soil conditions and edaphic factors.
5. Climatic factors-temperature, RH and rainfall, etc.
6. Farmers experience of pest, diseases and weeds etc.

4. Economic Threshold Levels (ETLs) :

To determine ETL of mustard aphid, observe 30 to 40 widely scattered plant per location/field once a week and then count the number of aphids (nymphs and adults) on the top 10 cm length of the terminal shoot; or observe 250 plant/ha, selected randomly from all the sides of the field to work out the per cent plant infested.

Pest		ETL	
1.	Mustard aphid	a)	30-40 aphids/10cm of terminal shoot or
			17-28% plants infested.

III. IPM Strategies :

A. Cultural Practices :

1. Deep ploughing soon after harvest, wherever possible.
2. Destruction of debris of previous crop.
3. Grow aphid resistant or tolerant varieties like Varuna, TM-2 & TM-4.
4. Early sowing (2nd fortnight of October) of the crop to escape mustard aphid attack.
5. Use recommended dose of fertilizer.
6. Irrigate the crop at early pod formation stage to reduce painted bug incidence.

B. Mechanical Practices :

1. Collection and destruction of egg mass and early instar (gregarious phase) larvae of cabbage caterpillar and hairy caterpillar.
2. Remove aphid infested twigs and destroy the aphids.
3. Hand picking and destruction of sawfly larvae in the morning hours.
4. Removal and destruction of leaf webbers along with the webbed leaves.

C. Bio-logical Control Practices :

Conserve the natural bio-control agents viz. coccinellids, chrysophids and syrphid by selecting safe insecticides (endosulfan is safer for predators and pollinators), proper timing of spray (Evening hours) by following only need base application of insecticide.

D. Chemical Control Practices :

Sl. No.	Pest/Diseases	Insecticide/Fungicide	Dosages
1.	Insect Pests-	Endosulfan 4% dust	25 kg/ha
	Mustard sawfly	* Malathion 5% dust	25 kg/ha
	Cabbage caterpillar, Flea beetle	* Malathion 50 EC 0.1%	2 ml/lit.
	** Mustard aphid	Oxydemeton methyl 25 EC at 0.025%	1 ml/lit.
	Painted bug	Endosulfan 35 EC at 0.030%	1 ml/lit.
	Hairy caterpillar	Dimethoate 30 EC at 0.03%	1 ml/lit.
	Diamond back moth	Monocrotophos 36 use use at 0.036%	1 ml/lit.
		Quinalphos 25 E at 0.025%	1 ml/lit.

★ Don't apply malathion after flowering in order to spare pollinators like honey bee.

★★ Spot application in case of early attack and strip application when the infestations is uniform against aphids.

2. Diseases :

Seed treatment with Matalaxyl (like Agvon 35 WS) @ 6 gm/kg to eliminate downy mildew and white rust of rapeseed and Mencozeb 75% WP @ 3 gm/kg of seed for Altermaria blight is recommended.

Spray Mencozeb 75% WP @ 2 gm/lit to control Alternaria blight, Downy mildew or white rust.

F. Crop Stage/Pest-wise IPM Practices:

Sl. No.	Crop Stage/Pest	IPM Component	IPM Practice
1.	Pre-sowing	Cultural Practice	1. Deep ploughing to expose the soil borne pathogens and hibernating stages of defoliators. 2. Destruction of plant debris. 3. Early sowing to avoid
	mustard-aphid, and major diseases.	damage due to	

			4. Seed treatment with Metalaxyl (like Agvon 35 WS) @ 6 gm/kg to eliminate downy mildew and white rust of rapeseed and Mencozeb 75% WP @ 3 gm/kg of seed for Altermaria blight is recommended.
2.	Seed and seedling Flea beetle.	Chemical Practice	Endosulfan 4% dust @ 25 kg/ha or Malathion 5% dust @ 251 g/ha or Malathion 50 EC at 0.1%.
	Mustard sawfly	Mechanical	Hand picking and destruction of larvae.
		Chemical	Endosulfan 4% dust @ 25kg/ha or
	Malathion 50 EC at 0.1%.	5% dust @ 25kg/ha or	
3.	Vegetative Phase		
	Mustard sawfly	Mechanical	Hand picking and destruction of larvae.
		Chemical	As in seedling stage.
	Flea Beetle	Chemical	As in seedling stage.
	Aphid	Mechanical	Removal of leaves showing early colonies of aphid.
	Cabbage caterpillar	Mechanical	Collection and destruction of gregarious larvae.
		Bio-control	Erection of short bamboo tops for predatory birds.
		Chemical	As against sawfly.
	Alternaria Blight	Chemical Practice	Spray the crop with Mancozeb 75% w.p. @ 2 gm/lit of water at the appearance of disease.
	Downy mildew	Chemical Practice	-do-
	White rust	Chemical Practice	-do-

4.	Flowering stage		
	Aphide	Mechanical	Removal of aphid infested twigs.
		Chemical	Strip application of insecticide in the afternoon with oxydemeton methyl 0.025% or phosphamidon 0.025% or dimethoate 0.03% or monocrotophos 0.036% or quinolphos 0.025%.
	Hairy caterpillar	Mechanical	Collection and destruction of egg masses and larvae.
		Chemical	As against aphid.
	Cabbage caterpillar	Mechanical	Collection and destruction of larvae (gregarious stages)
		Bio-control	Erection of short bamboo tops as perches for predatory birds.
		Chemical	As against sawfly.
	Alternaria Blight	Chemical Practice	Spray the crop with Manozeb 75% w.p. @ 2 gm/lit of water.
	White rust	Chemical	-do-
	Downy mildew	Chemical	-do-
5.	Pod formation stage		
	Aphid	Chemical	As in flowering stage.
	Diamond back moth	Chemical	As against aphid.
	Painted bug	Cultural	Irrigate the crop at early pod formation stage.
		Chemical	As against aphid.
	Alternaria blight	Chemical	Spray the crop with Manozeb 75% w.p. @ 2 gm/lit of water.

IV. Nematode Management :

There is no problem of nematode pest in these crop. However mustard is a antagonistic crop or enemy crop for nematode pest. The crop is recommended as trap crop for crop rotation or mixed crop with vegetables/pulses for reduction of root knot and reniform nematodes.

V. Weed Management :

Crop should be sown timely at proper moisture by using recommended seed rate, balances dose of fertilizer to achieve optimum population and healthy crop stand which would be capable of competing with weeds at initial stage of crop growth.

Crop should be maintained weed free initially for 45 days after sowing by restoring to hand hoeing/weeding at 20 and 40 days after sowing.

VI. Potential Natural Enemies of Mustard Pests :

A. Chrysopa : Green lacewing, adults are delicate, light green insects with net like wings. The eggs are laid on the stalks. It grubs posses sickle shaped mouth parts, wander on plants in search of soft bodied insects pray vigourously on them.

B. Lady Bird Beetles : They are predatory. The eggs are yellowish, grubs are usually blackish or blackish with yellow. Orange or red markings. Adults are brightly coloured (reddish, Yellowish, Black, Orange red) beetles with over upper side. The adults and feed on aphids.

C. Syrphid fly : The larvae are whitish in colour having sharp mouth parts which feed on aphids. The adults are not predaceous. These are also hoverfly and look like slender house fly.

VII. 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 posts, defenders, soil conditions. Plants health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices.

The basis components of AESA are :

1. Plant health at different stages (Phenophases)
2. Built-in compensation abilities of the plants.
3. Pest and defender population dynamics.
4. Soil conditions and edaphic factors.

5. Climatic factors temperature, RH, rainfall, etc.
6. Farmers experience of pest, diseases and weeds etc.

The methodology of AESA is as under :

A. Field Observations :

- a) Enter the field at least two ft. away from the bund. Select a site with a dimension of 1 sq.mt. randomly.
- b) Record the visual observations in following sequences :
 - i) Flying insects (both pests & defenders)
 - ii) Close observation on pests and defenders which remain on the plants.
 - iii) Record disease and its intensity.
 - iv) Record insect damage in percentage or population/plant.
- 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 factor viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

B. Drawings :

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 colour 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 clouds may be drawn in place of sun. In the case of partially sunny, the diagram of sun may be half marked with clouds.

C. Group Discussion and decision making :

The observations recorded in the previous and current charts should be discussed among the farmers by raising questions relating to change in pest and defender population in relation to crop stages, soil condition, weather factors such as rainy, cloudy or sunny, etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P : D ratio and take judicious for specific pest management practices.

D. Strategy for decision making (Examples) :

Some of the defenders like lady beetles, hrysoperia, syrphids, etc. play useful role in arriving at P : D ratio. Detailed list description is at Annexure –II.

E. AESA By Extension Functionaries :

The extension functionaries during their regular visit to the village mobilize 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 safe pesticides are to be used for specific pest situation. Such an exercise may be repeated by the extension functionaries during every visit to the village and motivate the farmers to adopt AESA in their fields.

F. AESA By Farmers :

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

Do's and Don'ts in Rapseed-Mustard IPM

Sl. No.	Do's	Don't
1.	Deep ploughing expose the weeds, soil borne pathogens and hibernating larvae of defoliators.	Do not plant or irrigate the fields immediately after ploughing.
2.	Grow commonly recommended varieties.	Do not grow varieties not suitable for the season or the region.
3.	Prefer to sow the crop early i.e. upto 20 th Oct.	Avoid late sowing of the crop as it may lead to reduced yields and high incidence of insect pests and diseases.
4.	Sow in the rows at optimum depths under proper moisture conditions for better establishment.	Do not sow seeds beyond 5 cm depth and under improper moisture conditions.
5.	Use fertilizers as per the soil test recommendations.	Avoid imbalanced use of fertilizer.
6.	Take decision on management practices based on AESA ETL, pest defender (P.D.) ratio only.	Do not apply chemical pesticides calendar basis.
7.	Use only the recommended chemical pesticides.	Do not use mixtures of chemical pesticides.
8.	Use the recommended doses of pesticides and the quantity of water.	Avoid indiscriminate use of pesticides and wrong sprayers.
9.	Spray the crop in morning or evening hours to avoid direct hit to the natural enemies and bee pollinators.	Do not spray the crop during noon hours as honey bees visit the crop in maximum numbers during this period.
10.	Use safer insecticides like endosulfan	Do not use insecticides highly toxic to parasites and predators.
11.	Use malathion 50 EC on the crop meant for Saag purpose and follow the waiting period of 8 days.	On a crop meant for Saag, do not spray any insecticide other than
12.	Sow the crop in the last fortnight of Nov. to escape flea beetle damage in endemic areas.	Do not sow early if the area has a case history of flea beetle attack.

IPM Package for Blackgram/Greengram

1. Major Pests :

A. Pests of national significance :

1. 1.1. White fly - *Bemisia tabaci*
- 1.2. Hairy caterpillar - *Spilosoma oblique*
Amsata moorie
- 1.3. Stemfly - *Ophiomya phaseoli*
- 1.4. Jassids - *Empoasca sp.*
- 1.5. Podborer - *Maruca testulalis*
- 1.6. Thrips - *Caliothrips indicus*

1. **Disease :** Yellow mosaic virus (YMV) cercospora leaf spot
cercospora sp.
Powdery mildew –*Erysiphe polygoni*.

Macrophamina blight – *M. phaseolina*.

3. **Weeds :** *Cyperus rotundus*
Cynodon dactylon
Digitaria setigera
Fimbristylis littoralis
Amaranthus viridis
Ageratum houstonianum
Spilonthes paniculata
Echinochloa spp.
Cleome viscom
Phyllanthus niruri

4. **Nematodes:** 4.1. *Meloidogyne incognita*
4.2. *Heterodera cajani*
4.3. *Meloidogyne javanica*

B. Pests of regional significance :

1. Inset/mite

- 1.1. Leaf folder - *Nacoleia vulgalis*
- 1.2. Flea beetle - *Monolepta signata*
- 1.3. Pod sucking bugs - *Riptortus linearis*, *R. pedestris*
- 1.4. Aphid - *Aphis craccivora*
- 1.5. Green stink bug - *Nezara viridula*
- 1.6. Lycaenid pod borer - *Euchrysops cnejus*
- 1.7. Red spider mite - *Tetranychus sp.*
- 1.8. Leaf weevil - *Myllocerus sp.*

2. Nematodes : 2.1. *Meloidogyne incognita*

3. Disease : 3.1. Yellow mosaic virus (YMV)
3.2. Cercospora leaf spot
3.3. Powdery mildew
3.4. Web blight

4. Weeds : 4.1. *Amaranthus viridis*
4.2. *Ageratum houstonianum*
4.3. *Mimosa pudica*
4.4. *Alternanthera resiliis*
4.5. *Cyperus rotundus*
4.6. *Cynodon dactylon*
4.7. *Digitaria seligera*
4.8. *Phyllanthus fraternus*

II. Pest monitoring :

3.1. Survey teams should undertake regular insect pest and disease monitoring on pre-selected routes at 15 days interval and assess bio-control potential in addition to insect pest and disease situation to give early forewarnings. Record should be kept about insect pest and disease incidence and bio-potential fauna on 5 plants per spot selected randomly at 10 spots per ha. after every 10 km. distance.

3.2. Field scouting :

Field scouting should be undertaken by the farmers/extension functionaries to keep a close watch on the appearance of insect pest, disease and bio-control fauna.

3.3. Agro-eco System Analysis (AESA) :

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.

III. Integrated Pest Management Strategies :

1. Cultural practices :

- 1.1. Deep ploughing, early sowing and timely irrigation is important for a good crop stand.
- 1.2. Keep the crop weed free upto 5th node stage (Upto 5 to 6 weeks)

to reduce attack of flea beetle, leaf folder and pod bugs. However, keep a weedy patch near the field for sheltering of natural enemies.

1.3. Resistant/tolerant varieties are recommended for cultivation. Some of the varieties showing resistance are as given below :

Crop	Variety	State
(a) Pod bug (<i>R. linearis</i>)		
1. Moong bean	T-44, ML-131	Assam*
(b) Leaf folder (<i>N. vulgalis</i>)		
1. Moong bean	Koper gaon PMB-14	Assam*
(c) Aphid (<i>A. craccivora</i>)		
1. Moong bean	Koper gaon PMB-14, ML-729	Assam*
(d) Yellow mosaic virus		
1. Green gram	K-851, ML-56, PIM-51, PIM-51	Assam* NBP Zone Assam
2. Black gram	T-9, PantU-19, UG-157, JU-18	Assam*
(e) Cercospora leaf spot		
1. Green gram	AAU-34, AAU-39, SGI K-851. ML-56, PIM-51, ML-131	Assam* NEP Zone of Assam

2. Mechanical practices :

1. Hand pick and destroy the eggs or 1st/2nd instar larvae of hairy caterpillar which remain in clusters in few leaves. Light trap is also effective against hair caterpillar.
2. At the initiation of aphid attack apical plant parts with aphid colonies should be lipped and destroyed.
3. Collect and destroy leaf folders/rollers in the initial stage of leaf folder attack.
4. Sweeping of hand net over the crop/between the rows to collect and destroy the nymphs and adults of pod bug and green stink bug.

3. Chemical control:

Against aphids, jassids and flea beetle, spray malathion 50 EC at 0.1% concentration (2 ml/lit of water). Spraying of endosulfan 35 EC at 0.07% concentration (2 ml/lit of water) may be followed against pod bugs, leaf folder, white fly and hairy caterpillar. Soil application of phorate 10 G @ 0.5 kg. a.i./ha or Carbofuran 3 G @0.5 kg. a.i./ha against leaf folder, flea beetle, jassid, stemfly and white fly in summer as well as kharif crop.

Spraying should be done only at ETL. Against aphids, spraying should be done in alternate strips in the afternoon to conserve natural enemies (*Coccinella repanda*, *Lemnia bipagiata*, *Micraspis discolor*, *Menochilus sexmanculatus*, *Coccinella septempunctata* and *Ischidon scellaris*). Untreated strips should be sprayed after 3 days.

Spraying against pod bugs and green stink bug should be avoided if natural enemies like – *Thomisus sp.* (Spider predator), *Trissolcus sp.* (egg parasitoid) or *Tyrophagous putreacentiae* (mite predator) are abundant in the field.

Similarly, no spraying should be done against leaf folder if natural enemies like *Ophionia indica* (predatory beetle), *Oxyopes ratnae* (predatory spider), *Marpissa tikaderi* (predatory spider) and *Megaselia scalaris* (larval pupal parasitoid) are abundant in the field.

For cerspora leaf spot copper oxychloride 0.3% should be applied as soon as the disease appear in the crop field. A second spraying at the interval of 7-10 day may be given.

For web blight (*R. solari*) carbendazim @ 0.05% should be sprayed on appearance of the disease.

4. Weed management practice :

4.1. The crop should be maintained weed free initially for 4 to 6 weeks following timely interculture and hand weeding.

4.2. One hand weeding at 20-25 days after sowing is recommended.

5. Economic threshold levels (ETL) :

5.1. Pod bug 4-5 bugs/10 plants or 2-3 bugs/10 sweeps in the summer green gram crop.

5.2. Green stink bug – 6 bugs/10 plants or 3 bugs/10 sweeps in the summer green gram crop.

5.3. Aphid 9-16 aphids/plant in the Kharif green gram crop.
10 aphids/plant in the Kharif green gram crop.

5.4. Flea beetle 3.5 adults/10 plants in summer black gram crop.

IV. Crop Stage-wise IPM Package :

Pre-sowing stage	Cultural practices	
Pre-sowing stage	Cultural practices	
		1. Deep ploughing of the field and removal of debris/ stubbles etc.
		2. Early sowing (Preferably in the 2 nd fortnight of February for summer crop and in the 2 nd fortnight of August for the Kharif crop)
		3. Growing resistant/tolerant varieties as recommended.
		Pod-bug (<i>R. linearis</i>)
		Moong bean – T – 44, ML-131
		Leaf folder (<i>N. vulgalis</i>)
		Moong bean – Kopergaon, PMB-14
		Aphid (<i>A. cracivora</i>)
		Moong bean – Kopergaon, PMB-14, ML-729
		Yellow mosaic virus (YMV)
		Moong bean (Summer): K-851, ML-56, PIMS-1, ML-131
		Urd bean (Summer): T-9, Part U 19, UG-157, JU-78
		Urd bean (Kharif): 7-9, T-27, Pant. U. – 19
		Cercospora leaf spot
		Moong bean (Summer): K-851, ML-56, PIMS-1, ML-131, AAU-34, AAU-39, SG-1.

		Moong bean (Kharif): K-851, ML-56, 11/395, ML-131
		Urd bean (Summer): T-9, Pant U 19, UG-157, JU-78
		Urd bean (Kharif): 7-9, T-27, Pant. U. – 19
	Chemical Practices (for leaf folder, flea beetle, jassid, stem fly, white fly)	4. Soil application of Phorate 10 G or Carbofuran 3G @ 0.5 kg a.i./ha in summer as well as Kharif crops.
Seed & Seedling	Cultural practices	1. Timely sowing proper seed rate and fertilizer management to have a desirable crop stand and to reduce attack of insect pests and weeds growth.
		2. Interculture and hand weeding to keep the crop weed free upto the 5 th node stage (5-6 weeks) to reduce attack of flea beetle, leaf folder and pod bugs. Keep a weedy patch nearby the field to provide shelter for natural enemies.
Vegetative stage	Mechanical Practices	1. Hairy caterpillars lay eggs in masses and first/second instar larvae remain congregated on one or two leaves. Such leaves can be easily spotted, collected and destroyed.
		2. Light traps are very effective against hairy caterpillar.
		3. Aphid infested apical plant part should be lipped and destroyed in the initial stages of attack.

		4. Collect and destroy leaf folds/rolls with the larvae inside in the initial stage of leaf folder attack.
		5. Sweeping of hand net over the crop/between the rows to collect and destroy the nymphs and adults of pod bug and green stink bug.
	Chemical Practices	1. Against aphids, jassids and flea beetle, spray malathion 50 EC at 0.1% concentration (2ml/lit of water).
		2. Against pod bugs, leaf folder, white fly and hairy caterpillar, spray endosfan 35 EC at 0.07% concentration (2ml/lit of water) Apply insecticides only at ETL of these pests. Don't apply insecticides if natural enemies are abundant in the field.
		3. Spray Cu-oxychlorids (Blitox 50/Fytolan/Fycop) at 0.3% (1.8-2 kg in 600-700 lit water/ha at 7-10 days interval or carbendazim (Bavistin) 0.05% (300-500 g in 600-700 lit of water/ha) at 12-15 days interval against leaf spot.
		4. Spray carbendazim (Bavistin) as above against blight.
		5. Against powdery mildew spray wettable sulphar (sulfex/thisvit) 0.2% (1-1.4 kg/ha in 500-700lit guratted) or Hexasul 0.5% (2.5-3.5 kg/ha) as soon as disease appears.

IPM Package for Pigeon pea

I. MAJOR PESTS

A. Pests of Natural Significance

1. Insect Pests

- 1.1. Pod borer *Heliothis (Helicoverpa) armigera*
- 1.2. Podfly (*Melanagromyza obtuse*)
- 1.3. Leaf webber (*Eucosma critica*)
- 1.4. Spotted podborer (*Maruca testulalis*)
- 1.5. Plume moth (*Exelastis atomosa*)

2. Disease

- 2.1 Wilt (*Fusarium adum*)
- 2.2 Sterility Mosaic Virus
- 2.3 Stem blight (*Phytophthora drachalari var. cajani*)

3. Weeds

- 3.1. *Cyperus rotundus*
- 3.2. *Digitaria sanguinalis*
- 3.3. *Setaria glaucae*
- 3.4. *Cleome viscosa*
- 3.5. *Tridax procumbens*
- 3.6. *Cynodon dactylon*
- 3.7. *Dactyloctenium aegyptium*
- 3.8. *Trianthema monogynae*
- 3.9. *Tribulus terrestris*

4. Nematodes

- 4.1. Cyst nematode, *Heterodera cajani*
- 4.2. Root-knot nematode, *Meloidogyne spp.*
- 4.3. Reniform nematode, *Rotylenchulus reniformis*

B. Pests of Regional Significance (Assam)

1. Insect Pests

- 1.1. Lycaenid pod borer – *Euchrysops cnejus*
- 1.2. Negro bug – *Megacopta cribrarium*
- 1.3. Pod bugs – *Riptortus linearis*, *R. pedestris*
- 1.4. Apion – *Apion ampulum*
- 1.5. Hairy caterpillar – *Spilosoma oblique*

2. Disease

- 2.1. Wilt (*Fusarium adum*)

3. Nematodes

- Root-knot nematode, *Meloidogyne spp.*
Reniform nematode, *Rotylenchulus reniformis*

4. Weeds

- Cyperus rotundus*
Cynodon dactylon
Digitaria sanguinalis
Setaria glaucae
Ageratum koustonianum
Oxalis debitis
Cuphea balsomona
Mikania mirontha

II. Pest Monitoring :

1. Rapid Roving Survey :

Survey teams should undertake regular inset pest and disease monitoring on preselected routes at 15 days' interval and assess bio-control potential in addition to insect pest and disease situation to give early forewarning. Record should be kept about insect-pest and disease incidence and bio-potential fauna on 5 plants per spot selected randomly at 10 spots per ha. after every 10 km. distance.

2. Field Scouting :

Field scouting should be undertaken by the farmers/extension functionaries to keep a close watch on the appearance of insect pest, disease and bio-control fauna.

3. Agro-eco system analysis (AESA) :

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 pheromone/Light trap :

Certain pests required positioning of various kinds of traps like pheromone trap, light trap, sticher trap etc. to monitor the pest built-up. Therefore state Department of Agriculture to initiate action for positioning different kinds of traps based upon the results of roving survey at strategic locations at village level. While the concept need to be popularized among the farming communities S.B.A. is to take greater initiative for pest monitoring through specific pheromone trapping methods. Instal lpheromone trap at a distance of 50 mtrs. @ 5 trap/ha. Use *Heliothis lare* and change it after every 20 days. Trapped method should be removed daily.

III. Economic threshold level (ETL)

1. For *H. armigera*: 2-3 eggs/5 fruits
1 larvae/plant at flowering stage (for North Zone of India)
2. For spotted pod borer: 1 larval/plant
(*M. testulalis*) Or
1 webbed inflorescence/plant
3. For Negro bug: 5-6 bugs/plant
(*M. cribrarium*)

IV. Management of Heliothis resistant strains:

For the last few years, incidence of insecticide resistance in *Heliothis* have been reported on important crops like cotton and pigeonpea in some parts of the country. Extension functionaries should get in touch with the experts of respective State Agricultural Universities for mapping such areas. Wherever the scientific input is available about occurrence of insecticide resistance in *Heliothis*, the areas should be very clearly demarcated. During the course of surveys and also in advising farmers about *Heliothis* management strategies, utmost care need to be taken "NOT TO ADVOCATE" the pesticide for which resistance has been reported in specific areas. Most of the cases of such resistance have been recorded from Andhra Pradesh and Tamil Nadu against synthetic pyrethroids.

V. IPM Strategies :

5.1. Cultural practices :

1. Summer deep ploughing
2. Apply FYM or neem cake
3. Select resistant/tolerant variety.
4. Cultivation of early maturing variety.
5. Synchronise sowing with single variety in a village/area.
6. Early planting (June) can be done to avoid peak infestation period of *H. armigera* on short duration pigeonpea.
7. Planting of tall maize varieties on borders conserves natural enemies and serve as perches for predatory bird.
8. Provide sitting facilities for birds like black drongo, Blue jay, Mayna (for defoliating pests) through fixing perches.
9. Trap crop like marigold may be grown in between rows.
10. Rogueing and burning of diseased plants.

5.2. Mechanical practices :

1. For insect pests like hairy caterpillar, blister beetle, lepidopteran larvae, Apion, Pod bug nymphs etc. Hand picking, jarring on cloth sheets or in bags is effective in a limited way in small areas.

5.3. Biological control practices :

1. Seed treatment with commercial formulation of Trichoderma @ 4gm/kg of seeds.
2. Predatory spiders like *Oxyopes shweta* (on *M. testulalis* larvae and *M. cribrarium*), predatory bug like *Antilohus coqueburti* (on *M. testulalis* larvae), parasitoids like *Comopimola* sp. & *Meloboris* sp. (on *M. testulalis* larvae), *Chrysoperla*, predatory wasps and birds play significant role in reducing pest population. Indiscriminate use of pesticide should be avoided to conserve them. Install bird perches for predatory birds.
3. Spray NPV @ 250 LE/ha or 33 LE/bigha on noticing egg/ 1st instar larva of *H. armigera* (2-3 eggs or 1 larva/5 twigs).

5.4. Chemical control :

1. Against pests infesting floral buds, pod and seeds.

To control lepidopteran, dipteran, coleopteran and hemipteran pests infesting floral buds, pods and seeds apply malathion 50 EC 0.1% (1 ml/lit of water) or endosulfan 35 EC 0.07% (2 ml/lit of water) or monocrotophos 40 EC 0.04% (1 ml/lit of water). Spraying should be done @ 500-700 lit/ha with hand sprayer or 175-250 lit/ha with low volume sprayer.

5.5. Disease management :

Seed treatment with carbendazim and Thiram (1 gm + 2 gm respectively)/kg of seed.

5.6. Weed management practices :

Follow recommended agronomic practice for land prep., seed rate, recommended fertilizer, irrigation management so as to achieve

optimum plant population and healthy crop to reduce weed competition at early crop stage.

Crop should be maintained weed free initially for 6 to 8 weeks by following timely interculture and hand weeding.

5.7. Nematode management practices :

1. Normally nematodes are not serious problem for pigeonpea. In problem soil avoid summer cropping. Removal of roots of the previously harvested crop from the soil check nematode multiplication.
2. Crop rotation with millets, sorghum or maize with pigeon peas reduce nematode problem.
3. Antagonistic crop like marigold, sesame, Mustard may be grown at alternate rows/mixed crop.

VI. Crop stagewise IPM package :

Sl. No.	Cropstage/pests	IPM Practice	Particulars
1.	Pre-sowing (Pod borer, wilt, sterility mosaic, alternaria blight)	Cultural Practice	<ol style="list-style-type: none"> 1. Deep ploughing in summer. 2. Apply FYM or neem cake. 3. Synchronize sowing with a single variety in a village/area. 4. Early planting (June) for avoiding peak infestation of <i>H. armigera</i>. 5. Resistant/tolerant varieties as indicated in Annexure-II 6. Cultivating early maturing variety like Sharad amongst late varieties for escaping peak activity period of <i>H. armigera</i>. 7. Planting tall maize varieties on borders for conserving natural enemies. These

			<p>plants also function as live perches for predatory birds.</p> <p>8. Planting short statured crops like cowpea, mung, bean, urdbean, fodder, soyabean etc. in 1 m wide band after 8-10 rows of pigeonpea to facilitate spraying and other operations after the harvest of these band crops before flowering of pigeonpea.</p>
	(Nematodes)		<ol style="list-style-type: none"> 1. Summer fallow and deep summer ploughing avoiding any crop during summer, if at all only non leguminous i.e. any cereal crop to be grown. 2. Antagonistic plant like Mustard, Marigold may be grown at alternate row in the nematode endemic areas. 3. Adopt crop rotation of pigeonpea with sorgham, millet, rice and maize for two years.
2.	Seed & Seedlings (<i>H. armigera</i> Phytophthora blight, wilt)	Cultural Practice	<ol style="list-style-type: none"> 1. Growing trap crop like marigold on the borders and in between rows as intercrop. Their flowers shall attract oviposition which can then be plucked and disposed. Ridge Planting+cover crops like soy-beans or cowpea in NEPZ. 2.

		Biological Practice	3.	Treatment of the seed with TRICHODERMA VIRIDE @ 4 gm/kg seed.
	(Wilt/Root rot)	Chemical Practice	4.	Seed treatment with arbandazim* +thirum (1gm+2gm/kg seed) or arbandazim (2gm/kg seed) or thirum (3gm/kg seed)
	(Nematode)	Chemical Practice	5.	Soil treatment with carbofuran granule @ 8 kg a.i./ha at planting or seed treatment @ 1-2% w/w.
	(Weeds)	Cultural Practice	6.	Follow recommended agronomic practices for land preparation, seed rate, proper & balanced fertilizer and irrigation management so as to have a desirable crop stand.
3.	Vegetative stage (Weeds)	Cultural Practice	1.	Interculture and hand weeding for keeping the crop, weed free for 6-8 weeks.
	(hairy caterpillar)	Mechanical Practice	1.	Hand picking, jarring on cloth or in bags is effective in a limited way in small areas.
	(All pests)	Biological Control	2.	Conservation of predatory birds, spiders and insects; and insect parasitoids by avoiding indiscriminate use of insecticides. Installation of bird perches for predatory birds.
4.	Pre-flowering & Flowering stage			

	(Blister beetle, lepidopteran larvae, pod bug nymphs, Apion etc.)	Mechanical Practice	1.	Hand picking and jarring on cloth sheet or in bugs is effective in a limited way in small areas.
	(All pests)	Biological Control	2.	Conservation of predatory birds, spiders and insects and insect parasitoids, by avoiding indiscriminate use of insecticides.
	Pod borers		3.	Installation of bird perches for predatory birds.
	(<i>H. armigera</i>)			
	(Lepidopterous, dipterous, Coleopterous & Hemipterous pests)	Chemical Control	4.	Spraying of 0.1% malathion 50 EC (2ml/lit) or E monocrotophos 40 EC 0.04% (1 ml/lit). Spraying should be done @ 500-700 lit/ha with hand sprayer or 175-250 lit/ha with low volume sprayer.
5.	Pod stage: (Pod borers, other lepidopterous pests, dipterous, Coleopterous and hemipterous pests)	Chemical Control	1.	Spraying of 0.1% malathion 50 E C(2ml/lit) or 0.07% endosulfan 35 EC (2ml/lit) or monocrotophos 40 EC 0.04% (1 ml/lit). Spraying should be done @ 500-700 lit/ha with hand sprayer or 175-250 lit/ha with low volume sprayer.
6.	After harvest	Mechanical Practices	1.	Destroy crop residues infected with diseases and nematodes. Removal of roots of the nematode infested crop and burning/ destroying them is essential to check further multiplication of nematodes in the soil.

ANNEXURE – II

Resistant varieties of pigeon pea

Sl. No.	Variety (s)	Area
1.	Wilt resistant/tolerant varieties- NP (WP) 15, Sharad (DA 11) Sharda.	Central & Eastern U.P., Assam, Bihar & West Bengal.
2.	Alternaria blight resistant sharad (DA 11), Pusa 9.	Eastern U.P., Assam, Bihar & West Bengal.

IPM PACKAGE FOR SESAME

1. MAJOR PESTS:

A. Pests of National Significance.

1. Insect Pests

- i) Leaf webber or leaf and pod caterpillar
- ii) Gall fly
- iii) Leaf hopper

2. Diseases

- i. Phyllody
- ii. Dry root rot
- iii. Phytophthora blight
- iv. Alternaria blight

3. Weeds

- i. Clock's comb
- ii. Crowfood grass
- iii. Horse purslane
- iv. Barnyard grass
- v. Bermuda grass
- vi. Spurge

B. Pests of regional significance

1. Insect Pests

- i) Hawk moth
- ii) Bihar hairy caterpillar
- iii) Pod bug

2. Diseases

- 2.1. Bacterial wilt
- 2.2. Phytophthora blight
- 2.3. Phyllody

3. Weeds

- Ageratum hioustonianum*
Oxalis corniculata
Cynodon dactylon
Cyperus rotundus
Paspalum longifolium

II. Pest Monitoring :

2.1 Rapid roving Survey :

Survey teams should undertake regular insect pest and disease monitoring on pre-selected routes at 15 days interval and assess bio-control potential in addition to insect pest and disease situation to give early forewarnings. Record should be kept about insect pest and disease incidence and bio-potential fauna on 5 plants per spot selected randomly at 10 spot per ha. after every 10 km. distance.

2.2 Field Scouting :

Field scouting should be undertaken by the farmers/extension functionaries to keep a close watch on the appearance of insect pest, disease and bio-control fauna.

2.3 Agro-eco System Analysis (AESA) :

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.

CROP STAGE-WISE PEST DISEASE MONITORING SCHEDULE :

Sl. No.	Crop stage	Observations	Sample	Frequency	Action
1.	Seedling Stage	a) Charcoal rot or dry root rot. b) Seedling blight Or Phytophthora blight (Visual observation)	3 sqm or 2 m row Fortnight (Count No. of plants at 5 locations in the field)		If the incidence is above 20% the field may be considered as sick and growing sesame may be discouraged in the affected field for 1-2 years. In case the disease incidence is less than 10% it should be taken in the following season to treat seed with recommended measures. Use resistant varieties.
2.	Vegetative stage	a) Leaf roller b) Hairy caterpillar	-do- Every 10 days -do-		If the incidence is more than 1-2 larva per plant, follow the recommended plant protection measures. On appearance of disease, follow the recommended control measures (Item 5 below)
3.	Flowering Stage	a) Gallfly b) Phyllody	-do- Weekly -do-		Action to be initiated at 2-5 galls per plant Or 10% damage. Rogue out the diseased plant and destroy.
4.	Pod formation and maturity	a) Capsule borer b) Phyllody	-do- -do-		Action to be initiated at 1-2 larva per plant. Rogue out the diseased plant and destroy.

III. Economic Threshold Level (EYL) :

- i) Leaf roller and Hairy caterpillar - 1 to 2 larva per plant
- ii) Gallfly - 2 to 5 galls per plant or 10 percent damage.
- iii) Capsule borer - 1 larva per plant.

IV. IPM Strategies :

1. Cultural Practices :

- i) Deep ploughing to reduce the population of soil harbouring insect pests and nematodes.
- ii) Synchronized sowing.
- iii) Grow resistant/tolerant varieties as under :

Sl. No.	Name of the varieties	Tolerant against
a)	TKG-21	Tolerant to bacterial and cercospora leaf spot.
b)	TKG-22	Tolerant to Phytophthora blight
c)	B-67	Tolerant to Macrophomina and Phyllody
d)	Krishna	Tolerant to Alternaria leaf spot and capsule borer
e)	Vinayak	Tolerant to leaf spots
f)	Gujarat Til. 2	Tolerant to Bacterial blight, wilt and Phyllody
g)	Haryana Til. 1	Field resistant to Phyllody
h)	TSS-6 (SVPR-1)	Tolerant to Phyllody, Alternaria leaf spots
i)	IMP Sel. 5 (Rama)	Resistant to Macrophomina rot

★ Timely sowing, proper seed rate (5 kg of seed per ha) Thinning operation should be done to maintain 30 x 15 cm spacing so as to give optimum plant population.

★ Keep the crop weed free upto 45 days after sowing by two hand hoeing/weedings at 20 and 35 days.

★ Intercropping is beneficial with green gram, red gram and pearl millet.

2. Mechanical Practices :

- i) Collection and destruction of larvae of hawthorn moth, leaf webber/capsule borer and hairy caterpillar.
- ii) Use light traps against Lepidopteran pests.
- iii) Uproot the phyllody affected plants.
- iv) Mechanically remove the roots of previously harvested crops as they harbour cyst nematode.

3. Biological Control :

- i) Seed treatment with Trichoderma viride @ 4 gms. per kg. seeds for the control of root rot.

4. Chemical control :

i) Insect Pests :

Spray any of the following insecticide at ETL – Monocrotophos 40 EC @ 1ml./lit. or Dichlofos 100 EC @ 0.5 ml./lit. or Nemazol (5 ml./lit. grater) or 0.5%.

5. Disease :

- 5.1. Seed treatment with 2 gm thirum+2 gm carbendazim against Phytophthora blight.
- 5.2. When diseases appear spray ancozeb @ 1.5 kg.a.i. 750 ltrs. of water against Phytophthora blight.
- 5.3. In case bacterial wilt drench streptomycin 200 ppm @ 200 ml. solution/plant.

6. Weed Management Practices :

- 6.1. Follow all agronomic practice as per recommendation.
- 6.2. One hand weeding and thinning of plant as per recommended spacing at 20 days after sowing.

VI. Crop Stage-wise IPM Package :

Sl. No.	Crop stage/pest	IPM Package	Particulars
1.	PRESOWING	Cultural Practices	Deep ploughing to reduce the population of insect pests and nematodes. Synchronised sowing. Timely sowing and proper seed rate (5 kg of seed per ha) Grow resistant/tolerant varieties.
	Seedling blight Dry root rot		Timely irrigation to maintain good crop stand.
	Alternaria leaf spot	Bio-controls	Treat the seed with Trichoderma viride @ 4 gm/kg of seeds.
	Bacterial blight		Use bio-fertilizers Azospirillum and Phospho-bacteria as recommended.
	Bacterial leaf spot	Chemical Practice	Seed treatment with Agrimycin-100 (250 ppm) or streptomycin or Streptomycin suspension 0.05% for 30 minutes.

			Seed treatment with 2-2.25 gm/kg seed of Agrimycin or Streptocycline.
2.	SEEDLING	Mechanical and Chemical Practices	Crop sanitation/weeding.
	Dry root rot		Foliar spray with Mancozeb 1.125-1.5 kg. a.i./ha. a.i. 750 l water.
	Phytophthora blight		Rouge out disease infected plants.
3.	VEGETATIVE		
	Hawk moth hairy caterpillar	Mechanical	Collection and destruction of larvae of hawk moth, hairy caterpillar (gregarious instars).
	Leaf webber & hairy caterpillar	Chemical	Spray monocrotophos 45 E @ 1 ml./lit. or dichlorvos 100 EC @ 0.5 ml./lit. or nemazal 5% @ 3 lit./ha. mixed with 600 lit water.
4.	Flowering stage hawk moth hairy caterpillar	Mechanical	Collection and destruction of larvae of hawk moth and hairy caterpillar (gregarious instars).
		Chemical	Spray monocrotophos or dichlorvos or Nemazal as in vegetative stage.
5.	Pod formation and maturity pod caterpillars (Capsule borers)	Mechanical	Pluck and destroy the bored capsules.

VII. Safety parameters :

Annexure II deals with safety parameters interalia classification of toxicity as per Insecticides Rules, 1971, WHO Classification of hazards, colour of toxicity triangle. First aid measures, symptoms of poisoning and treatment of poisoning. The extension functionaries of the State Department of Agriculture have to make use of this information as under.

- i) Basic precautions which are required to be taken as per classification of toxicity as well as hazard criteria by WHO may be seen as per Annexure III.
- ii) The extension functionaries are to educate the farmers on safety use of pesticides with the help of colour toxicity triangle as the farming community can follow the colour and corresponding safety precautions.

- iii) The symptom of poisoning must be known to the extension functionaries to enable them to extend first aid measures to affected persons to the extent possible.
- iv) Basically, the information on first aid measures and treatment of poisoning is required to be passed on by the extension functionaries to the doctors at Primary Health Centres as well as to the Private Doctors in the vicinity of spraying of pesticides.
- v) Extension functionaries must ensure that names of common pesticides during plant protection measures alongwith a copy of the leaflet, which is an integral part of a pesticide container must be made available to the doctors in the vicinity of plant protection operations.
- vi) Extension functionaries are to request the doctors to intervene in procurement of antidotes for different pesticides as cited under "Treatment of poisoning".

VIII. DO's AND DON'T's :

Sl. No.	DO's	Sl. No.	DON'T's
1.	Grow only resistant/tolerant varieties	1.	Discourage susceptible varieties.
2.	Adopt Synchronised sowing	2.	Avoid Staggered sowing.
3.	Adopt crop rotation.	3.	Avoid monocropping.
4.	Use organic manure, FYM & neem cake and bio-fertilizers as per recommended dose.	4.	Restrict Insecticide spray period to protect pollination.

IPM PACKAGE FOR POTATO

A. Pest of National Significance

1. Insect Pest

- 1.1 Aphids
- 1.2 Potato tuber moth

2. Diseases

- 2.1 Late blight
- 2.2 Viruses
- 2.3 Black scurf
- 2.4 Common scab
- 2.5 Wart
- 2.6 Leaf spot complex

3. Weeds

Broad Leaved Weeds

- 3.1 Lamb square
- 3.2 Swine cross
- 3.3 Corn spurry
- 3.4 Sweet clover
- 3.5 Pimpernel

Grassy weeds

- 3.6 Cana ry grass
- 3.7 Blue grass
- 3.8 Rabbit foot grass

4. Nematode

- 4.1 Potato cyst nematode (PCN)

5. Rodent

- 5.1 Smaller bandicoot

B. Pest of Regional Significance

1. Insect Pest

- 1.1 Red ant : *Dorylus orientalis*
- 1.2 Cut worm : *Agrotis ipsilon*
- 1.3 Mole cricket : *Gryllotalpa africana*
- 1.4 Tuber moth : *Phthorimaea operculella*
- 1.5 Aphid : *Myzus persicae*
- 1.6 White grub : *Holetrichia spp.*

2. Diseases

- 2.1 Late blight of Potato
- 2.2 Bacterial wilt
- 2.3 Virus diseases
- 2.4 Leaf spot complex

3. Weeds

- 3.1 *Ageratum houstonianum*
- 3.2 *Ameranthus viridis*
- 3.3 *Chenopodium album*
- 3.4 *Polygonum barbatum*
- 3.5 *Oxalis debilis*
- 3.6 *Cyperus rotundus*
- 3.7 *Cynodon dactylon*
- 3.8 *Fleusin Indica*
- 3.9 *Digitaria setegera*

4. Rodent

- 4.1 Smaller bandicoot : *Bandicota bengalensis*

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 (RPS)

Survey teams should undertake regular insect pests and disease monitoring on preselected routes at seven days interval and assess biocontrol potential in addition to insect pest and disease situation to give early forewarnings. Records should be kept about insect pests 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 practice. 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. Soil conditions
5. Climatic factors
6. farmers past experience

Details methodology for undertaking AESA exercise is given in Annexure-I.

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

1. 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.

2. Yellow pan/sticky traps

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

C. Economic Threshold Level (ETL)

- | | |
|----------------------------------|--|
| 1. Aphids | 20 aphids/100 leaves |
| 2. Potato tuber moth | 15-20 moth/trap consecutive for 3 nights |
| 3. Late blight | not more than 1% leaf area affected |
| 4. Bacterial wilt | 1% of plant population |
| 5. Potato viruses | 1% of plant population |
| 6. Soil and tuber borne diseases | 5% potato tuber |

III. Integrated Pest Management

A. Cultural Practice :

1. Summer deep ploughing to expose soil inhabiting/resting stages of insects and pathogens.
2. Trimming of field bunds and flooding to destroy the rodent holes and tunnels.

3. Plant disease free tubers at optimum date (2nd fortnight of October).
4. Use resistant/tolerant varieties.

Tolerant variety for rodent and cut worm : Lalpahari
(Local variety Rangpuria)

Moderately resistant for late blight : Kufri Jyoti Kufri
Badshah, Kufri Megha

5. Apply recommended NPK dose :
6. Prepare ridges to cover the seed tubers to avoid tuber moth infestation.
7. Timely irrigation as per recommendation helps in suppressing red ant and cutworm infestation in potato field.
8. maintain proper field moisture to avoid disease and mole cricket attack.
9. Follow crop rotation with non solanaceous crop.
10. Crop should be maintained weed free initially upto six weeks after planting by restoring to hand hoeing/earthing up operation at 3 and 6 weeks after planting.
11. Roguing of virus infected plants.

B. Mechanical Practices

1. Collect and destroy larvae, pupae and adults of cutworms and white grubs.
2. Sort out late blight infected tubers, cut worm and white grub damaged 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. Pesticide application

a. Insect Control

1. In areas where red ant/termite infestations are there, application of azadirachtin 1500 ppm @ 3 l/ha proves to be effective. The treatment is to be applied at the time of planting and at earthing as soil drenching.
2. For other insects spraying of Chlorpyrifos 20EC @ 2ml/lit or Fenitrothion 50EC 500 grams a.i./ha should be done upon attaining ETL.

b. Disease Control

1. Apply mancozeb 75% WP @ 2.5 kg/ha for the control of late blight and early blight diseases or copper oxy-chloride 50% WP @ kg/ha or chorothalonil 75% WP @ 1.25 kg/ha.
2. Apply metalaxyl 80% + mancozeb 64% WP combination formulation @ 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.
3. Apply streptomycin 0.02% (200 mg/lit) or spray 100 ppm streptomycin for the control of bacterial wilt.

c. Weed Control

1. Application metribuzin @ 0.5 kg/ha or alachlor 2.5 a.i./ha or atrazine 0.25 kg a.i./ha. or fluchloralin 0.45-0.67 kg a.i./ha as pre-emergence for controlling major weeds.

d. Rodent Control

1. 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 grams per burrow to be placed inside the live burrows after pre-baiting 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

Sl. No.	Crop Stage	IPM practice	Pest	Applicable to	
				Type of crop	Location
1.	Planting	- Clean cultivation and Ploughing	All	All	All
		- Avoid collateral host	All	All	All
		Soil application of Carbofuran 3G @ 1.0kg and 2.6kg a.i./ha	White grub and red ant	All	All
		- Deep ploughing	PTM	All	All
		- Select resistant varieties-	Late blight	All	Assam
2.	Emergence	- Spray fenitrothion 50EC @ 500 gms, a.i./ha Dicofol 18.5 EC @ 550 gm a.i./ha	Leaf hoppers, Mites spid	All	All
		- Spray chlorphyriphos 20 EC @ 0.5 kg. a.i./ha	Cut worms	All	All
			Red ant, Cutworm	All	Assam

3.	Tuber initiation	- Azadirachtin 1500 ppm @ 31/ha	Red ant, termite	All/Seed	Assam
		- Apply mancozeb 75% WP @ 2.5kg. a.i./ha for the control of late blight and early blight	Late blight/Early blight		Hills
		- Apply Metalaxy 8% + mancozeb 64% combination formulation when the weather is congenial for further buildup of the disease	Late blight	All	Hills
4.	Bulking	- Apply streptomycin 0.02% Rouge out off types and virus infected plants	Bacterial wilt Virus	All All	Assam All
		- Irrigate the crop when the night temperature drops below 4°C	Blight	All	All
		- Spray fenitrothion 50EC and dicofol 18.5EC	Leaf hopper and mites	All	Plains
		- Removal of collateral host and spraying them with endosulfan 35EC or quinalphos 25EC @ 0.005% a.i.conc	Write grub	All	Hills
		- Light traps during initial showers	Write grub	All	Hills
		- Prophylactic application of mancozeb 75% WP @ 0.25% against late blight	Late blight	All	Hills
		Subsequent application of metalaxyl 8% + mancozeb 64% combination formulation (0.25%) in alternation with mancozeb at 8 and 14 days interval respectively.			
		- 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 - Irrigate the crop when the night temperature drops below 4°C	Virus Blight	All All	All All
5.	Leaf senescence	Haulm cutting for vector control - Pheromone traps for mass trapping of PTM - Cut haulms when the late blight infection crosses 80%	Aphids PTM Late blight	Seeds All All	All All All
6.	Harvesting	- Early harvest and disposal/storage - Collection and destruction of pest/diseased damaged tubers - Cut the haulms and stop irrigation one week before the harvest - Curing of potatoes in heaps for 7-10 days - Sorting out of cut/bruised tubers before storage - Seed tuber treatment with boric acid (3%) for 20 minutes before storage	All All Blight Blight Blight & other diseases Blight & other diseases All	All All All All All All	All All All All All All
7.	Storage	- Preferably store potatoes in cold stores in country stores - Clean the store before placing material - Pheromone trap @ 4 traps/100m ³ of storage space	PTM	Mid hills	All

V. POTATO PEST MANAGEMENT

Do's	Don'ts
1. Grow only recommended variety/hybrid.	Do not grow the underscrip material which vary greatly in tuber formation 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 repots.	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) Regular surveillance : 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 mixtures of various insecticides which are not recommended in any case. Do not use the insecticide at lesser/over dosages than the recommendations.
d) Spray technology : 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, atleast 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 a 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 crop.	Pre-emergence herbicides should not be applied after emergence of crop and/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 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 zine phosphide baiting more than once.

IPM PACKAGE FOR TOMATO

1. Major Pests

A. Pests of National Significance

1. Insect Pests

- 1.1 Fruit borer
- 1.2 Whitefly
- 1.3 Serpentine leaf miner

2. Diseases

- 2.1 Damping off
- 2.2 Tomato leaf curl virus
Gemini plant virus transmitted by whitefly
- 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 Namb squire
- 4.2 Pimpernel
- 4.3 Sweet clover
- 4.4 Swine cross
- 4.5 Fumetry
- 4.6 Cornspurry
- 4.7 Cluster weed
- 4.8 Blue grass
- 4.9 Canary grass
- 4.10 Rabbit food grass

B. Pest of Regional Significance

1. Insect Pests

- 1.1 Fruit borer, Helicoverpa armigera
- 1.2 Leaf cating caterpillar Spodoptera litura
- 1.3 Fruit fly Dacus tan

2. Diseases

- 2.1 Late Blight of Tomato
- 2.2 Bacterial wilt
- 2.3 Leaf curl
- 2.4 Blossom end rot

3. Weeds

- 3.1 *Ageratum houstonianum*
- 3.2 *Amaranthus viridis*
- 3.3 *Polygonum burbature*
- 3.4 *Oxalis debilis*
- 3.5 *Cyperus rotundus*
- 3.6 *Cynodon dactylon*

2. Pest Monitoring

A. Agro Eco System Analysis

Agro Ecco System Analysis (AESAs) 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 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 required skill. So only the training 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 5 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 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 fruit borer is 8 to 10 moths per day per trap.

D. Yellow Pan Water trap/Sticky Traps

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

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

E. 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 practice such as spraying a pesticide. At the ETL, the benefit of 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:

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

3. IPM Strategies for Tomato

A. Cultural Practices

1. Crop rotation with frenchbeans 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 drainage thereby avoid damping off in solanaceous nurseries by preventing soil borne fungi viz., *Pythium*, *Phytophthora*, *Rhizoctonia*, etc.
3. Deep summer ploughing helps in exposing resting stages of pests.
4. Resistant varieties like Punjab NR-7, NR-3, NT-8, NT-12, Hisar N-1, Hasar N-2 and Hisar N-3 may be sown.
5. Wilt resistant variety VC-48-1 may be grown.
6. Destruction of crop residues after harvest.
7. Crop sanitation.

B. Mechanical Control :

1. Collection and distribution of egg masses, larvae to Tobacco cutworm/leaf eating caterpillar and tomato fruit borer.
2. Regular destruction of damaged fruits at each harvest.
3. Installation of pheromone traps @ 5 per ha for monitoring *H. armigera* and *S. litura*.
4. 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 intercropping 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 replanted. 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 fields along with the flowers. This trap cropping system also helps in reducing the root knot nematode infestation.

C. Biological control :

1. Conservation

- (a) Some parasites are very active in the field against serious pests of vegetable crop eg. *Trichogramma* sp., *Trichogramma toideae armigera*, *Compoletis Chlorideae*, *Carcelia illota*, *Eriborus argenteopilosus*, *Hyosoter didynator*, *Palexorista laxa*, *Goniophthalmus halli* on *H. armigera*, *Telenomus remus*, *chelonus heliopae*, *C. Formosanus*, *C. Blackburni Iriborus sp.* *Cotesia colemani*, *Cotesia marginiventris*, *microplitis sp.*, *Charops obtuse*, *Euplectrus sp.*, *Peribae orbata* against *S. Litura*.
- (b) In addition to these parasites, general predators like Coccinellids, Syrphids, Spiders, Carabids, Staphylinids, Dragonfly, damselfly. Predatory miridbugs, predatory pentatomids, Nabid bugs, Reduviid bugs, anthocoridbugs, Geocorid bugs, predatory mite, predatory thrips also actively suppress the pest population. *Stethorus apuperculus* is active predator on red spidermite.
- (c) Need based and judicious application of insecticides are to be applied for conservation of natural enemies.
- (d) Grow cowpea or pulses on the border area of main crop to build up natural enemy fauna.

2. Augmentation :

1. Inundative release of *Trichogramma brasiliensis*. *T. Chilonis* or *T. priteosum* @ 50,000 per ha. Starting from formation stage for 6 times at weekly interval.
2. Spray *Bacillus thuringiensis* var *Kurstaki*, the commercial preparation @ 0.5 kg/ha against lepidopteran pests.

D. Chemical Control :

1. Treat nursery bed with 0-3 to 0.6 gms a.i./sq.m of Carbofuran 3 G for nematode management.
2. Spray 100 ppm Streptocycline sulphate on unripened fruits of tomato to control bacterial spot *Xanthomonas compestris pv vesicatoria* or dipping seedlings in 100 ppm streptocycline sulphate before transplanting.
3. Application of calcium chloride (1%) on green fruits to control blossom end rot application of lime @ 5-10 g/ha in the soil.
4. Application of carbofuran 1 kg a.i. per ha during early stages of crop to avoid sucking pests and also nematodes.
5. Spraying of *Bacillus thuringiensis* 1-1.5 lit/ha.

Stage	Pest	Practices
1. Pre-sowing	Soil borne fungus Nematodes	Deep summer ploughing soil solarization.
	Resting stages of Insect pests Nematode	Application of Neem cake @ 200 kg. per ha. Raising African marigold nursery. 15 days prior to tomato nursery against <i>H. armigera</i> as trap crop. If nematode is severe in the area, apply carbofuran granules @ 1 to 2 kg. a.i./ha. For weed control, use Fluchloralin @ 0.67 to 0.9 kg. a.i. For weed control, use Fluchloralin @ 0.67 to 0.9 kg. a.i./ha as preplanting soil incorporation.
2. Seed Seedling	Damping off	Seed treatment with <i>T. viridae</i> 2 g or carbendazim 2g/100g seed

	Serpentine leaf miner	<p>Growing of nematode resistant/tolerant varieties.</p> <p>Raise Nursery beds of least 10 cm high.</p> <p>Thin sowing with proper drainage facilities.</p> <p>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.</p> <p>Avoid excess dose of Nitrogen. 5 percent NSKE commercially available neem formulation. Interplanting with beans reduces the attack of serpentine leaf miner.</p>
	Whitefly	<p>Spray Endosulfan at the rate of 650 g a.i./ha.</p> <p>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.</p>
3. Vegetative	Late blight Leaf curl disease	<p>Field sanitation.</p> <p>Destruction of affected plant/plant part.</p> <p>Spray 0.02 percent Mancozeb @ 1.125-1.5 kg a.i. in 750 lit/water/ha.</p> <p>Roughing of affected plants. Install bird perchers @ 50/ha to encourage birds to feed on pests.</p>
4. Reproductive	Tomato fruit borer	<p>Field sanitation.</p> <p>Spray captan @ 1.25 kg a.i./ha in 750 to 1000 litres of water.</p> <p>Install pheromone traps with replacement of lures once in 15 days.</p>

	Leaf curl disease Mosaic	<p>Release T. Brasiliensis/ T. priteosum/ T. chilonis @ 50000/ha. for 6 times at weekly interval. Hand collection of larvae of Helicoverpa on marigold trap crops.</p> <p>Spray HANPV @ 250 LE per ha (6X10X12 PIB/ha) twice during evening hours at 10 days interval.</p> <p>Spray 5 percent NSKE or B.Thuringeniensis var kurstaki 500 g/ha.</p> <p>As shown in vegetative stage roguing of effected plants, careful intercultivation operation.</p>
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IPM PACKAGE FOR BRINJAL

I. Major Pests

A. Pests of National Significance

1. Insect Pests

- 1.1 Jassids
- 1.2 Shoot and fruit borer
- 1.3 Aphid

2. Diseases

- 2.1 Phomopsis blight
- 2.2 Bacterial Wilt
- 2.3 Little leaf of brinjal

3. Nematodes

- 3.1 Root-knot nematode

4. Weeds

- 4.1 Lamb square
- 4.2 Pimpernel
- 4.3 Sweet clover
- 4.4 Fumitory
- 4.5 Cornspary
- 4.6 Cluster Weed
- 4.7 Blue grass
- 4.8 Canary grass
- 4.9 Rabbit foat grass

II. Pest of Regional Significance

1. Insect Pests

- 1.1 Shoot and fruit borer (*Leucinodes orbanalis*)
- 1.2 Brinjal leaf webber/roller (*Antoba (Eubellema) olivacea*)
- 1.3 Aphid (*Aphis gossypii*)
- 1.4 Epilechna beetle (*Henos epilacna vigintioctopunctata*)

2. Diseases

- 2.1 Blight
- 2.2 Cercospora leaf spot
- 2.3 Root and Collar rots
- 2.4 Damping off
- 2.5 Spotted wilt virus

3. Nematode

- 3.1 Root-knot nematode

4. Weeds

- 4.1 *Amaranthus viridis*
- 4.2 *Cyperus rotundus*
- 4.3 *Cyperus iria*
- 4.4 *Echinochola sp.*
- 4.5 *Cynodon dactylon*

II. Pest Monitoring

II. 1. 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-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

The details of AESA are given in Annexure -1.

II.2 Field Scouting

AESA required skill and 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.

III. IPM Strategies for Solanaceous Crops

III. 1.A Cultural Practices

1. To reduce bacterial wilt, crop rotation with French bean. For nematode management, inter-cropping is to be done with marigold, onion and garlic.

2. Deep ploughing soon after harvest of the crop.
3. Recommended package are to be followed. Balanced doses of fertilizers are to be applied for proper crop stand, which would be capable to check the insect injury like shoot and fruit borer.
4. Resistant/tolerant varieties should be adopted against shoot fruit borer.
 e.g – Purple round,
 Borbengena JC-3, JC-4, JC-5
5. Proper water management in the crop field to avoid damping off.

III. 2.B Mechanical Control

1. Collection and destruction of egg masses, larvae and adults of epilechua beetle/leaf roller.
2. Removal and destruction of shoots, fruits & leaves infested by fruit borer/leaf roller.
3. Regular destruction of damaged fruits at each harvest against shoot and fruit borer to reduce the population.
4. Rogueing and destruction of virus infested plants.
5. Keep the crop weed free for 4-6 weeks after planting by hand hoeing & hand weeding.

III. 3. C Biological Control

Conserve the natural biocontrol agents like braconids, lacewing, *Phanerotoma* etc.

D. Chemical Control

1. Chemical pesticide use should be need based.
2. Application of Furadon granule @ 2.5g/plant at 20 days after transplanting against shoot and fruit borer.
3. Application of Deltamethrin (Decis 2.8 EC)
 @ 1 ml/1 or fenvalerate (Sumicidin 20 EC)
 @ 1 ml/1 at fortnightly interval for 3 times against shoot and fruit borer/leaf roller.

IV. Crop Stage wise IPM Practices :

Stage	Pest	Practice
1. Pre sowing	Resting stages of pests	Deep summer ploughing
2. Seed & Seedling	Leaf roller Epilachna beetle Aphid	Mechanical/chemical Malathion 50EC @ 2 ml/1 -do- -do-
3. Vegetative	Fruit and shoot borer/leaf roller Epilachna beetle Aphid	Remove damaged shoots Deltamethrin (Decis 2.8EC) @ 1 ml/1 or Fenvalerate (Sumicidin 20EC) @ 1ml/1 Release of T.Chilonis @ 5000/ha for 5 times at weekly interval. Same as seed and seedling stage
4. Reproductive	Fruit & shoot borer Epilachna beetle	Removal of damaged shoots 1. If possible, biological control (same as in vegetative stages) should be continued - Spraying of Fenvalerate (Sumicidin 20 EC @ 2 ml/lit) Same as seed and seedling stage

IPM PACKAGE FOR OKRA & BHINDI

Major Pests

A. Pests of National Significance

1. Insect Pests

- 1.1. Jassids
- 1.2. Fruit borer
- 1.3. Aphid
- 1.4. White fly

2. Diseases

- 2.1. Yellow vein mosaic virus
- 2.2. Powdery mildew
- 2.3. Leaf spot
- 2.4. Damping off

B. Pests of Regional Significance

1. Insect Pests

- 1.1. Fruit borer (*Earias vittela*)
- 1.2. White fly (*Bemesia tabacci*)
- 1.3. Jassids (*Amrasca biguttula buguttula*)

2. Diseases

- 2.1. Bacterial wilt
- 2.2. Yellow mosaic virus

3. Major weeds

- 3.1. *Cynodon dactylon*
- 3.2. *Cyperus rotundus*
- 3.3. *Eleusine indica*
- 3.4. *Ageratum houstonianum*
- 3.5. *Amaranthus viridis*
- 3.6. *Mimosa pudica*
- 3.7. *Cuphea balsamona*

II. Pest Monitoring

A. 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-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

The details of AESA are given in Annexure -1.

B. Field Scouting

AESA required skill and 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 *H. armigera*, *S.litura*, *Earias* sp. Install 5 traps per hectare with lures for each pests, keep the distance of 5 meters between the traps. Traps should be installed in the field in such a way that the position of lure is always 6" to 12" above the crop canopy. Replace the lures once in 15 to 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 trap.

D. Yellow Water Pan /Sticky Traps

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

E. Root knot nematode

Root knot nematode causes galls and reniform nematode causes "dirty roots". Their presence can be deducted by using "Trypan Blue" stain, which turns nematode egg sacs dark blue in colour, whereas the roots remain 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 practice 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 up the appropriate measures, whenever the incidence crosses ETL. The ETL for some of the major pests are listed below:

Insect	ETL
White fly	4 adults/leaf
Shoot and fruit borer	1 infected plant/meter row
Jassids	2.5 nymphs/leaf

III. IPM strategies for Okra/Bhindi (Ladies finger)

A. Cultural Practices

1. Field sanitation and removing alternate hosts helps the crop free from pests.
2. Crop seed should be sown timely in well prepared field at recommended spacing. Use balanced dose of fertilizer for obtaining optimum plant population and healthy crop stand, which would be capable of completing with weeds at initial stages of crop growth.
3. Crop rotation with non-host knot and reniform nematodes eg. Wheat, Sorgham. Intercropping with marigold, onion, garlic is also useful.

B. Mechanical Control

- a. Destruction of infested fruits
- b. Installation of pheromon traps for *Earias* & *Helicoverpa* @ 5 per ha.
- c. Yellow pan/sticky traps @ 10 per ha for monitoring white flies.
- d. Crops should be maintained weed free for 4-6 weeks after planting by resorting to timely hand hoeing/hand weedings.

C. Biological Control

1. Conservation

- 1.1. Conserve parasites like *Erythmelus empoasca*, *Anagrus empoasca* which are active against *Amrasca bigutulla*; Parasites like *Microbracon lefroyi*, *Rogas testaceus*, *R. aligarensis*, *Bracon hebetor*, *B. greeni* and *Trichogramma sp.* on *earias* are found active.

- 1.2. *Aphelinus flavipes* parasitizes *Aphis gossypii* and *Eurytoma sp.* Parasitizes *M. Hibisci*.
- 1.3. In addition to these parasites, general predators like coccinellids, syrphids, spiders, carabids, Staphylinids, dragonfly, damselfly, predatory miribugs, predatory pentatomids, nabid bug, reduvild bug, Anthocorid bug, Geocorid bug, predatory mite, predatory thrips also actively suppress the pest population. Since these natural enemies are highly prone for pesticides, avoiding unnecessary sprays is the best way to conserve them.

2. Augmentation

1. Release of *T.priteosum/T.chilonis* @ 50,000 ha against *H.armigera* and *Earias sp.*
2. Release *Chrysoperla carnea* @ 2 grubs per plant 2 times at weekly interval against whitefly and other soft bodied insects.
3. Spray HINPV 250 LE/ha for 2 times at a weekly interval.
4. Spray *B. Basiana* (1 X 10⁴ cfu/g) for whitefly nymph control for 2 times at weekly interval.

D. Chemical Control

1. Chemical pesticides should be used on need basis as a last report, only when pest population intensity crossed economic threshold level, the safer pesticides should be applied judiciously.
2. Apply fluchloralin @ 0.9-1.25 kg a.i./ha as preplanting soil incorporation for weed management.
3. For fruit and shoot borer and jassids, application of Deltamethrin (Decis 2.8 EC) @0.5ml/lit.

Or

Malathion 50EC @ 2ml/lit is useful to manage the pest effectively.

IV. Okra Crop stage wise IPM Practices

Stage	Pest	Practice
1. Pre-sowing	Exposing resting stages of pests Weeds	Deep summer ploughing Application of more FYM Application of Neem-cake @200 kg per ha. Apply Fluchloralin @ 0.9 to 1.25 kg a.i./ha as preplanting soil incorporation.
2. Seed and vegetative stage	Earias sp.	1. Remove affected shoots and destroy. 2. Application of Deltamethrin 28 EC @ 0.5ml/lit or Malathion 50 EC @2ml/lit
3. Reproductive	Earias sp.	As in vegetative stage.

IPM Package for Leguminous Vegetables Peas, French bean, Cowpea, Cluster bean.

1. Major Pests

A. PEST OF NATIONAL SIGNIFICANCE

1. Insect Pests

- 1.1 Aphids
- 1.2 Leaf miner
- 1.3 Pea pod borer
- 1.4 Pod borer
- 1.5 Bean
- 1.6 Flower thrip
- 1.7 Spider mite
- 1.8 Bean shoot borer
- 1.9 Leaf hopper
- 1.10 Cutworm

2. Disease

- 2.1 Charcoal rot or Ashy stem blight
- 2.2 Anthracnose
- 2.3 Bacterial blight
- 2.4 Powdery mildew

3. Nematodes

- 3.1 Root knot nematode
- 3.2 Reinform nematode

4. Weeds

- 4.1 Lamb square
- 4.2 Pimpernel
- 4.3 Sweetclover
- 4.4 Fumitory
- 4.5 Cornspurry
- 4.6 Cluster
- 4.7 Blue grass
- 4.8 Canary grass
- 4.9 Rabbitfoot grass

B. PESTS OF REGIONAL SIGNIFICANCE

1. Insect Pests

- 1.1 Pea aphid
- 1.2 Cowpea aphid
- 1.3 White fly
- 1.4 Pod bugs
- 1.5 Serpentine leaf miner
- 1.6 Flea beetle
- 1.7 Pod borers

2. Diseases

- 2.1 Rhizoctonia leaf blight
- 2.2 Cercospora leaf spot
- 2.3 Ascochyta blight
- 2.4 White rot or wet rot
- 2.5 Yellow mosaic virus (YMV)

3. Nematode

- 3.1 Root knot nematode

4. Weeds

- 4.1 Ageratum (*Ageratum harstonianum*)
- 4.2 Foxtail grass (*Setaria pumila*)
- 4.3 Day flower (*Commelina diffusa*)
- 4.4 Crab grass (*Digitaria setigera*)
- 4.5 Nuts edge (*Cyperus rotundus*)
- 4.6 Touch me not (*Mimosa pudica*)
- 4.7 Knot grass (*Panicum repens*)

II. Pest Monitoring

A. 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-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

The details of AESA are given in Annexure -1.

All host crops of the locality observed at each spot 20 plants at random. Record population potential of different biocontrol fauna. Record the major disease and their intensity.

B. Field Scouting

AESA requires skill and 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 Podborer, Tobacco caterpillar. Install five traps with lures for each pests, keep the distance of 5 meters between the traps. Traps should be installed in the field in such a way that the position of lure is always 6" to 12" above the crop canopy. Replace the lures once in 15 to 25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for Podborer is 8 to 10 moths per day per trap.

D. Yellow Water Pan /Sticky Traps

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

E. Root Knot Nematode

Root knot causes diagonistic symptoms of galls formation and reniform causes dirty roots. Their presence can be detected by using "Trypan Blue"/cotton blue stain, solution in water, which turns nematode egg sacs dark blue in colour, whereas the roots stay uncoloured. The cyst nematode adult female cause "Pearly root disease" at 30 to 45 days crop stage. Examine roots held upside down with handlens.

E. 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 a pesticide. At the

ETL, the benefit of spraying is equal to the losses caused by the insects in field. The farmers are advised to take up the appropriate measures, whenever the incidence crosses ETL. The ETL for some of the major pests are listed below:

Pest	Crops	Economic Threshold Level
Pod borers		One egg or one larva per plant or one damaged fruit per plant.
Leaf hopper		2.5 Leaf hoppers/leaf
Root knot nematode		1-2 juveniles/g of soil

III. IPM Strategies for Legumes

III. 1-A Cultural Practices :

1. Deep summer ploughing to expose resting stages of pests and soil borne nematodes. This practice should be done thrice at an interval of 15 days in nematode infested areas.
2. Early sowing of the crops to avoid peak infestation of pests.
3. Timely and optimum irrigation to contain major foliar diseases.
4. Crop rotation with cereals; rice/maiza against pod borers of beans, it also helps in reducing *Epilachna* beetles and thrips. Nematode populations also reduce by this rotation. Marigold may be used as an intercrop.
5. Use higher seed rate in bean stem fly in endemic areas.
6. Application of 200 kg neem cake per ha helps in controlling root rot diseases, nematodes, bean stem fly, etc.
7. Mixed and multiple cropping to reduce bean shoot borer and other pests. Marigold should be incorporated to reduce nematodes.
8. Crop seedling should be planed timely in well prepared fields at recommended spacing. Use balanced doses of fertilizers to obtain optimum plant population and healthy crop stand, which would be capable of competing with weeds at initial stages of crop growth.
9. Removal of any previous crop residues is very essential to prevent population build up of soil borne rematodes.
10. Thick layer of dry organic mulch on soil surface to suppress the weeds.
11. Stale seed bed technique to kill the first flush of weeds before sowing.
12. Use of well decomposed organic manure.
13. Destruction of weeds before their seed setting.

B. Mechanical Control

1. Rouging of affected plants particularly virus infested plants.
2. Hand collection and destruction of egg mass larvae and infected leaves.
3. Installation of pheromone traps @ 5/ha for monitoring of lepidopteran pests.
4. Crop should be maintained weed free for 4 to 6 weeks after planting by reporing to timely hand hoeing/hand weedings. In case of row planted crop, use of dryland weeder is cost effective.

C. Biological Control :

1. Conservation :

- a) Some parasites are very active in the field against serious pests of leguminous crop. Eg. *Trichogramma sp. Trichogrammatoidea armigera. Compoletis chloridae, Carcelia illota, Eriborus orgenteopilosus, Hyposter didynotor, Palexorista laxa, Gonoiphthalmus halli on H. Armigera; Telenomus remus, Chelonus heliopa, C. Formosanus, C. Blackburni, Eriborus sp., Cotesia colemani, Cotesia marginiventris, Microplitis sp., Charope obtuse, Euplectrus sp., Peribaea orbata* against *S. Litura; Goniozus, sp. Cotesia sp., Bracon habetor, Cedria paradoxa Brocon greeni, Telenomus sp., Phaneraotoma sp.* are found active against *Maruca sp., Chrysonofomyia appannai, Chrysocharis johnsoni, Elasmus sp. Pediobius foveolatus, Tetrastichus ovulorum* against *Epilachna sp.*; conserve *Hemitarсенus varicornis, Gonotoma hrysonotomyia sp., on serpentine leaf miner, Aphidius sp., Aphelinus sp., on aphids; Stethorus pauperculus* is active parasite on red spider mite.
- b) In addition to these parasites, general predators like Coccinellids, Syrphids, Spiders, Carabids, Stophylinids, Dragonfly, Damselfly predatory mirid bugs, predatory pentatomids nabid bug, reduvid bug. Anthocorid bug, Geocorid bug, predatory mite, predatory thrips also actively suppress the pest population.
- c) Nematodes like *Hexameremis sp.* Entomopathogenic fungi like *Nemuria releyi, Metarhizium anisipoliae, Heterorhabditis* and *Steinernema* are active during rainy season against lepidopteran pests.

d) Erect bird perches @ 50/ha to attract local predatory birds, which in turn feed on insect pests.

1.2 Augmentation

a) Seed treatment with *Trichoderma viride* @ 2 g per 100 g seed to contain soil borne fungal infection.

b) Release *T.chilonis* @ of 50,000/ha at per flowering and to be continued for 5 times at an interval of 7 days.

D. Chemical Control

1. Chemical pesticide should be used on need basis as a last resort. Only when pest population intensity crossed economic threshold level, the safer pesticides should be applied judiciously.

2. Spray 5 percent NSKE 30 days after sowing and same should be repeated for 2 times once in 10 days.

3. Soil application of carbofuran granulea at 30 kg/ha may be followed before sowing of summer crops for protection against thrips and flea beetle and for kharif crop, for protection against stem fly and jassi. It also reduces the incidence of YMV disease and nematodes.

4. Spray wettable sulphur @ 12.5 kg/750 to 1000 lt. Water/ha to control powdery mildew.

5. Fluchloralin (Basalin 45EC) @ 1.5 kg a.i/ha as pre-planting incorporation for weed control. Alachlor 10 G @ 2.5 kg/ha as pre emergence herbicide is recommended for weed management.

6. Seed treatment with carbosufan 25 ST @ 3 per cent (W/W) reduces nema tode population on soil.

7. Application of dichlorvos (Nuvan 100EC) @ 0.5 ml/1 should be applied against pod borer, podbugs and leaf miner. Against pea aphid and cowpea aphid, apply malathion 50 EC @ 2 ml/1

E. Leguminous Crop Stage-Wise IPM Practices :

Stage	Pest	Practice
1. Pre-sowing	Resting stage of pests,nematodes: Soil borne pathogen nematodes weeds Weeds	Deep summer ploughing Application of neam-cake @ 200kg per ha Crop rotation with maize and other coarse cereals Stale seed bed technique Use of well-decomposed organic manure.
2. Seed-Seedling	Weeds :	Apply Fluchloralin @ 1.5 kg a.i./ha as pre-planting incorporation. Alachlor 10G @ 1.5 kg a.i./ha as pre-emergence.
	YMV	Seeds from healthy plant be selected.
	Stem fly	Higher seed rate in endemic areas, roguing of affected plants. Spray 5% NSKE Spray endosulphan @ 0.07% when the initial puncher marks are noticed and spray a gain when 5 petioles are mined per 10 unifoliate leaves.
	Nematodes	Apply Carbofuran @ 30kg/ha in endemic area Seed treatment with carbosulfan 3% (W/W)
	White rot	Seed treatment with 5 gm talc based <i>Trichoderm herzianum</i> /kg of seed.
3. Vegetative	Red spider mites	Removal of alternate hosts and destruction of affected plants/ plant parts.
	Nematodes	Removal of weeds which act as alternate hosts.

4. Reproductive	Weeds	Maintain weed free field for 4-6 weeks after planting by hand hoeing or dryland weeder.
	Leaf spot	Spray 0.2% Mancozeb.
	White rot	Spraying with Carbendazim @ 0.1% at flowering stage.
	Anthrachnose	Destruction of affected plants.
	Podborer (<i>Euchrysops cnejus</i>)	Destruction of bored pea pods alongwith the larvae/pupae inside.
	Pea aphid, cowpea aphid	Destruction of initial aphid colonies by hand crushing. Apply malathion 50EC @ 2ml/1
	Leaf miner, pod bugs, pod borer.	Apply dichlorvos (Nuvan 100EC) @ 0.5ml/1

**IPM PACKAGE FOR CUCURBETACEOUS VEGETABLES
(CUCUMBER, BOTTLE-GOURD, BITTER-GOURD, SPONGE-GOURD,
SNAKE-GOURD, ASH-GOURD,
SNAKE-GOURD, ASH-GOURD, PUMPKIN, SQUASH)**

Major Pests

A. Pests of national significance

1. Insects

- 1.1 Spotted leaf beetle
- 1.2 Green leaf hopper
- 1.3 Fruit fly
- 1.4 Red pumpkin beetle

2. Diseases

- 2.1 Anthracnose
- 2.2 Wilt
- 2.3 Downy mildew
- 2.4 Powdery mildew

3. Nematodes

- 3.1 Root-knot nematode
- 3.2 Reniform nematode

4. Rodent

- 4.1 Small bandicoot

B. Pest of Regional Significance

1. Insect Pests

- Fruit fly
- Red pumpkin beetle
- Spotted cucumber beetle (*Epilachna* beetle)
- White fly

2. Disease

- Cucumber mosaic viral disease
- Downey mildew
- Powdery mildew
- Anthrachnose

3. Nematode

Root-knot nematode

4. Weeds

- Mile-a-minute (*Mikania micrantha*)
- Crab grass (*Digitaria setogera*)
- White smart weed (*Polygonum orientale*)
- Ageratum (*Ageratum harstonianum*)
- Knot grass (*Panicum repends*)
- Thorny smart weed (*Polygonum perfoliatum*)

II. Pest Monitoring

A. 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 dynamics.
4. Soil conditions.
5. Farmer's Past experience.

The details of AESA are given in Annexure -1.

B. Field Scouting

AESA required 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. Yellow Water Pan /Sticky Traps

Set up yellow pan/sticky traps for monitoring whitefly, thrips etc. @ 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.

D. Nematodes

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

E. 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 practice 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 measures when the incidence crosses ETL. The ETL for some of the major pests are listed below –

Pests	ETL
Leap hopper	2.5 nymphs/leaf
Spotted leaf beetle	1 insect/Sq.m
Nematodes	1-2 juveniles/g of soil

IPM STRATEGIES FOR CUCURBIT VEGETABLES

1. Cultural Practices :

- 1.1 Deep ploughing during summer to expose the nematodes to solar radiation and also the resting stages of the pests.
- 1.2 Crop rotation with paddy in low-lying areas is very effective, against downy and powdery mildew.
- 1.3 Preventing the crops from overlapping and adequate spacing to minimize the length of leaf wetness period, for downy mildew disease management.
- 1.4 Crop seedling should be planted timely in well prepared fields at recommended spacing. Use balanced dose of fertilizer for obtaining plant population and healthy crop stand, which would be capable of competing with weeds in initial stages of crop growth.
- 1.5 Application of thick dry organic mulch helps to suppress weeds.
- 1.6 Ranking to the vine yard around the plant to expose the pupae of fruitfly.

2. Mechanical Control :

- 2.1 Growing a few scattered cucurbit plant in January and destroying the attacked beetle by hand collection is useful.
- 2.2 Eradication of disease infected plants.
- 2.3 Removal of alternate hosts from the field particularly for virus disease management.
- 2.4 Destruction of wild cucurbit plant and crop residues reduces the incidence of root knot nematode and anthracnose and powdery mildew respectively.
- 2.5 Remove damaged fruit and burn.
- 2.6 Careful cultivation and harvesting avoiding wounds, helps in reducing infection particularly to gummy stem blight disease.
- 2.7 Hand collection of adult beetle from plants.
- 2.8 Vinegar + sugar syrup in a pumpkin as baiting to chnique helps in controlling fruit fly.
- 2.9 Covering of fruit with strew or cloth bag to prevent fruit fly attack.
- 2.10 Uprooting of climbing/twining weeds.

3. Biological Control :

3.1 Conservation

- a) Conserve natural enemies such as *Opius Compensatus*, *O. Incisus Spalangia philippinensis*, *O. Composans* which are very active parasite against fruit fly in the field by regular monitoring.
- b) In addition to these parasites, general predators like coccinellids, Syrphids, Spiders, Carabids, Stophylinids, Dragonfly, Damselfly predatory miridbugs, predatory Pentatomids, Nabid bugs, Reduvid bugs, Anthocorid bug, Geocorid bugs, predatory mites, predatory thrips also actively suppress the pest population.
- c) Since these natural enemies are highly prone for pesticides, avoiding unnecessary sprays are the best way to conserve them.
- d) Erect bird perchers @ 50/ha to attract birds, which in turn feeds on pest.

3.2 Augmentation

- a) Seed treatment with T.Viride 2 g per 100 g of seed
- b) Application of T.Viride @ 50 gm in 10 kg. FYM during early stages of the crops along the rows, which helps in inhibiting soil borne fungus infection.

4. Chemical Control :

- 4.1 Chemical pesticide should be used on need basis as a last resort. Only when pest population intensity crossed economic threshold level, the safer pesticides should be applied judiciously.
- 4.2 Application of 2 kg a.i. carbofuran/ha before sowing helps in controlling pests of early stages and root knot nematode population in soil.
- 4.3 Spraying of Chloropyriphos 100 g a.i./ha to kill adult pumpkin beetle when they are found on foliage.
- 4.4 Spray five per sent NSKE during early stage of the crop once and later at 15 days interval will effectively control sucking pests.
- 4.5 Foliar spray with thiophanate, methyl 1000 g a.i./ha or mancozeb or zineb 1.125 to 1.5 kg a.i./750 lt. of water/ha. Helps in controlling the anthracnose disease.
- 4.6 Spraying with dinocap 100ml/750 lt. of water/ha gives good control over powdery mildew.
- 4.7 In direct seeded crops, treatment of seed with carbosulfan (25ST) @ 3% (W/W) reduces the root knot nematode problem.
- 4.8 Spray malathion 50EC @ 2ml/1 mixed with 1% molasses to control fruit fly adults. Spraying should in the evening time on the crop as well as to the vicinity of the crop on vegetations.

IV. CURRENT CROP STAGE WISE IPM PRACTICES

STAGE	PEST	PRACTICES
1. Presowing	Resting stages of pests Nematodes, Rodents	Deep summer ploughing Application on 200 kg neem cake. Crop rotation with non crucif erous crops once in a year. Application of carbofuran @ 2 kg of a.i. at the time of sowing in heavily infested areas. Seed treatment with Carbosulfan (25ST) @ 3% (W/W) Deep ploughing and trimming of the bunds to destroy the existing rodent burrows.
2. Seed/ seedling	Collar rot	Seed treatment with <i>T.Viride</i> @ 2 g per 100 g seeds. Apply 50, <i>T.Viride</i> in 10 kg powdered FYM, all along the rows.
	Virus infected plants	Removal of alternate hosts from field
	Beetles	Hand collection of grubs and adults from the foliage. Spray <i>B.bassiana</i> (2x10 sq.m cfu/g) Spray Carba ry1 1000 g a.i./ha
3. Vegetative	Beetle	As in seedling stage.
	Powdery mildew, leaf spot	Spray Dinocap/Kanathane 100 ml/ 750 lit water per ha.
	Downy mildew	Spray Ridomil MZ78 @ 2.5 g/lit
	Virus infected plants and nematodes	Removal of alternate hosts from field
	Pumpkin caterpillar	Release of <i>C. cannea</i> @ 2 grubs/plant.
4. Reproductive	Downy midew & powdery mildew Virus infected plants	Field sanitation Optimum irrigation Removal of alternate hosts from field.

	Beetles	Hand collection of gubs and adults from the foliage.
	Fruit fly	Careful harvest to avoid mechanical damage to the fruits. Vineger + sugar syrup solution in a pot. Methy1 eugnol or citronella oil 1% in water in small pots for monitoring. Mix 180 kg of jaggery in 18 lt. of water and make it clear solution. Cover the fruits with straw or cloth bag Spray malathion 50EC @ 2ml/1 mixed with 1% molasses.

- 4. PEST MONITORING IN VEGETABLES :** (as in booklet)
 Safety parameters in pesticide usage : (as in booklet)
 Basic precautions in pesticide usage : (as in booklet)
 Warnings : (as in booklet)

IPM PACKAGE FOR CRUCIFEROUS VEGETABLES OR COLE CROPS

1. Cabbage, 2. Cauliflower, 3. Knol-khol, 4. Radish.

1. MAJOR PESTS

A. Pests of National Significance

1. Insect Pests

- 1.1 Diamond backmoth
- 1.2 Leaf webber
- 1.3 Head borer
- 1.4 Cabbage aphid
- 1.5 Sawfly
- 1.6 Tobacco caterpillar

2. Diseases

- 2.1 Black rot
- 2.2 Damping off

3. Nematodes

- 3.1 Root-knot nematode
- 3.2 Reniform nematode

4. Weeds

- 4.1 Lamb square
- 4.2 Pimpernel
- 4.3 Sweetclover
- 4.4 Fumitory
- 4.5 Cornspurry
- 4.6 Cluster weed
- 4.7 Blue grass
- 4.8 Canary grass
- 4.9 Rabbitfoot grass

B. Pest of Regional Significance

1. Insect Pests

- 1.1 Cabbage butterfly
- 1.2 Diamond backmoth
- 1.3 Semilooper
- 1.4 Cabbage aphid
- 1.5 Cut worm
- 1.6 Field cricket
- 1.7 Chrysomelid beetle
- 1.8 Red ant

2. Diseases

- 2.1 Black rot
- 2.2 Alternaria leaf spot
- 2.3 White rust
- 2.4 Soft rot
- 2.5 Club root

3. Nematodes

- 3.1 Root Knot nematode

4. Weeds

- 4.1 Slender amaranth (*Amaranthus viridie*)
- 4.2 Red smart weed (*Polygonum viscosum*)
- 4.3 Cud weed (*Gnaphalium indicum*)
- 4.4 Wood Sorrel (*Oxalis debilia* Var. *corymbosa*)
- 4.5 Bermuda grass (*Cynodon dactylon*)

II. PEST MONITORING

A. 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-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.

The details of AESA are given in Annexure -1.

B. Field Scouting

AESA required 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 *H. armigera*, *S.litura*. Install five traps with lures for each pests; keep the distance of meters between the traps. 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 trap.

D. Yellow Water Pan /Sticky Traps

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

E. Nematode

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 nematodes egg sac dark in colour whereas roots remain uncoloured.

E. 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 practice 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

measures when the incidence crosses ETL. The ETL for some of the major pests are listed below –

Leaf webber	1 Larva per meter row of length
Nematodes	1-2 Juveniles per gm of soil
Spider mite	2 mites per leaf
Saw fly radish	1 larva per plant
Diamond backmoth	1 larva per plant.

III. IPM STRATEGIES FOR CRUCIFEROUS VEGETABLES

A. Cultural Practices

1. Deep ploughing during summer to expose resting population of insects, nematodes and disease causing organisms.
2. Follow crop rotation.
3. Select resistant and tolerant varieties.
4. Remove and destroy crop residues after harvest.
5. Crop seedlings should be timely planted in well prepared field at recommended spacing and balanced dose of fertilizer.
6. Solarization of nursery bed by covering it with polythene transparent sheet (60-100 gauge) for 15-21 days is recommended to avoid nematode problem.
7. Well rotten cowdung or compost should be applied to reduce weed population.
8. Destroy weeds before their seed setting.
9. Stale seed bed technique to kill first flush of weeds before sowing of crop.
10. Remove and destroy weeds from vicinity of crop field to check diseases.
11. In club root infected fields, do not grow cruciferous crop for 8 years.
12. Apply borax @ 5-10 kg/ha for reducing black rot.
13. Grow non-cruciferous crops for two years for reducing black rot.
14. To prevent club root, incidence, add lime to the soil to raise the PH to 7.0
15. Sanitary measures are to be adopted against diseases.

B. Mechanical Control

1. Hand collection of life Stages of insect pests reduces the infestation.
2. Collection and destruction of infected old leaf of cole crops regularly.
3. Roguing of borer affected cabbage/cauliflower plants.
4. Crop should be maintained weed free for 4-6 weeks after planting by resorting to timely hand hoeing/hand weedlings.
5. Flooding to kill the crickets in burrows.

C. Trap Crop Technology

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

D. Bio-logical Control

1. Avoiding spraying of broad spectrum pesticides to conserve the natural enemies.
2. Erect bird percher @ 50 nos. per ha. helps the birds to come and eat the insect larvae.
3. Distribute small quantity of cooked rice at different places in the field which attracts birds like yellow wage tile, gray wage tile, common swallows and Indian myna.
4. Seed treatment with *Trichoderma viridie* @ 2 gm.per 100 100 gm. of seed.
5. Release *Trichogramma toidea* bactrea or *T. chilonis* or *T. pretiosum* egg parasites @ 50,000 per ha., 4-5 times with interval of 5-7 days helps in controlling DBM and other lepidopteran pests.
6. Make inoculative release of *Cotesia plutellae* @ 5,000 per ha. on 10-15 days after planting to control DBM.
7. Spray commercial preparation of *Bacillus thuringiensis* Var. *kurstaki* @ 500 gm. per ha. after 15 days planting and should be repeated after every 15 days to control DBM and other lepidopteran pests.
8. Spray *Beauveria bassiana* (1×10^6 cfu/g) @ 2 gm per litre of water after every 20 days to control lepidopteran pests.

9. Spray *Entomophthora* sp. (2×10^7 cfu/g) @ 2 gm per litre of water after every 20 days to control lepidopteran pests.
10. Apply twice at 15 days interval of 5% NSKE beginning from head initiation stage.

E. Botanical pesticides

1. Apply twice at 15 days interval of 5% NSKE beginning from head initiation stage. This treatment would be more effective in cole crop mustard intercrop field.
2. Lemon juice 1% as a foliar spray for controlling DBM is also found to be effective.

F. Chemical Control

1. Chemical pesticides should be applied on need basis as a last resort. Only when pest population intensity crosses ETL, the safer pesticides like malathion 50 EC @ 1.5 ml per litre of water should be applied.
2. Treat seeds in 100 ppm streptomycin solution for 30 minutes for managing black rot.
3. Treat seeds with 2 gm. carbendazim per kg. of seed for the control of seed and soil borne fungal pathogens.
4. Apply mancozeb 75% WP @ 1500-2000 gm per ha. for black rot disease management whenever disease inoculum and climatic conditions are noticed.
5. Treat the nursery bed with carbofuran 3 g. @ 0.3 to 0.6 g.a.i. per sq. meter.
6. Apply 3 sprays of Cu-oxchloride (3 gm. per litre) at 14 days intervals for black rot disease management, whenever disease initiation is observed and climatic condition favours.

IV. CRUCIFEROUS CROP STAGE-WISE IPM PRACTICES

STAGE	PEST	PRACTICES
1. Pre-sowing	Resting stages of pests, nematodes, weeds, bacterial & fungal pathogens.	- Deep summer ploughing. - Raised nursery beds. - Soil solarization. - Treat the nursery bed with carbofuran 3 gm. @ 0.3 to 0.6 gm.a.i. per sq. metre.
	DBM & other pests	- After land preparation leave two ridges at the beginning, after every 25 rows and at the end.

		Sow bold mustard seeds densely in one of the ridges 15 days before cabbage planting as a trap crop.
	Weeds	- Use of well rotten cow dung or compost stale seed bed technique.
	Club rot	- Add lime to the soil raise the PH to 7.0
	Black rot	- Apply borax @ 5-10 kg. per ha.
2. Sowing / Planting	Black rot	- Seed treatment with 100 ppm streptocycline solution for 30 minutes.
	Seed & Soil borne fungal pathogens	- Seed treatment with carbendazim 2 gm. per kg. seed. - Apply optimum dose of N & P fertilizers as basal dose.
	Weeds	- Adopt optimum irrigation. - Timely planting, optimum spacing and balanced dose of fertilizer.
3. Vegetative	Black rot	- Apply 3 sprays of Copper-oxchloride (3 gm. per litre of water) at 14 days interval for black rot management, whenever disease initiation is observed & climatic conditions favour. - Spray 100 ppm streptocycline sulphate + mancozeb 2-2.5 gm.a.i. per litre of water against black rot and leaf spot.
	Weeds	- Two hand weedings at 20 & 40 days after transplanting in lieu of herbicide application. - Use of dryland weeder is cost effective.
4. Head Department	Lepidopterran pests	- Erect bird perchers.
	Aphids	- Spray malathion 50 EC @ 1.5 ml per litre of water.
5. Crop maturation	Black rot DBM Head borer	- Spray 100 ppm streptocycline sulphate + mancozeb 2 – 2.5 gm.a.i. per litre of water. - Destruction of old leaves affected with DBM.
	Black rot	- Roguing of affected plants. - Remove affected heads.
		- Destroy the crop residues after harvest.

IPM PACKAGE FOR CHILLI/CAPSICUM

1.1 Pest of national Significance

1.1.1 Insect pests

1. Thrips
2. Aphids
3. Mites

1.1.2 Diseases

1. Damping off
2. Anthracnose
3. Wilt
4. Bacterial wilt
5. Pepper blight

1.1.3 Nematoses

1. Root knot nematodes
2. Reniform nematodes

1.1.4 Major Weeds

1. Lamb square
2. Pimpemel
3. Sweet clover
4. Fumitory
5. Corns purry
6. Blue grass
7. Canary grass
8. Rabbit foot grass

1.2 Pests of Regional Significance

1.2.1 Insect Pests

- Leaf eating caterpillar
- Capsicum fruit fly (Fruit borer)
- Flea beetle
- White fly
- Thrips
- Mite

1.2.2 Diseases

- Bacterial wilt
- Anthracnose/Fruit rot
- Leaf curl
- Leaf spot

1.2.3 Nematode

Root Knot nematode

1.2.4 Weeds

Chick weed (*Stellaria media*)
Ageratum (*Ageratum harstonianum*)
Nut sedge (*Cyperus rotundus*)
Crab grass (*Digitaria setigera*)
Cuphea (*Cuphea balsamona*)
Bermuda grass (*Cynodon dactylon*)

II. Pest Monitoring

II.1 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-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.

The details of AESA are given in

II.2 Field Scouting

AESA required skill and 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.

II.3 Pheromones

Pheromone traps with lures are commercially available for pests like *H. armigera*, *S.litura*. Install five traps with lures for each pests; keep the distance of meters between the traps. 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 to 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 trap.

II.4 Yellow Water Pan /Sticky Traps

Set up yellow pan/sticky traps for monitoring whitefly, thrips etc. @ 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.

II.5 Nematode

Root knot causes diagnostic symptoms of gall formation and reniform nematodes causes "dirty root" symptom. Their presence can be detected by using "Trypan Blue Stain" solution in water which turns nematodes egg sacs dark blue in colour whereas roots remain uncoloured.

II.6 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 practice such as spraying a pesticide. At the ETL be benefit of spraying is equal to the losses caused by the insects in the field. The farmers are advised to take appropriate measures, whenever the incidence crosses ETL. The ETL for some of the major pests are listed below :

Thrips	6 thrips per leaf or 10% affected plants
Leaf hopper	2.5 nymphs per leaf
Fruit borer	One egg or one larvae per plant or one damaged fruit per plant.
Root knot nematode	1-2 junveiles/g of soil

III. IPM Stragies for Solanaceous crops

III.1. Cultural Practices

- III.1.1. Phytosanitation to reduce sources of inoculum such as removal of plants after final harvest volunteer plants. Clean planting material, preferably certified seeds should be used.
- III.1.2. Crop rotation with French beans or dhainsa reduces the bacterial wilt disease incidence. Crop rotation with cereals and inter-cropping with marigold onion and garlic reduces nematodes.
- III.1.3. Adopt raised nursery bed (10 cms) for good dra inage, thereby avoid damping off in solanaceous nurseries by preventing soil borne fungi viz., Pythium, Phytophthora, Rhizoctonia, etc.

- III.1.4. Soil solarization using transparent polythene sheets 60-100 gauge thick on nursery beds for about 15 to 21 days which helps in killing weed seeds, nematodes and resting stages of insects and diseases.
- III.1.5. Deep summer ploughing to expose resting stages of pests and soil borne nematodes and diseases, weed seeds and retative propagules of weeds to sun light.
- III.1.6. Destruction of crop residues/debris and alternate host material reduces the inoculum load of any foliar diseases and nematode.
- III.1.7. Crop seedling should be timely planted in well prepared seed bed at recommended spacing. Use balanced dose of fertilizer to get optimum plant population and healthy crop stand, which would be capable of competing with weeds at the initial stages of crop growth.
- III.1.8. Stale seed bed technique to kill the first flush of weeds before planting of the crop.
- III.1.9. Use well rotten cowdung or compost to reduce weed population.
- III.1.10. Remove weeds before their seed setting.

III.2. Mechanical Control

- III.2.1. Collection and destruction of egg masses, larvae, grubs and adults of Epilachna beetle, tobacco cutworm, etc.
- III.2.2. Removal of damaged shoots and fruits and destruction.
- III.2.3. Use of yellow pan/sticky traps for sucking pests @ 10 per ha.
- III.2.4. Installation of Pheromone traps @ 5 per ha. for monitoring H. armigera and S.litura.
- III.2.5. Crops should be maintained weed free for 4-6 weeks after planting be resorting to timely hand hoeing and hand weedings.

III.3. Biological Control

III.3.1

- (a) Some practices are very active in the field against serious pests of vegetable crop as required. E.G., Aphidius sp., Aphelinus sp., on aphids; Eurytoma sp.
- (b) In addition to these parasites, general predators like coccinelids, syrphids, Spiders, Carabids, Stophylinids, Dragonfly, Damselfly, predatory miridbugs.

- (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.
- (e) Install bird percher @ 50 per ha.

III.3.2 Augmentation

- (a) Spray of HaNPV @ 250 LE (6x10⁹ PIB per LE) for these times starting from flower initiation to fruit development stage in chillies/capsicum.
- (b) Spray *Bacillus thuringiensis* var kurstaki, the commercial preparation @ 500 g per ha. against lepidopteran pests.
- (c) Seed treatment with Trichoderma viride/T. Harziamum @ 2 gm per 100 gm of seeds to prevent seed and soil borne infection of fungal diseases.

III.3.3 Botanical Pesticides

- (a) Five percent NSKE spray for sucking pests in early stages of the crop, which also takes care of serpentine leaf miner, etc.
- (b) Application of neem cake @ 200 kg. per ha. as a basal dose at the time of land preparation for contolling root-knot nema tode infection.

III.3.4 Chemical Control

- (a) Chemical pesticide should be used on need basis as a last resort. Only when pest population intensity crossed economic threshold level, the safer pesticides should be applied judiciously.
- (b) Seed treatment with Carbendazim @ 2 g/100 g seed to contain seed borne infection.
- (c) Foliar spray of mancozeb 1.125-1.5 kg a.i./ha to control early leaf spot and anthracnose/fruit rot whenever the diseases are noticed.
- (d) Application of bleaching powder @ 15 kg/ha before planting against bacterial wilt infection in chillies in endemic areas.
- (e) Application of carbofuran 1 kg a.i. per ha. During early stages of crop to avoid sucking pests and also nematodes.
- (f) Spray endosulfan 525 g a.i./ha Quinalpos 25 EC 1000 ml/ha, to control insect pests. Alternate spray of Endosulan @ 525 g a.i./ha and Cypermethrin 50 g a.i./ha at 15 days interval.

(g) Treat nursery beds with Carbofuran 3f g @ 0.3 to 0.6 gm a.i./sq.m. In direct seeded crops treat the seed with Carbofuran/Carbosulfan (25 ST) @ 3% (W/W) to reduce root-knot nematode problem.

IV. Chilli Crop Stage Viz-A-Viz IPM Practices

Stage	Pest	Practices
1. Pre-sowing	Resting stages of insects disease causing spores, nematodes, weeds	Deep summer ploughing Soil solarization Stale seed bed technique Use of well rotten cowdung or compost Application of neem cake @ 200 kg/ha Treat the nursery bed with carbofuran 3G @ 0.3-0.6 g a.i./sq.m Application of bleaching power @ 15 kg/ha before planting.
2. Seed-seedlings	Bacterial wilt Nematodes	Seed treatment with Carbofuran/ carbosulfan (25 ST) @ 3% W/W
	Thrips	Grow resistant varieties-NP 46a, Pusa, Jwala Realease Chrysoperia @ 2 grubs/plant Spray dimethoate 0.02%
	Anthracoese	Seed treatment with Trichoderma viride @ 2 g/100 g seed and bavistin @ 1 g/100g seed. Adopt recommended spacing and timely planting in well prepared seed bed. Use balanced dose of fertilizer.
3. Vegetative	Weeds	Apply Oxadicozen @ 0.5 kg a.i./ha. or Pendimethalin @ 1 to 1.25 kg a.i./ha as preemergence herbicide.
	Tobacco	Installation of pheromone traps @ five traps per ha. Replace lure once in 15 days. Hand collection of egg masses/early instar larvae. Release of Telenomus remus @ 50000/ha for four times at weekly intervals. Spray S1 NPV @ 250 LE/ha (6x10 PIB/LE) during evening hours.

4. Reprod-uctive	Weeds	Use of bird perchers @ 50 per ha. Augment the natural enemies by keeping the egg masses collected from the fields in the netted cage. Spray 5% NSKE. Maintain weed free crop for 4-6 weeks after planting by resorting to hand hoeings and hand weedings. Spray Dicofol 500 g. a.i./ha
	Mites	Release C.cornea @ 2 grubs/plant. Spray Endosulfan @ 312-625 g. a.i./ha
	Thrips Tobacco cut worm, fruit borer, H. armigera	As shown in vegetative stage. Install pheromone traps with replacement of lures once in 15 days. Release T.brasillensis/T.priteosum/T.chilonis @ 50,000/ha for six times at weekly interval hand collection of larvae of helioverpa on main and trap crops. Spray NaNPK @ 250 LE per ha (6x10 PIB/ha.) twice during evening hours. Spray 5% NSKE or B. Thuringienses var kurstaki 500 g./ha. Spray endosulfan 525 g. a.i./ha and carbary1 1000 g. a.i./ha.
	Mites Thrips Anthracoese/Fruit rot	As shown in vehetative stage. As shown in vehetative stage. Apply mancozeb 1.125-1.5 kg a.i./ha.
Weeds	Remove weeds before their seed setting.	

IPM PACKAGE FOR ONION

1. Major Pests

A. Pests of National Significance

1. Insect Pests

- 1.1 Thrips
- 1.2 Mites

2. Diseases

- 2.1 Leaf blight/purple blotch
- 2.2 Smudg
- 2.3 Downy mildew
- 2.4 Blast and neck rot

3. Weeds

- 3.1 Lamb square
- 3.2 Pinpemel
- 3.3 Sweetclover
- 3.4 Funitory
- 3.5 Corn sparry
- 3.6 Cluster weed
- 3.7 Blue grass
- 3.8 Canary grass
- 3.9 Rabbit foot grass

B. Pest of Regional Signature

1. Insect Pests

- 1.1 Onion thrips
- 1.2 Onion mite
- 1.3 Onion maggot

2. Diseases

- 2.1 Purple blotch
- 2.2 Basal rot and wilt

3. Weeds

- 3.1 Chick weed (*Stellaria media*)
- 3.2 Ageratum (*Ageratum harstonianum*)
- 3.3 Nutsedge (*Cyperus rotundus*)
- 3.4 Crab grass (*Digitaria setigera*)
- 3.5 Cuphea (*Cuphea balsamona*)
- 3.6 Bermuda grass (*Cynodon dactylon*)

II. Pest Monitoring

1 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 interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basic components of AESA are:

1. Plants health at different stages.
 2. Built-in-compensation abilities of the plants.
 3. Pest and defender population dynamics.
 4. Soil conditions.
1. Climatic factors.
 2. Farmer's Past experience

The details of AESA are given in

2. Field Scouting

AESA required skill and 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.

3. Yellow Water Pan /Sticky Traps

Set up yellow pan/sticky traps for monitoring whitefly, thrips etc. @ 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.

4. Economic Threshold Level (ETLs)

The Economic Threshold Level (ETL) is an attempt to improve decision making practices by using partial economic analysis on the impact of the control practice 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 measures, whenever the incidence crosses ETL. The ETL for some of the major pests are listed below :

Onion maggot – 1 maggot/hill

III. Integrated Pest Management Strategies

A. Cultural Practices

1. Crop rotation with coarse cereals reduces the blotch incidence.
2. Application of neem cake @ 200kg per ha., against nematodes and soil borne fungus.
3. Crop seedling should be timely planted in well prepared field at recommended spacing by using balanced dose of fertilizers for obtaining optimum plant population and healthy crop stands which would be capable of competing with the initial stages of the crop growth.
4. Stale seed bed technique to kill the first flush of weeds before planting of the crop.
5. Destruction of weeds before their seed setting.
6. Use of well rotten cowdung manure or compost to reduce weed population.

B. Mechanical Control

1. Jet sprinkling of water through jet nozzles to prevent thrips multiplication.
2. Crop should be maintained weed free for 4-6 weeks after planting by resorting timely hand hoeing/hand weeding.

C. Biological Control

1. Conservation

General predators like Coccinellids, Syrphids, Spiders, Dragonfly, Damselfly, predatory bugs are actively suppress the onion pests. Avoiding unnecessary broadspectrum chemical sprays is the best way to protect them.

2. Augumentation

- a) Seed treatment with *Trichoderma Viride* @ 2 g/100 g of seed.
- b) Conservation of predatory bugs.

D. Chemical Control

1. Chemical pesticide should be used on need basis as a last resort. Only when pest population intensity crossed economic threshold level, the safer pesticides should be applied judiciously.

2. Spray 0.5% NSKE during vegetative stage
3. Spray malathion 50EC @ 2ml/1 to control thrips.
4. Spray Mancozeb 1.125 to 1.5 kg a.i./ha. for onion blotch/leaf blight.
5. Against weeds, spray fluchloralin @ 670g-980 g a.i./ha as preplanting soil incorporation or pendimethalin @ 750 g-1000 g a.i./ha as preemergence.

IV. Bulb Crop Strategies IPM Practice

Stage	Pest	Practice
1. Pre-sowing	Resting stages of pests, soil borne Pathogens, weeds	Deep summer ploughing Soil incorporator of fluchloralin @ 670-980 g a.i./ha or spray pendimethalin @ 750 to 1000 g a.i./ha as a premergence of weeds.
	Weeds	Stale seed bed technique. Use of well rotten cowdung/compost.
2. Seed/Seedling	Blotch	Seed treatment with bavistin 0.01% Spray mancozeb 0.2% whenever disease symptoms noticed
	Thrips	Yellow sticky traps @ 5 per ha Spray malathin 50EC @ 2ml/lit.
3. Vegetative	Onion maggots	Removal alternate hosts, Optimum irrigation management.
	Weeds	Optimum spacing timely planting; balanced dose of fertilizers. Maintain weed free field for 4-6 weeks after planting by hand hoeing/hand weeding. Destruction of weeds before their seed setting.
	Thrips	Continue sticky traps; Conserve coccinellid predators spray malathion 50EC 2ml/1. Hand collection of different stages of the in insect.
	Tobacco caterpillar	Spray Dicofol @ 450 g a.i./ha.
	Mites Blotch	Spray mancozeb 1.25-1.5 kg a.i./ha

AGRO-ECOSYSTEM ANALYSIS IN VEGETABLES

IPM is based on ecological interactions between the environment, plants, herbivores and their natural enemies. The maximum yield of the crop is determined by plants and their health. The health of the plant is determined by the environment and the herbivores. The herbivores are balanced by their natural enemies.

Agroecosystem analysis (AESA) is an approach, which can be gainfully employed by group of farmers for decision making in IPM. The basic components of AESA are :

- a. Plant health at different stages.
- b. Compensation abilities of the plants.
- c. Pest and defender population.
- d. Soil conditions, irrigation status etc.
- e. Weather conditions.
- f. Pest experience of the farmer in the situation.
- g. Other investment opportunities.

The goal of the AESA activity is to analyse the field situation by observation, drawing and discussion. At the end of the activity the group should have made a decision about any action required for the field. The eco-system analysis is done weekly.

Time required = 120 minutes.

Materials required – one note book, two large size paper, pencils and drawing crayons, polythene bags, plastic vials, rubber band and chloroform.

Procedure

Go to the field, leave the border side, select fifth plant in a row for observation. Move 1-2 rows and select the fifth plant from that position for second observation. Likewise select a total of ten plants. Observe each plant with the following parameters and record.

Insect-pest, disease and defenders count : Count the large pests and beneficial found on different branches and leaves of the plant. Start from the top of the plant and work downwards. Count the egg masses, larvae and adults of defoliators and workout defoliation percentage. Count the flower and fruit feeding insects and assess the percentage of fruits affected by them. Count the branches that are affected by die-back or other shoot diseases.

Select three leaves from the sample plant, one taken from the top, one from the middle and one from the bottom of the plant. Pick or turn the leaf and count the number of sucking pests and predatory mites. Also record different leaf spot disease symptoms and count the number of spots. Estimate the percentage of leaf area affected.

Out of ten sample plants assess the number of plants with virus symptoms. Likewise, for wilting symptoms. Pull wilting plants and observe symptoms on the roots (cut the root observe the colour of the vascular tissue).

Out of ten sample plants, note the number of plants with flowers/fruits to assess the percentage of plants flowering/fruitletting.

Plant parameters : Measure the height of the plant, number of leaves, width of foliage etc.

Walk through the whole plot the assess any other beneficial, pests or diseases, not observed on the ten sample plants, is occurring, note the uniformity in growth of the plants. Make records of the soil condition, water situation and presence of weeds (observe the different kind of weeds and severity).

Rate : Count number of plants affected by rat, also record number of live burrows in the plot.

Weather : Record last week's weather situation.

Find a shady place to sit as a group. Each group should sit together in a circle with pencils, crayons, data from each of the field activities and the drawing of the AESA of the previous week.

Make a drawing on the large piece of paper for each plot observed. The rules of drawing are as follows :

Draw the plant with the correct number of branches, leaves, flowers, fruits; write the plant height and number of green and yellow leaves some where. If the plant is healthy, colour the plant green. If disease occur, draw the disease. If the plant is yellow, colour it yellow. Draw dead or dying leaves in yellow. For weeds draw the approximate density and size of weeds in relation to the size of the vegetable plant. Draw the kinds of weed in the field.

For pest populations draw the different insects found in the field on the right side of the plant, write the average number next to the insect. Also write the local name next to the insect. The date can also be summarized in a table on the right side.

For natural enemy populations, draw the insects and spiders as found in the field on the left side of the plant. Write the average number of natural enemies and their local names next to the drawing.

For rats write the average number of fruits/head attacked.

If the week was mostly sunny draw a sun. if the week was mostly sunny and cloudy together, draw a sun but half covered with dark clouds. If the week was cloudy all the day for most of the week, put just dark clouds.

If the fertilizer was applied, then draw a picture of a hand throwing N, P or K depending on the type of fertilizer used.

If pesticides were used in the field, show sprays with a nozzle and right the type of chemical coming out of the nozzle. If granules were broadcast, show a hand with the name of pesticide being broadcast.

Now discuss the field situation among the group and arrive at a conclusion for the management practices required for the field. The discussion may be centred around detailed below:

Eco System Analysis :

Steps	What to observe	What to ask? Discuss	Actions
1. Weather		Rain/dry? Trends in weather dry/wet season, effects on crop.	Do we need to water? Preparation of beds? Disease management.
2. Crop conditions		Age of crop, seedling /Veg. Growth/flowering/ fruiting/colour of leaves, leaf spots? Die back? Diseases?	Need Fertilizer? Need watering? Special topic? Fungicide?
3. Field condition		Soil structure hard/wet? Weeds present?	Hand weeding? Soil aeration?
4. Herbivores		What herbivores? Population? Damaging?	Insect zoo Special topic
5. Natural enemies (and neutrals)		What NE? Population? Damaging?	Insect zoo Special topic
6. Activities in neighbours fields		Do neighbours spray? What was sprayed?	Compare with FP plot.
7. Decisions made last week		Was the decision made effective? Do we need to do similar action?	Insect zoo Special topic

2. PIT FALL TRAP

Due to nocturnal behaviour and hiding during day time many insect pests like greasy cutworm, *Agrotis ypsilon* can't be observed on plant in the vegetable fields during day time. Like wise many ground dwelling predators like ground beetles which play major role in regular the population of lepidopterous pest like *Helicoverpa armigera*, *Spodopetra litura* cannot be assessed properly by visual observations.

The pit fall trap method is effective in these situations. Pit fall trap is a simple plastic container (1 liter capacity) with lid. Container with half filled water with a few drops of teepol on water surface is buried in the field in such a way that the top surface is at level with that of soil surface. Observation should be made 48 to 72 hours after fixing the trap. Ten traps may be required per hectare of vegetable crop.

IV. DO'S AND DON'T'S IN VEGETABLE IPM

Do's	Don't
1. Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be kept exposed to sun light at least for 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.
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. Pre-emergence herbicides should be applied immediately after sowing before the emergence of weeds and crop.	Pre-emergence herbicides should not be applied after emergence of crop and/or weeds, as they cannot control the germinated weeds as well as they may cause phytotoxicity to the crop.

Do's	Don't
7. Herbicides like fluchloralin should be incorporated into the soil immediately after spraying to avoid its photo degradation.	Soil incorporation of fluchloralin should not be delayed or avoided for achieving effective weed control.
8. Apply only recommended herbicides at recommended dose, proper time, as appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.	Pre-emergency as well as soil incorporated herbicides should not be applied in dry soils. Do not apply herbicides alongwith irrigation water or by mixing with soil, sand or urea.
9. Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crop weed competition.	Crops should not be exposed to moisture deficit stress at their critical growth stages.
10. Use NPK fertilizers as per the soil test recommendation.	Avoid imbalanced use of fertilizers.
11. Use micronutrient mixture after sowing test recommendations.	Avoid imbalanced use of fertilizers
12. Conduct AESA weekly in the morning preferably before 9 a.m. Take decision on management practice based on AESA, ETL, and PD ratio only.	Do not apply chemical pesticides on calendar basis.
13. Install pheromone traps at appropriate period.	Do not store the pheromone lures at normal room temperature (keep them in refrigerator).
14. Release parasites only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation.	Do not apply chemical pesticides within seven days of release of parasites.
15. Apply HaNPV, SINPV at recommended dose when a large number of egg masses and early instar larvae are noticed. Apply NPV only in the evening hours after 5 pm.	Do not use the same sprayer for application of chemical pesticides and biocides.

Do's	Don't
16. In case of pests which are active during night like Spodoptera spray recommended biocides/chemicals at the time of their appearance in the night.	Do not apply pesticides/biocides when it is not absolutely required.
17. Spray pesticides thoroughly to treat the undersurface of the leaves, particularly for mites, Spodoptera, Epilachna grubs etc.	Do not spray pesticides at midday since, most of the insects are not active during this period.
18. Apply short persistent pesticides to avoid pesticide residue in the soil and produce.	Do not apply pesticides during preceding 7 days before harvest.
19. Maintain isolation distance of minimum 200 m in cucurbits between varieties to avoid contamination in cross pollination.	Do not spray insecticides during flowering season of cucurbits to protect honeybees, which helps in cross pollination.
20. Follow the recommended procedure of trap crop technology on tomato and Cole crops.	Do not apply long persistent on trap crop, otherwise it may not attract the pests and natural enemies.

Annexure-III
SAFETY PARAMETERS IN PESTICIDES USAGE

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							
A. Chlorinated Hydrocarbons 1. Endosulfan	Highly Toxic	Yellow	Class II Moderately hazardous	Remove the person from contaminated environment In case of (a) Skin contact – Remove all contaminated clothings wash with lot of water and soap; (b) Eye Contamination – Wash the eyes with plenty of cool 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.	Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death.	Gastric lavage with 2-4 Lit. 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. Diazepam also can be given. Watch breathing closely, administer oxygen and/or artificial respiration, if needed. Avoid oils orally, oil laxatives. Do not give any stimulants. Give calcium gluconate (10% in 10 ml. ampules) intravenously every four hours.	21

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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)
				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.			
B. Organophosphorous Compounds							
2. Chlorpyrifos	Highly toxic	Yellow	Class II Moderately toxic	In case of breathing difficulty, give mouth to mouth or mouth to nose breathing.	Mild-Anorexia headache, dizziness, weakness anxiety, tremors of tongue and eyelids, miosis, impairment of visual acuity.	For extreme symptoms of OP poisoning, injection of atropine (2-4 mg. For adults, 0.5-1.0 for children) is recommended, repeated at every 5-10 minute intervals until signs of atropinization occur is preferred.	Not available
3. Dichloro-ovos	Extremely toxic hazardous	Red	Class-Ia Extremely	External cardiac (heart) massage may be given if heart action ceases.	Moderate-nausea salivation, lacrimation, abdominal cramp, vomiting, sweating slow pulse muscular tremors, miosis.	Atropine injection-2 to 4 mg. Repeat 2 mg. When toxic symptoms begin to recur (15-16 minutes intervals). Excessive salivation is a good sign indicating need for more atropine.	07

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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)
4. Formothion	Highly toxic	Yellow	Classa-II Moderately hazardous	Medical Aid Take the patient to a Doctor/Primary Health Centre immediately along with the original container leaflet and label.	Severe diarrhoea, pinpoint and nonreactive pupils, respiratory difficulty, pulmonary oedema, cyanosis, loss of sphincter, control, convulsions, coma and heart block.	Keep airways open. Do tracheotomy and give artificial if needed. Not available.	Not available
5. Trichlor-phos	Moderately toxic	Blue	Classa-III Slightly hazardous			If ingested lavage stomach with 5% sodium bicarbonate, if not vomiting. For skin contact, wash with soap and water (eyes-wash with isonic saline). Wear rubber gloves while washing contact area.	Not available
6. Dimet-hoate	Highly toxic	Yellow	Classa-II Moderately hazardous	If there is no specific antidote, the doctor may treat the patient symptomatically.		In addition to atropine give 2-PAM (2-pyridine aldoxime methiodide). 1g. 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.	60 16
7. Phospha-midon	Extremely toxic	Red	Classa-Ia Extremely hazardous				14
8. Quinal-phos	Highly toxic	Yellow	Classa-II Moderately hazardous				75 - 110

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)
9. Phorate	Extremely toxic	Red	Class-Ia Extremely hazardous			Avoid morphine, theopyllin, aminophyllin barbiturates or phenothiazines. 75-110	05
10. Malat-hion	Moderately toxic	Blue	Class-III Slightly hazardous			Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.	
C. Carbo-nate 11. Carbo-furan (Furadon)	Extremely toxic	Red	Class-Ib Highly hazardous		Constriction of pupils, salivation, profuse sweating lassitude muscle incoordination, nausea, vomiting, diarrhoea epigastric pain, tightness in chest.	Atropine injection 2 to 4 mg. Repeat 2 mg. When toxic symptoms begin to recur (15-50 minute interval) Excessive salivation is a good sign indicating need for more atropine. Keep airway open. Do tracheotomy and give artificial respiration if needed.	50

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)
D. Fungicides (Thiocarbamates)	Slightly toxic	Green	Table-5 (Unlikely to present acute hazards in normal use)			If ingested, 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 area. Give oxygen, morphine, if needed. Avoid theophyllin and aminophyllin/barbiturates. 2-PAM and other oximes are not harmful and in fact contra indicated for routine usage. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine. No specific antidote. Treatment essentially eymptomatic. NA	NA

BASIC PRECAUTIONS IN PESTICIDE USAGE

A. Purchase

1. Purchase only JUST required quantity e.g. 100, 250, 500 or 1000 g/L for signal application in specified area.
2. Do not purchase leaking containers, loose, unsealed or torn bags.
3. Do not purchase pesticides without proper/approved LABELS.

B. Storage

1. Avoid storage of pesticides in house premises.
2. Keep only in original container with intact seal.
3. Do not transfer pesticides to other containers.
4. Never keep them together with food or feed/fodder.
5. Keep away from reach of children and livestock.
6. Do not expose to sunlight 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 polythene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polythene bag contaminated with pesticides).
5. Read the label on the container before preparing spray solution.
6. Prepare spray solution as per requirement.
7. Do not mix granules with water.
8. Concentrated pesticides must not fall on hands etc., while opening sealed containers. Do not smell the pesticides.
9. Avoid spilling of pesticide solution while filling the sprayer tank.
10. Do not eat, drink, smoke or chew while preparing solution.
11. The operator should protect his bare feet and hands with polythene bags.

E. Equipment

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
4. Don't blow/clean clogged-nozzle with mouth. Use old tooth-brush tied with the sprayer and clean with water.
5. Do not use same sprayer for weedicide and insecticide.

F. Precautions for applying pesticides

1. Apply only at recommended dose and dilution.
2. Do not apply on hot sunny day or strong windy condition.
3. Do not apply just before the rains and also after the rains.
4. Do not apply against the wind direction.
5. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer.
6. Wash the sprayer and buckets etc., with soap water after spraying.
7. Containers, buckets etc., used for mixing pesticides should not be used for domestic 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.

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PROGRAMME FOR RICE FFS

Week No.	Days After Transplanting (DAT)	Activities
0	-	Village Immersion (Survey, Rough Sketch, Distance)
1	1 DAT	Pre Evaluation, Grouping, Rice Physiology, Discussion on rice ICM And its relevance, Top Dressing And INM Rodent management, AESA introduction Setting up of IPM Non IPM plots.
2	28 DAT	AESA, PAR (Defoliation, Detillering), Bird Percher, Integrated Weed Management, IDM, Group Dynamic, spraying at non-IPM plots, and habitats study of spiders.
3	35 DAT	AESA (IPM-Non IPM), management of YSB and Rice defoliators, group Dynamic and PAR Expt.
4	42 DAT	AESA, observation of PAR, group Dynamics, Defoliation Management (contd.), Rice physiology study and IDM.
5	49 DAT	AESA, IDM, IPM, Setting up of pot cage study, Vial study, group Dynamics pest Defender identification.
6	56 DAT	AESA, Demonstration of water pan collection, sucking pest Management Importance of PPI stage, top dressing water management, and introduction of flock media.
7	63 DAT	AESA, ROLE of Bio-fertilizer and BIPM, observation of PAR, management of Rice pest of later stage, group Dynamics and pot cage study.
8	70 DAT	AESA Pesticides hazard, safe use of pesticides, Pest defender identification.
9	77 DAT	AESA, NE and their efficacy in Rice Ecosystem. Discussion on new generation pesticides especially to the Rice eco-system.
10	84 DAT	AESA (Compilation and decision making), PAR (compilation and conclusion), post evaluation, farmers feed back on IPM, and closing.

Abbr – ICM-integrated crop management, INM-integrated nutrient management, AESA-Agro eco-system analysis, PAR-participatory action research, IDM-Integrated Disease Management YSB-yellow stem borer. PPI-panicle primordial initiation. DAT-Days After Transplanting.

LESSON PLAN FOR VEGETABLE IPM IN FFS

PERIOD	CROP STAGE	ACTIVITIES
One or two days	Pre-sowing	- Selection of village and farmers. - Farmers meeting to explain FFS programme. - Bench mark survey.
Week – I	Germination	- Registration - Introduction - Group formation - Leader Selection - Pre-evaluation test (Ballot box) - Seed germination test - Nursery bed preparation - Group Dynamics “Numbering”
Week – II	Seedling/Sowing	- Seed treatment test with imidachloprid - Collection of vegetable field fauna & flora - Sorting and identification - G.D. “Message relay”
Week – III	Seedling/ Vegetative stage	- Sampling technique and introductions to AESA - Bio-ecology of major pest - Proper application of manures & fertilizers - G.D. “Water brigade”
Week – IV	Transplanting/ Vegetative	- AESA - Identification of Disease and its management - Insect zoo - G.D. “IPM rain”
Week – V	Vegetative	- AESA - Bio-ecology of major pest - Predation experiments - Installation of pheromone traps - IPM approaches for major pest - G.D. “Land distribution”
Week – VI	Vegetative/ Flowering	- AESA - Parasitism study on eggs and larvae of <i>Helicoverpa</i> - Installation of yellow sticky traps - Pesticide poisoning on natural enemies. - G.D. “Tower Building”

PERIOD	CROP STAGE	ACTIVITIES
Week – VII	Flowering/ Fruiting	- AESA - Spraying of NSKE and its comparative study with non sprayed field - Preparation of NPV at village level - G.D. :IPM line”
Week – VIII	Flowering/ Fruiting	- AESA in NSKE sprayed & unsprayed fields - Rat population growth and its management - Bio-ecology of major pest - G.D. “Word answering”
Week – IX	Fruiting	- AESA - IPM approaches for major pest - Nematode problem and its management - Farmers presentation - G.D. “Weight distribution”
Week – X	Fruiting	- Farmers presentation - Yield comparison between IPM and Non IPM fields - Post evaluation Test (Ballot box) - Discussion on Pest harvest technology with special reference to Tomato
Field day		- Interaction of IPM and Non-IPM farmers in IPM stall - Certificate distribution

Note: The week wise crop stage may vary from crop to crop and variety to variety.

AVAILABLE BIOPESTICIDES AND ITS USE IN AGRICULTURE

1. *Trichoderma* spp. :

Trichoderma spp. Viz. *Trichoderma viride*, *T. harzia-num*, *T. Koningii*, *T. Hamatum*, etc. have been in use to produce various biopesticides under different trade or commercial names. It is highly active on root rot, foot rot, Collar rot, stem rot, damping off, wilt, blight/ leaf spot, downy and powdery mildews of pulses, oilseeds, cucurbitaceous crops like cucumber, pumpkin, bottle gourds; ridgegourd, solanaceous crops like tomato, brinjal, chillies, capsicum; cole crops such as cabbage, cauliflower; root crops diseases like tuber, rhizome rot of potato, ginger, turmeric alongwith rotting diseases of garlic, flowers etc. The product is also effective against sheath rot, sheath blight and bacterial leaf blight (BLB) of paddy.

Treatments :

A. Seed treatment :

Dose : 5g / kg of seed or as prescribed on container.

Method : Make a paste or slurry adding 5 gm in 10-20 ml of water or rice gruel. Pour 1 kg. of seed in – to the paste or slurry and mix properly to coat the seeds uniformly. Shade dry the coated seeds for 20-30 minutes before sowing.

B. Tuber / Rhizome Sett treatment :

Dose : As prescribed in the treatment/Recommendation manual.

Method : Dip the tubers / rhizomes / setts in the suspension prepared @ 10 gm./litre of water, shade dry for 15 min. before planting.

C. Seedling treatment :

Dose : 300 gm to treat seedling roots to cover 1 bigha.

Method : Prepare a suspension @ 5-10 gm/litre of water. Dip the roots of seedlings for 15 minutes and shade dry for 15 minutes before transplanting.

D. Nursery bed treatment :

Dose : 250 gm for 400 sq.m. nursery bed.

Method : i. Prepare a suspension by adding 250 gm in 50 litres of water and drench the nursery bed soil.

ii. Mix 250 gm in 2 kg. cowdung /Compost /FYM and spread over 400 sq.m. nursery bed and irrigate the bed.

E. Soil treatment :

a) Direct broadcasting :

Dose : 300 gm for 1 bigha of land..

Method : Mix 300 gm. in 6 kg. of FYM. Broadcast in 1 bigha of land irrigate the field.

b) Awaited broadcasting:

Dose : 30 gm for 1 bigha of land.

Method : Mix 30 gm. in 6 kg. of FYM. Cover the mixture with polythene sheets for 7-15 days and broadcast in the field.

c) Furrow application :

Dose : Any one of E (a) or E (b) as above.

Method : It is highly effective in root crops like potato, ginger turmeric etc. and sugarcane. The mixture is applied in furrows at the time of earthing up or after 30 days of planting.

F. Foliar application :

Dose : 500 gm./ Bigha

Method : Make a paste by adding 10 gm. in 15 ml water and then add the paste to 1.5 litre of water. Mix properly before spraying on the plant pasts.

2. *Bacillus thuringiensis Serover Kurstaki* :

The bio-pesticide produced from *B. thuringiensis* is highly active on Dimond back moth of cabbage, army worm and selilooper of cole crops. Pod borer of Bengal gram, fruit borer to tomato, shoot and fruit borer of brinjal, bhindi, red hairy caterpillar and prodenia (*Spodoptera* spp.) of groundnut, lemon butterfly, etc.

Treatment :

Dose : a) 100 – 150 gm./Bigha for field crops.

b) 150 – 200 gm./Bigha for a orchard.

Method : The powder is first mixed with small quantity of water to prepare a uniform suspension. Then the required quantity of water is added and thoroughly mixed before spraying.

N.B. : If the plants to be sprayed have waxy coating, a sticker or surfactant should be used in the suspension. The crop like cabbage, cauliflower contain waxy coating on leaves.

3. Nuclear polyhedrosis virus (NPV) :

i. NPV (*Helicoverpa*) : It is highly active on *Helicoverpa armigera* pest of cotton, gram, pea, pigeon pea, tomato, cabbage, groundnut, millets, oilseeds and roses.

ii. NPV (Spodoptera) : The biopesticide prepared from this bioagent is highly effective against Spodoptera litura caterpillar pest of cotton, gram, pigeon pea, cabbage, tomato, chillies, cabbage, tobacco, oil seed crops.

Treatments :

Dose : 250 – 500 ml / ha.

Method : i. Shake the bottle properly and prepare a solution @ 1 ml. /litre of water.

ii. Spray the solution 2-3 times at 10-15 days intervals.

iii. Spray preferably in the evening and on young larval stages or on sighting of eggs laying.

4. Beauveria bassiana :

This bio-pesticide is prepared from entomopathogenic fungus B. bassiana that infects insect pests. It is most effective against lepidopteran caterpillar pests of vegetables and fruits plants and sucking pests like mites and spider of vegetables and flowers, borer, white flies on cotton and vegetables, aphids, scale insects, Colorado beetle of potato, B. bassiana is also highly effective against Rice Hispa.

Treatments :

a. Foliar spray :

Dose : 400-500 gm. in 1 bigha.

Method: Mix 5 gm. in 1 litre of water and spray and spray on the plant parts.

b. For Soil drench :

Dose : 250-500 gm / 3 bighas or as prescribed in the container.

5. Neem based pesticides (Azadiractin 0.15% EC)

This insecticide acts as excellent broad spectrum control of aphids, jassids, white flies, beetles, caterpillars, cutworms on vegetables, pulses, oilseed crops, fruits trees, sugarcane. It acts on insects through multiple actions as repellent, antifeedant, insect growth regulator and oviposition treatment.

Treatments :

Dose : 1 litre / ha.

Method : a. Prepare a solution @ 3-5 ml. / litre of water and spray at the time of hatching eggs and young stages of pests.

b. Repeat in spray at 15 days intervals based on population.

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