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.

Place: Guwahati
Date: 27/02/2004

(Dr. M.M. Kalita)
Director of Agriculture, Assam.

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.

N. N. Barpujari
Jt. Director of Agriculture (PP)
Assam, Khanapara, Ghy – 22
IPM PACKAGE FOR RICE

I. Major Pests

A. Pest of National Significance :

1. Insect Pests :
   1.1. Yellow stem borer (Scirpophago 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 meltada)
   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 stem borer – 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.

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 :

<table>
<thead>
<tr>
<th>Local Name</th>
<th>Cynodon dactylon</th>
<th>Digitaria setigera</th>
<th>Paspalum conjugatum</th>
<th>Eleusine indica</th>
<th>Mimosa pudica</th>
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<td></td>
<td>Dubori</td>
<td>Sirabon</td>
<td>Lokosha-bon</td>
<td>Bodosa-bon</td>
<td>Nilajibon</td>
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</table>
3.2 Transplanted rice:

<table>
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<tr>
<th>Local Name</th>
<th>Species Name</th>
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<tr>
<td>Murphula-bon</td>
<td>Cyperus iria</td>
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<td>Bhat-meteka</td>
<td>Monochoria vaginalis</td>
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<td>Junga-bon</td>
<td>Scirpus juncoides</td>
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<td>Dol</td>
<td>Sacciolepis interrupta</td>
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<td>Kona-simolu</td>
<td>Commelina diffusa</td>
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<td>Lokosha-bon</td>
<td>Rottboellia Cochinchinensis</td>
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<td>Kododhan</td>
<td>Paspalum scrobiculatum</td>
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<td>Pani-tengeshi</td>
<td>Marsilea minuta</td>
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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 along with diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant if the attribute is sunny. If cloudy, the clouds may be drawn in place of sun. In 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 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 greater 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 observed.

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):

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

#### C. Mid tillering :

1. Leaf folder 1-2 freshly damaged leaves/ hill
2. Stem borer 5% dead hearts or 1 egg mass or 1 adult / sq.m.
3. Gall midge 5% silver shoot
5. Green leafhopper 10-20 insects/ hill (2 insects/ hill in RTD endemic areas)
6. Hispa 1 adults or 1-2 damaged leaves/ hill.
7. Blast Light (5-10% disease severity)
8. Bacterial leaf blight Light (2 to 5% disease severity)
9. Sheath blight 5% or more affected tillers
10. Tungro 1 affected hill/ sq.m.

#### D. Panicle initiation to booting :

1. Stem borer 1 egg mass/ moth/ sq.m.
2. Leaf folder 1-2 freshly damaged leaves/ hill
3. Green leafhopper 20 insects/ hill
5. White backed planthopper 5 - 10 insects/ hill
6. Blast 2-5% leaf area damage
7. Bacterial leaf blight Light to Moderate (2-5% disease severity)
8. Sheath blight 5% or more tillers affected

#### E. Flowering and after :

2. Climbing cutworm 4-5 leaves/ sq.m.
3. Gundhi bug 1 or 2 bugs/ hill
4. Blast 5% leaf area damaged or 1 to 2% neck blast
5. Sheath rot/ brown spot 2-5% tillers affected
6. Sheath blight 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 seeding 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 twings 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 1/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*
cruisgalli, 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 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 practices wherever possible to destroy perennial weed vegetation.

c. Stale seed bed should be prepared wherever possible and pudding 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 weeds after transplanting in case where mechanical methods are to be used.

h. One hand weeding may be given 4-6 weeds 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 (*Aphelenchides bessyri*)
   1.1 Hot water treatment of seed at 52°C for 10 minutes after a pre-soak 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 (*Hirschmannidla aryzae*)
   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 @ 33 kg./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.
   3.2 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, Cow pea, Sesamum, 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, TMK 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* (*Elencine 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:**

<table>
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<tr>
<th>Variety</th>
<th>SB</th>
<th>GM</th>
<th>Blast</th>
<th>BLB</th>
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<tr>
<td>Ketaki</td>
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<td>MR</td>
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** Variety | SB | GM | Blast | BLB | SLB | Ufra |
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<td>Pankaj</td>
<td>MR</td>
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<td>R</td>
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<td>Joymati</td>
<td>MR</td>
<td>MR</td>
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<td>Brazil 65</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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**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 chlorpyriphos (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:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Crop stage &amp; Pest</th>
<th>ETL (Technical name)</th>
<th>Insecticide (Technical name)</th>
<th>Dose</th>
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<td>1</td>
<td>A. Nursery</td>
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<tr>
<td>1</td>
<td>Thrips</td>
<td>At the appearance of damage symptom (curling and yellowing to reddish discoloration)</td>
<td>Quinalphos 25 EC</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Monocrotophos 40 EC</td>
<td>1.2 ml</td>
</tr>
<tr>
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<td></td>
<td>Chlorpyrophos 25 EC</td>
<td>2.5 ml</td>
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<td></td>
<td>Fenitrothion 50 EC</td>
<td>1 ml</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Phosalone 35 EC</td>
<td>1.4 ml</td>
</tr>
<tr>
<td>2</td>
<td>Green leaf hopper</td>
<td>1-2 insects/sqm in RTD endemic area</td>
<td>Monocrotophos 40 EC</td>
<td>1.2 ml</td>
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<tr>
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<td>Chlorpyrophos 20 EC</td>
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<td></td>
<td>Dimethoate 30 EC</td>
<td>1.6 ml</td>
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<td>Quinalphos 25 EC</td>
<td>2 ml</td>
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<td></td>
<td>Phosalone 35 EC</td>
<td>1.4 ml</td>
</tr>
<tr>
<td>3</td>
<td>Gallmidge</td>
<td>1 silver shoot/sqm</td>
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<td></td>
<td>Monocrotophos 40 EC</td>
<td>12 ml</td>
</tr>
<tr>
<td>4</td>
<td>Stemborer</td>
<td>1 moth or 1 egg mass/sqm</td>
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<td></td>
<td>Monocrotophos 40 EC</td>
<td>12 ml</td>
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<tr>
<td>5</td>
<td>Blast</td>
<td>Endemic</td>
<td>Adopt seed dressing With tricyclazole 75 WP or pyroquilon 50 WP</td>
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<td>Carbendazim 50 WP</td>
<td>1g</td>
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<td></td>
<td>ediphenphos 50 EC</td>
<td>1 ml</td>
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<td>Tricyclazole 75 WP</td>
<td>0.6 gm</td>
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<tr>
<td>B</td>
<td>Planting to pre-tillerin</td>
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<tr>
<td>1</td>
<td>Whorl maggot</td>
<td>20% of damaged hill</td>
<td>Carbofuran 3 G</td>
<td>30Kg/ha</td>
</tr>
<tr>
<td></td>
<td></td>
<td>upto 30 DAT</td>
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<td>25 ml</td>
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<td>2</td>
<td>Case worm</td>
<td>1-2 barrel cases/hill</td>
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<td>Monocrotophos 40 EC</td>
<td>12 ml</td>
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<td>3</td>
<td>Leaf folder</td>
<td>1-2 freshly damaged leaves / hill</td>
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<td></td>
<td>Monocrotophos 40 EC</td>
<td>12 ml</td>
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<td></td>
<td>Dimethoate 30 EC</td>
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<tr>
<td>4</td>
<td>Green leaf hopper (GLH)</td>
<td>10 or more insects/hill</td>
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<td></td>
<td>Chlorpyrophos 20 EC</td>
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<td>Quinalphos 25 EC</td>
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<td>Dimethoate 30 EC</td>
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<td>White backed plant hopper (WBPH)</td>
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<td>Dimethoate 30 EC</td>
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<td></td>
<td>Chlorpyrophos 20 EC</td>
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<td></td>
<td>Dimethoate 30 EC</td>
<td>1.6 ml</td>
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<td></td>
<td>Phosalone 35 EC</td>
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<td>7</td>
<td>Stem borer</td>
<td>1 egg mass or 1 moth/sqm or 5% dead hearts</td>
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<td>Carboufur 3 G</td>
<td>30Kg/ha</td>
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<td>8</td>
<td>Rice hispa</td>
<td>2 adults or 2 damaged leaves/hill</td>
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<td>Monocrotophos 40 EC</td>
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<td>Quinalphos 25 EC</td>
<td>2 ml</td>
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<td></td>
<td>Carboufur 3 G</td>
<td>30Kg/ha</td>
</tr>
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<td>9</td>
<td>Gall midge</td>
<td>1 gall/sqm in case of endemic area or 5% silver shoot in non-endemic area</td>
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<td>1.2 ml</td>
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<td></td>
<td>Carboufur 3 G</td>
<td>30Kg/ha</td>
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<td>Phorate 10 G</td>
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<td>Monocrotophos 40 EC</td>
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<td>Dichlorvors 70 EC</td>
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<td>Monocrotophos 40 EC</td>
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<td>Ediphenphos 50 EC</td>
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<td></td>
<td>Tricyclazole 75 WP</td>
<td>0.6 gm</td>
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<td>12</td>
<td>Bacterial leaf blight</td>
<td>2-5% disease severeity</td>
<td>Skip top dressing of N fertilizer when infection is seen</td>
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<tr>
<td><strong>13</strong></td>
<td>Sheath blight</td>
<td>5% affected tiller/sqm</td>
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<tr>
<td></td>
<td>Carbendazim 50 WP</td>
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<td>Mancozeb 45 WP</td>
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<td>Contaf 50 EC</td>
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<tr>
<td><strong>C</strong></td>
<td>Mid tillering</td>
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<tr>
<td><strong>1</strong></td>
<td>Rice hispa</td>
<td>2 adults or 2 damaged leaves/hill</td>
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<td></td>
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<tr>
<td></td>
<td>Chlorpyriphos 20 EC</td>
<td>2.5ml</td>
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<td></td>
<td>Monocrotophos 40 EC</td>
<td>1.2ml</td>
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<tr>
<td></td>
<td>Phosalone 35 EC</td>
<td>1.4ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quinalphos 25 EC</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Carbofuran 3 G</td>
<td>1.2 ml</td>
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<tr>
<td><strong>2</strong></td>
<td>Leaf folder</td>
<td>1-2 freshly damaged leaves /hill</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quinalphos 25 EC</td>
<td>2 ml</td>
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<tr>
<td></td>
<td>Monocrotophos 40 EC</td>
<td>1.2ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorpyriphos 20 EC</td>
<td>2.5ml</td>
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<td></td>
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<tr>
<td></td>
<td>Fenitrothion 50 EC</td>
<td>1 ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dimethoate 30 EC</td>
<td>1 ml</td>
<td></td>
<td></td>
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<tr>
<td><strong>3</strong></td>
<td>Green leaf hopper (GLH)</td>
<td>10 or more insects/hill or 2 insects/hill in RTV endemic areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monocrotophos 40 EC</td>
<td>1.2ml</td>
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<tr>
<td></td>
<td>Chlorpyriphos 20 EC</td>
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<td></td>
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<tr>
<td></td>
<td>Phosalone 35 EC</td>
<td>1.4ml</td>
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<td><strong>4</strong></td>
<td>Brown plant hopper</td>
<td>As mentioned under 'B' planting to pre tillering.</td>
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<tr>
<td><strong>5</strong></td>
<td>White backed planthopper</td>
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</tr>
<tr>
<td><strong>6</strong></td>
<td>Stem borer</td>
<td></td>
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</tr>
<tr>
<td><strong>7</strong></td>
<td>Gallmidge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>Blast</td>
<td>5-10% disease severity</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>As mentioned under 'B'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>9</strong></td>
<td>Bacterial leaf blight</td>
<td>2-5% disease severity</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Stop top dressing of nitrogenous fertilizer</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>10</strong></td>
<td>Sheath blight</td>
<td>5% more affected tillers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>As mentioned under 'B'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>Tungro</td>
<td>One affected hill/sqm</td>
<td></td>
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<tr>
<td></td>
<td>Remove and destroy affected plants and apply additional nitrogen for early recovery. Apply carbofuran granules @ 1 kg a.i/ha or spray monocrotophos 40 EC 1.2 ml/lit of water</td>
<td></td>
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</tr>
</tbody>
</table>

**D** Panicle initiation to booting stage

| **1** | Stem borer | 1 egg mass/sqm |
| **2** | Leaf folder | 1-2 freshly damaged leaves/hill |
| **3** | Brown plant hopper | 5-10 insects/hill |
| **4** | Climbing cutworm | 1 larvae/hill |
| **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 |
| **8** | Brown spot | 2-5% tillers affected |
| **9** | Sheath blight | 5% of more tillers affected |

---

**Notes:**
- **Carbendazim 50 WP**: 1g
- **Mancozeb 45 WP**: 2.5 g
- **Contaf 50 EC**: 2 ml
- **Chlorpyriphos 20 EC**: 2.5ml
- **Monocrotophos 40 EC**: 1.2ml
- **Phosalone 35 EC**: 1.4ml
- **Quinalphos 25 EC**: 2 ml
- **Carbofuran 3 G**: 1.2 ml
- **Fenitrothion 50 EC**: 1 ml
- **Dimethoate 30 EC**: 1 ml
- **Monocrotophos 40 EC**: 1.2ml
- **Chlorpyriphos 20 EC**: 2.5ml
- **Dimethoate 30 EC**: 1.6 ml
- **Phosalone 35 EC**: 1.4 ml
- **Malathion 5% dust**: @ 20 kg/ha or endosulfan 4% dust @ 25 kg/ha
- **Carbofuran granules**: @ 1 kg a.i/ha
- **Monocrotophos 40 EC**: 1.2 ml/lit of water
## A. Pests of Major Importance:

### 1. Diseases:

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

### 2. Nematodes:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Ear cockle (seed</td>
<td>Major problem in NWPZ, low to moderate in parts of NWPZ (Northern Rajasthan)</td>
</tr>
<tr>
<td>gall nematode)</td>
<td></td>
</tr>
<tr>
<td>2.2 Tundu disease</td>
<td>Western &amp; Southern Haryana.</td>
</tr>
<tr>
<td>2.3 Cereal cyst</td>
<td>Moderate to high in drier areas of NWPZ (Northern Rajasthan and Haryana)</td>
</tr>
<tr>
<td>nematode</td>
<td></td>
</tr>
</tbody>
</table>

### 3. Insect Pests:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Termites</td>
<td>Major problem in dry areas of the wheat growing zones.</td>
</tr>
<tr>
<td>3.2 Aphids (Newly</td>
<td>Major problem in most of the wheat growing areas.</td>
</tr>
<tr>
<td>emerging problem)</td>
<td></td>
</tr>
<tr>
<td>3.3 American pod borer</td>
<td>Mostly low; sometimes moderate (especially under cotton-wheat &amp; Rice-wheat rotations).</td>
</tr>
<tr>
<td>3.4 Armyworm/Rice</td>
<td>NWPZ, NEPZ and CZ, especially in late sown crops.</td>
</tr>
<tr>
<td>caterpillar</td>
<td></td>
</tr>
<tr>
<td>3.5 Brown mite</td>
<td>Normally low in NWPZ, CZ, NEPZ but rarely moderate to high in dry winter in isolated</td>
</tr>
<tr>
<td></td>
<td>pockets.</td>
</tr>
<tr>
<td>3.6 Shoot fly</td>
<td>Low in part of NWPZ.</td>
</tr>
<tr>
<td>3.7 Root aphid</td>
<td>Low to moderate in parts of CZ (Central MP)</td>
</tr>
<tr>
<td>3.8 Pink borer</td>
<td>Low in parts of NWPZ, CZ and NEPZ.</td>
</tr>
</tbody>
</table>

### 4. Rodents:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Smaller Bandicoot</td>
<td>Throughout wheat growing areas.</td>
</tr>
<tr>
<td>4.2 Soft furred field</td>
<td>NWPZ, CZ.</td>
</tr>
<tr>
<td>rat</td>
<td></td>
</tr>
<tr>
<td>4.3 Indian gerbil</td>
<td></td>
</tr>
</tbody>
</table>

### 5. Major weeds:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Lamb square</td>
<td>NWPZ, NEPZ &amp; CZ</td>
</tr>
<tr>
<td>Pimpernel</td>
<td></td>
</tr>
<tr>
<td>Fumitory</td>
<td></td>
</tr>
<tr>
<td>Lathyrus</td>
<td></td>
</tr>
<tr>
<td>Medic</td>
<td></td>
</tr>
<tr>
<td>Cluster weed</td>
<td></td>
</tr>
<tr>
<td>Corn spurry</td>
<td></td>
</tr>
<tr>
<td>Sweet clover</td>
<td></td>
</tr>
</tbody>
</table>
5.2 Grassy weeds

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canary grass* wild oat</td>
<td>*Major problem in NWPZ and NEPZ (especially in rice-wheat rotation). Absent or rare in CZ and PZ.</td>
</tr>
</tbody>
</table>

Darnel

Blue grass

Rabbit foot grass

B. Pests of regional significance:

1. Inset Pests:

   1.1. Wheat aphid *Sitobion miscanthi*
   1.2. Pink borer *Sesamia inferens*
   1.3. Tarmite *Mirottermes obesi, Odontotermes obesus*
   1.4. Army Worm *Mythimna separata*
   1.5. Thrips *Anaphothrips favicinctus*
   1.6. Cut worm *Agrotis ipsilon*
   1.7. Ear head cutipillar *Helicoverpa armigera*
   1.8. Cricket *Brachytres achatinus*

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. *Cyperus rotundus*
   3.2. *Digitaria sanquinalis*
   3.3. *Cyperus iria*
   3.4. *Cynodon dactylon*
   3.5. *Chenpodium album*
   3.6. *Polygonum brubatum*
   3.7. *Amaranthus viridis*
   3.8. *Polygonum visosum*

4. Rodents:

   4.1. Lesser bandicoot *Bandicota bangalensis*

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, crinking 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 data 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 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 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 (Helicothis) 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.
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 termitaria (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 height to attract insectivorous birds like swallow, Mayana, rodenticorous 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/arbendazim @ 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
   Oxynemeton 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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop Stage/pest</th>
<th>IPM Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Presowing</td>
<td>i) Deep summer ploughing in May-June to expose soil borne diseases and nematodes to solar radiation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) Apply well rotten farm yard manure only.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii) Avoid late sowing of crop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>2.</td>
<td>Seed</td>
<td>i) Treat the seed with chlorpyriphos @ 4 ml/kg seed or endosulfan @ 7 ml/kg seed before sowing to control termite damage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) Observe the damage by root aphid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>3.</td>
<td>Seedling stage</td>
<td>i) If termite damage is notices at seedling stage, apply treated soil by broadcasting @ 175 gm/a.l/ha of endosulfan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) Observe the damage by root aphid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>4.</td>
<td>Vegetative stage</td>
<td>i) Erect bird perches for insectiveorous &amp; rodenticorous birds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) For army worm and pink borer control apply the recommended nematodes in the evening hours.</td>
</tr>
<tr>
<td>5.</td>
<td>Ear head stage</td>
<td>i) To control aphids use the above mentioned pesticides.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) For army worm and ear head caterpillar, spray, Endosulfan 1 ml/lit or dichlorvos 1 ml/lit or fenrothion 2 ml/lit.</td>
</tr>
</tbody>
</table>

Note 1. Insecticide should only be sprayed when pest population attain economic threshold level.
VI. Do’s and Don’ts:

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

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 (Phyllooctreta cruciferage)
      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)
   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.

<table>
<thead>
<tr>
<th>Pest</th>
<th>ETL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mustard aphid</td>
<td>a) 30-40 aphids/10cm of terminal shoot</td>
</tr>
<tr>
<td></td>
<td>or</td>
</tr>
<tr>
<td></td>
<td>17-28% plants infested</td>
</tr>
</tbody>
</table>

III. IPM Strategies:

A. Cultural Practices:
   1. Deep ploughing soon after harvest, wherever possible.
   2. Destruction of debrises of previous crop.
   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 (gragarious 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:

Conservate the natural bio-control agents viz. cocoinclids, 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:

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

★ 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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop Stage/Pest</th>
<th>IPM Component</th>
<th>IPM Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pre-sowing</td>
<td>Cultural Practice</td>
<td>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 disease.</td>
</tr>
<tr>
<td></td>
<td>mustard-aphid disease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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4. Flowering stage

<table>
<thead>
<tr>
<th>Aphid</th>
<th>Mechanical</th>
<th>Removal of aphid infested twigs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>Strip application of insecticide in the afternoon with oxydemeton methyl 0.025% or phosphamidon 0.025% or dime thote 0.03% or monocrotophos 0.036% or quinolphos 0.025%.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hairy caterpillar</th>
<th>Mechanical</th>
<th>Collection and destruction of egg masses and larvae.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>As against aphid.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cabbage caterpillar</th>
<th>Mechanical</th>
<th>Collection and destruction of larvae (gregarious stages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-control</td>
<td>Erection of short bamboo tops as perches for predatory birds.</td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>As against sawfly.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternaria Blight</th>
<th>Chemical Practice</th>
<th>Spray the crop with Manozeb 75% w.p.@ 2 gm/lit of water.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White rust</td>
<td>Chemical</td>
<td>-do-</td>
</tr>
<tr>
<td>Downy mildew</td>
<td>Chemical</td>
<td>-do-</td>
</tr>
</tbody>
</table>

5. Pod formation stage

<table>
<thead>
<tr>
<th>Aphid</th>
<th>Chemical</th>
<th>As in flowering stage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamond back moth</td>
<td>Chemical</td>
<td>As against aphid.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Painted bug</th>
<th>Cultural</th>
<th>Irrigate the crop at early pod formation stage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>As against aphid.</td>
<td></td>
</tr>
</tbody>
</table>

| 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 crops. However mustard is an 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 possess 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) bettles with 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 predeceous. 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 pests, 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 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

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

IPM Package for Blackgram/Greengram

1. Major Pests:

A. Pests of national significance:
   1.1. White fly - Bemisia tabaci
   1.2. Hairy caterpillar - Spilosoma oblique Amsata moorie
   1.3. Stemfly - Ophiomyia 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
   Fimbrystylis littoralis
   Amaranthus viridis
   Ageratum houstonianum
   Spilonthes poniculata
   Echinocola 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 vulgaris
   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 cneju
   1.7. Red spider mite - Tetranhythys sp.
   1.8. Leaf weevil - Mylocerus 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 up to 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:

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

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 biplagiata, Micraspis discolor, Menochilus sexmanculus, 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.
5.4. Flea beetle 3.5 adults/10 plants in summer black gram crop.

IV. Crop Stage-wise IPM Package :

<table>
<thead>
<tr>
<th>Pre-sowing stage</th>
<th>Cultural practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep ploughing of the field and removal of debris/stubbles etc.</td>
<td></td>
</tr>
<tr>
<td>Early sowing (Preferably in the 2nd fortnight of February for summer crop and in the 2nd fortnight of August for the Kharif crop)</td>
<td></td>
</tr>
<tr>
<td>Growing resistant/tolerant varieties as recommended.</td>
<td></td>
</tr>
<tr>
<td>Pod-bug (R. linearis)</td>
<td></td>
</tr>
<tr>
<td>Moong bean – T – 44, ML-131</td>
<td></td>
</tr>
<tr>
<td>Leaf folder (N. vulgaris)</td>
<td></td>
</tr>
<tr>
<td>Moong bean – Kopergoaon, PMB-14</td>
<td></td>
</tr>
<tr>
<td>Aphid (A. cracivora)</td>
<td></td>
</tr>
<tr>
<td>Moong bean – Kopergoaon, PMB-14, ML-729</td>
<td></td>
</tr>
<tr>
<td>Yellow mosaic virus (YMV)</td>
<td></td>
</tr>
<tr>
<td>Moong bean (Summer): K-851, ML-56, PIMS-1, ML-131</td>
<td></td>
</tr>
<tr>
<td>Urd bean (Summer): T-9, Part U 19, UG-157, JU-78</td>
<td></td>
</tr>
<tr>
<td>Urd bean (Kharif): 7-9, T-27, Pant. U. – 19</td>
<td></td>
</tr>
<tr>
<td>Cercospora leaf spot</td>
<td></td>
</tr>
<tr>
<td>Seed &amp; Seedling Cultural practices</td>
<td>Chemical Practices (for leaf folder, flea beetle, jassid, stem fly, white fly)</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>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.</td>
<td>4. Soil application of Phorate 10 G or Carbofuran 3G @ 0.5 kg a.i./ha in summer as well as Kharif crops.</td>
</tr>
<tr>
<td>2. Interculture and hand weeding to keep the crop weed free up to the 5th 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.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vegetative stage Mechanical Practices</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hairy caterpillars lay eggs in masses and first/second instar larvae remain congested on one or two leaves. Such leaves can be easily spotted, collected and destroyed.</td>
<td></td>
</tr>
<tr>
<td>2. Light traps are very effective against hairy caterpillar.</td>
<td></td>
</tr>
<tr>
<td>3. Aphid infested apical plant part should be lipped and destroyed in the initial stages of attack.</td>
<td></td>
</tr>
</tbody>
</table>

| 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 endosulfan 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 sulphur (sulphex/thisvit) 0.2% (1-1.4 kg/ha in 500-700 lit 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 pod borer (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 dracahalari var. cajani)

3. Weeds
   3.1. Cyperus rotundus
   3.2. Digitaria sanguinalis
   3.3. Setaria glaucae
   3.4. Cleome viscoso
   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, Heteroderca 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

II. Pest Monitoring:

1. Rapid Roving Survey:
   Survey teams should undertake regular insect 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 pheromone 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 larva/plant at flowering stage (for North Zone of India)
2. For spotted pod borer: 1 larva/plant
   *(M. testulalis)*
   Or
   1 webbed inflorescence/plant
3. For Negro bug: 5-6 bugs/plant
   *(M. cribarium)*

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 inset 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. cribarium*), 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. Instal 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/1lit 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 prepn., 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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop stage/pests</th>
<th>IPM Practice</th>
<th>Particulars</th>
</tr>
</thead>
</table>
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 H. armigera.  
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 H. armigera.  
7. Planting tall maize varieties on borders for conserving natural enemies. These plants also function as live perches for predatory birds.  
8. Planting short statured crops like cowpea, mung, bean, urdbeam, 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 rops before flowering of pigeonpea. |
| 2.      | Seed & Seedlings (H. armigera Phytophthora blight, wilt) | Cultural Practice | 1. Growing trap crop like marigold on the borders and in between rows as intercrop. Their flowers shall attract oviposition which an then be plucked and disposed. Ridge Planting+cover crops like soy-beans or cowpea in NEPZ.  
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. |
<table>
<thead>
<tr>
<th>Stage</th>
<th>Practice</th>
<th>Treatment/Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetative stage</td>
<td>Cultural</td>
<td>1. Interculture and hand weeding for keeping the crop, weed free for 6-8 weeks.</td>
</tr>
<tr>
<td>(Weeds)</td>
<td>Biological</td>
<td>2. Conservation of predatory birds, spiders and insects; and insect parasitoids by avoiding indiscriminate use of insecticides. Installation of bird perches for predatory birds.</td>
</tr>
<tr>
<td>All pests</td>
<td>Biological</td>
<td>2. Conservation of predatory birds, spiders and insects; and insect parasitoids by avoiding indiscriminate use of insecticides. Installation of bird perches for predatory birds.</td>
</tr>
<tr>
<td>Pre-flowering &amp; Flowering stage</td>
<td>Mechanical</td>
<td>1. Hand picking and jarring on cloth sheet or in bags is effective in a limited way in small areas.</td>
</tr>
<tr>
<td></td>
<td>Biological</td>
<td>2. Conservation of predatory birds, spiders and insects; and insect parasitoids by avoiding indiscriminate use of insecticides.</td>
</tr>
<tr>
<td></td>
<td>Mechanical</td>
<td>3. Installation of bird perches for predatory birds.</td>
</tr>
<tr>
<td></td>
<td>Chemical</td>
<td>4. Spraying of 0.1% malathion 50 EC (2ml/lit) or 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.</td>
</tr>
</tbody>
</table>
|                     | Chemical | 5. Pod stage: (Pod borers, other lepidopterous pests, dipterous, Coleopterous and hemipterous pests)  
|                     | Mechanical | 5. Pod stage: (Pod borers, other lepidopterous pests, dipterous, Coleopterous and hemipterous pests)  
|                     | Mechanical | 6. After harvest  
|                     | Chemical | 6. After harvest |

**ANNEXURE – II**

### Resistant varieties of pigeon pea

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variety (s)</th>
<th>Area</th>
</tr>
</thead>
</table>
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. Crowfoot 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 houstonianum
      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 lose 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 :
III. Economic Threshold Level (EYL):
i) Leaf roller and Hairy caterpillar - 1 to 2 larva per plant
ti) Gallfly - 2 to 5 galls per plant or 10 percent damage.
ii) 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.

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

★ 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 hawh moth, leaf webber/capsule borer and hairy caterpillar.
ii) Use light traps against Lepidopteran pests.
iii) Uproot the phyldody 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 Dichlovos 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 streptocycline 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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop stage/pest</th>
<th>IPM Package</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PRESOWING</td>
<td>Cultural Practices</td>
<td>Deep ploughing to reduce the population of insect pests and nematodes. Synchronized sowing. Timely sowing and proper seed rate (5 kg of seed per ha) Grow resistant/tolerant varieties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seedling blight</td>
<td>Dry root rot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alternaria leaf spot</td>
<td>Bio-controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacterial blight</td>
<td>Use bio-fertilizers Azoepirallum and Phospho-bacteria as recommended.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacterial leaf spot</td>
<td>Chemical Practice</td>
</tr>
</tbody>
</table>
2. SEEDLING Mechanical and Chemical Practices
Seed treatment with 2-2.25 gm/kg seed of Agrimycin or Streptocycline.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry root rot</td>
<td>Foliar spray with Mancozeb 1.125-1.5 kg. a.i./ha. a.i. 750 l water.</td>
</tr>
<tr>
<td>Phytophthora blight</td>
<td>Rogue out disease infected plants.</td>
</tr>
</tbody>
</table>

3. VEGETATIVE

<table>
<thead>
<tr>
<th>Pests</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawk moth hairy caterpillar</td>
<td>Collection and destruction of larvae of hawk moth, hairy caterpillar (gregarious instars).</td>
</tr>
<tr>
<td>Leaf webber &amp; hairy caterpillar</td>
<td>Spray moncrotophos 45 E @ 1 ml./lit. or dichlorvos 100 EC @ 0.5 ml./lit. or nemazal 5% @ 3 lit./ha. mixed with 600 lit water.</td>
</tr>
</tbody>
</table>

4. Flowering stage hawk moth hairy caterpillar

<table>
<thead>
<tr>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection and destruction of larvae of hawk moth and hairy caterpillar (gregarious instars).</td>
</tr>
</tbody>
</table>

5. Pod formation and maturity pod caterpillars (Capsule borers)

<table>
<thead>
<tr>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pluck and destroy the bored capsules.</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>DO’s</th>
<th>Sl. No.</th>
<th>DON’T’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Grow only resistant/tolerant varieties</td>
<td>1.</td>
<td>Discourage susceptible varieties.</td>
</tr>
<tr>
<td>3.</td>
<td>Adopt crop rotation.</td>
<td>3.</td>
<td>Avoid monocropping.</td>
</tr>
<tr>
<td>4.</td>
<td>Use organic manure, FYM &amp; neem cake and bio-fertilizers as per recommended dose.</td>
<td>4.</td>
<td>Restrict Insecticide spray period to protect pollination.</td>
</tr>
</tbody>
</table>
A. Pest of National Significance

1. Insect Pest
   1.1 Aphids
   1.2 Potato tubermoth

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 Canary 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 : Hyletrichia 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 (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 practice. The basic components of AESA are :-

1. Plant health at different stages
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 tubermoth for mass trapping the field @ 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 tubermoth 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 5% potato tuber borne diseases

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. Rogueing 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 earning as soil drenching.
2. For other insects spraying of Chlorpyriphos 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

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop Stage</th>
<th>IPM practice</th>
<th>Pest</th>
<th>Applicable to</th>
<th>Type of Crop</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Planting</td>
<td>- Clean cultivation and Ploughing</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Avoid collateral host</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Soil application of Carbofuran 3G @ 1.0 kg and 2.6 kg a.i./ha</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>Assam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Deep ploughing</td>
<td>PTM</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Select resistant varieties - Kufri jyoti, Badsah &amp; Kufri Megha Lalpahari, Rongpuria</td>
<td>Late blight</td>
<td>All</td>
<td>Assam</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Emergence</td>
<td>- Spray fenitrothion 50EC @ 500 gms. a.i./ha Dicofol 18.5 EC @ 550 gm a.i./ha</td>
<td>Leaf hoppers, Mites sphid</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Spray chlorphyriphos 20 EC @ 0.5 kg. a.i./ha</td>
<td>Cut worms</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop Stage</th>
<th>Pest</th>
<th>Applicable to</th>
<th>Type of Crop</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Tuber</td>
<td>- Azadirachtin 1500 ppm @ 31/ha</td>
<td>Red ant, termite</td>
<td>All/Seed</td>
<td>Assam</td>
</tr>
<tr>
<td></td>
<td>initiation</td>
<td>- Apply mancozeb 75% WP @ 2.5kg. a.i./ha for the control of late blight and early blight</td>
<td>Late blight</td>
<td>All</td>
<td>Hills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Apply Metalaxy 8% + mancozeb 64% combination formulation when the weather is congenial for further buildup of the disease</td>
<td>Late blight</td>
<td>All</td>
<td>Hills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Apply streptomycin 0.02% Rouge out off types and virus infected plants</td>
<td>Bacterial wilt</td>
<td>All</td>
<td>Assam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Irrigate the crop when the night temperature drops below 4°C</td>
<td>Virus</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Irrigate the crop when the night temperature drops below 4°C</td>
<td>Blight</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>4.</td>
<td>Bulking</td>
<td>- Spray fenitrothion 50EC and dicofol 18.5EC</td>
<td>Leaf hopper and mites</td>
<td>All</td>
<td>Plains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Removal of collateral host and spraying them with endosulfan 35EC or quinalphos 25EC @ 0.005% a.i.conc</td>
<td>Write grub</td>
<td>All</td>
<td>Hills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Light traps during initial showers</td>
<td></td>
<td>All</td>
<td>Hills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Prophylactic application of mancozeb 75% WP @ 0.25% against late blight</td>
<td>Late blight</td>
<td>All</td>
<td>Hills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequent application of metalaxyl 8% + mancozeb 64% combination formulation (0.25%) in alternation with mancozeb at 8 and 14 days interval respectively.</td>
<td>Late blight</td>
<td>All</td>
<td>Plains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Apply metalaxyl 8% + mancozeb 64% when weather conditions for disease buildup are favourable (continuous overcast sky and intermittent rains)</td>
<td>Late blight</td>
<td>All</td>
<td>Plains</td>
</tr>
</tbody>
</table>
### V. POTATO PEST MANAGEMENT

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virus</strong></td>
<td><strong>Blight</strong></td>
<td><strong>Aphids</strong></td>
</tr>
</tbody>
</table>
| Rogue out off types and virus infected plants  
- Irrigate the crop when the night temperature drops below 4°C | All | All |
| Haulm cutting for vector control  
- Pheromone traps for mass trapping of PTM  
- Cut haulms when the late blight infection crosses 80% | Aphids | Seeds | All |
| - 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 | All |
| Preferably store potatoes in cold stores in country stores  
- Clean the store before placing material  
- Pheromone trap  @ 4 traps/100m³ of storage space | PTM | Mid hills | All |

#### Do’s

1. Grow only recommended variety/hybrid.
2. Agronomic practices
   - a) Timely sowing
   - b) Judicious use of fertilizers.  
     - Always use recommended NPK fertilizers in balanced proportion based on soil testing reports.
   - 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.
   - b) Selection of effective pesticides and its doses at right stage.
   - c) Use only recommended pesticides of the recommended doses for control of various pests.
   - d) Spray technology : Always follow the recommended spray technology using adequate spray of material.
   - e) Use recommended pesticides

#### Don’ts

1. Do not grow the underscribed material which vary greatly in tuber formation and pest susceptibility.
2. 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.
3. Do not keep the virus infected plant in the field to check the further spread of the diseases.
4. Do not go for blanket sprays without field roving.
5. 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.
6. Do not use substandard nozzles with high discharge rate which lead to poor coverage of the target site.
7. Do not purchase insecticides without bills and the information on batch number.
### 4. Weed management

<table>
<thead>
<tr>
<th>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.</th>
<th>Do not plough 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crops-weed competition.</td>
<td>Less seed rate of crops should not be used.</td>
</tr>
<tr>
<td>c) Pre-emergence herbicides should be applied immediately after sowing before emergence of weeds and crop.</td>
<td>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.</td>
</tr>
<tr>
<td>d) Apply only recommended herbicides at recommended dose, proper time, appropriate spray solution with standard equipment along with flat fan jet nozzles.</td>
<td>Pre-emergence as well as soil incorporated herbicides should not be applied in dry soils.</td>
</tr>
</tbody>
</table>

### 5. Rodent control

| Pre-baiting for one day should be done before applying zinc phosphide baiting. | Do not use zinc phosphide baiting more than once. |

### 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
   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 eating 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 burbatune
   3.4 Oxalis debilis
   3.5 Cyperus rotundus
   3.6 Cynodon dactylon

2. Pest Monitoring
   A. Agro Eco System Analysis
      Agro Eco System Analysis (AESA) is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their 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 pests. 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” strain which turns nematode eggs sac 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:

<table>
<thead>
<tr>
<th>Pest</th>
<th>Economic Threshold Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato fruit borer</td>
<td>One egg/one larve/one damaged fruit per plant</td>
</tr>
<tr>
<td>Whitefly (as a sucking pest)</td>
<td>4 adults/leaf</td>
</tr>
<tr>
<td>Root-knot reniform nematode</td>
<td>1-2 larvae/g soil</td>
</tr>
</tbody>
</table>

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 Tobbacco 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 a 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 alongwith 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 tooideae armigera, Compoletis Chlorideae, Carceliaillota, Erirborus argenteopolisus, Hyosoter didynator, Palexorista laxa, Goniophthalmus halli on H. armigera, Telenomus remus, chelonus heliopa, C. Formosanus, C. Blackburni riborus 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, Reduvid 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 thurigiensis 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 St reptocycline sulphate on unriped 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 rotar application of lime @ 5-10 g/ha in the soil.
4. Application of carbufuran 1 kg a.i. per ha during early stages of crop to avoid sucking pests and also nematodes.
5. Spraying of Bacillus thusingunses 1-1.5 lit/ha.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pest</th>
<th>Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-sowing</td>
<td>Soil borne fungus Nematodes</td>
<td>Deep summer ploughing soil solarization.</td>
</tr>
<tr>
<td></td>
<td>Resting stages of Insect pests Nematode</td>
<td>Application of Neem cake @ 200 kg. per ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raising African marigold nursery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 days prior to tomato nursery against H.armigera as trap crop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It nematode is severe in the area, apply carbufuran granules @ 1 to 2 kg. a.i./ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For weed control, use Fluchloralin @ 0.67 to 0.9 kg. a.i.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For weed control, use Fluchloralin @ 0.67 to 0.9 kg. a.i./ha as preplanting soil incorporation.</td>
</tr>
<tr>
<td>2. Seed Seedling</td>
<td>Damping off</td>
<td>Seed treatment with T.viridae 2 g or carbendazim 2g/100g seed</td>
</tr>
<tr>
<td>Stage</td>
<td>Disease / Pest</td>
<td>Control Measures</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Vegetative</strong></td>
<td><strong>Serpentine leaf miner</strong></td>
<td>Growing of nematode resistant/tolerant varieties. Raise Nursery beds of at least 10 cm high. Thin sowing with proper drainage facilities. Transplanting 25 days old healthy Tomato seedlings and 40 days old Marigold seedlings on every 16th row as a trap crop for H. armigera management. Avoid excess dose of Nitrogen. 5 percent NSKE commercially available neem formulation. Interplanting with beans reduces the attack of serpentine leaf miner.</td>
</tr>
<tr>
<td><strong>Whitefly</strong></td>
<td></td>
<td>Spray Endosulfan at the rate of 650 g a.i./ha. 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.</td>
</tr>
<tr>
<td><strong>Late blight</strong></td>
<td><strong>Leaf curl disease</strong></td>
<td>Field sanitation. Destruction of affected plant/plant part. Spray 0.02 percent Mancozeb @ 1.125-1.5 kg a.i. in 750 lit/water/ha. Roughing of affected plants. Install bird perchers @ 50/ha to encourage birds to feed on pests.</td>
</tr>
<tr>
<td><strong>Reproductive</strong></td>
<td><strong>Tomato fruit borer</strong></td>
<td>Field sanitation. Spray captan @ 1.25 kg a.i./ha in 750 to 1000 litres of water. Install pheromone traps with replacement of lures once in 15 days.</td>
</tr>
<tr>
<td><strong>Leaf curl disease</strong></td>
<td><strong>Mosaic</strong></td>
<td>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. Spray HANPV @ 250 LE per ha (6X10X12 PIB/ha) twice during evening hours at 10 days interval. Spray 5 percent NSKE or B. Thuringeniensis var kurstaki 500 g/ha. As shown in vegetative stage roguing of effected plants, careful intercultivation operation.</td>
</tr>
</tbody>
</table>
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 Cornsparry
      4.6 Cluster Weed
      4.7 Blue grass
      4.8 Canary grass
      4.9 Rabbit foot 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 Epilachna 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:

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

<table>
<thead>
<tr>
<th>Insect</th>
<th>ETL</th>
</tr>
</thead>
<tbody>
<tr>
<td>White fly</td>
<td>4 adults/leaf</td>
</tr>
<tr>
<td>Shoot and fruit borer</td>
<td>1 infected plant/meter row</td>
</tr>
<tr>
<td>Jassids</td>
<td>2.5 nymphs/leaf</td>
</tr>
</tbody>
</table>

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 empoascae, Anagrus empoascae which are active against Amrasca biguttula; 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 gossypi and Eurytoma sp. Parasitizes M. Hibisci.
1.3. In addition to these parasites, general predators like coccinellids, syrphids, spiders, carabids, Stophylinds, dragonfly, damselfly, predatory miribugs, predatory pentatomids, nabad bug, reudvid 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.pruteosum/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 10^4 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

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pest</th>
<th>Practice</th>
</tr>
</thead>
</table>
| 1. Pre-sowing             | Exposing resting stages of pests | Deep summer ploughing Application of more FYM Application of Neem-cake @200 kg per ha.  
Weeds | 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 diagnostic 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 hand lens.

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:

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

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 nematodes.
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, Gonoipthalmus halli on H. Armigera; Telenomus remus, Chenus heliopae, C. Formosanus, C. Blackburn, 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., Phaneratoma sp. are found active against Maruca sp., Chrysonofomyia appannai, Chrysocharis johnsoni, Elasmus sp. Pedobioides foeloeatus, Tetrastichus ovularum against Epilachna sp.; conserve Hemitarsonus varicornis, Goniota hrysonotymia 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, Damsel fly predatory mirid bugs, predatory pentatomids nabil bug, redvid bug. Anthocorid bug, Geocorid bug, predatory mite, predatory thrips also actively suppress the pest population.
   c) Nematodes like Hexamermis 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 sulhur @ 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 10G @ 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

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**E. Leguminous Crop Stage-Wise IPM Practices :**

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

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*)

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<table>
<thead>
<tr>
<th>Pests</th>
<th>ETL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leap hopper</td>
<td>2.5 nymphs/leaf</td>
</tr>
<tr>
<td>Spotted leaf beetle</td>
<td>1 insect/Sq.m</td>
</tr>
<tr>
<td>Nematodes</td>
<td>1-2 juveniles/g of soil</td>
</tr>
</tbody>
</table>

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 stern blight disease.

2.7 Hand collection of adult beetle from plants.

2.8 Vinegar + sugar syrup in a pumpkin as baiting to technique 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 national 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, Stophyllinids, 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 cent 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

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PEST</th>
<th>PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Presowing</td>
<td>Nematodes, Rodents</td>
<td>Deep summer ploughing Application on 200 kg neem cake. Crop rotation with non cruciferous 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. Seed treatment with Carbosulfan (25ST) @ 3% (W/W) Seed treatment with T.Viride @ 2 g per 100 g seeds. Apply 50 T.Viride in 10 kg powdered FYM, all along the rows. Seed treatment with T.Viride @ 2 g per 100 g seeds. Apply 50 T.Viride in 10 kg powdered FYM, all along the rows.</td>
</tr>
<tr>
<td>2. Seed/seedling</td>
<td>Collar rot</td>
<td>Seed treatment with T.Viride @ 2 g per 100 g seeds. Apply 50 T.Viride in 10 kg powdered FYM, all along the rows.</td>
</tr>
<tr>
<td></td>
<td>Virus infected plants</td>
<td>Removal of alternate hosts from field Hand collection of grubs and adults from the foliage. Spray B.bassiana (2x10 sq.m cfu/g) Spray Carbarry 1 1000 g a.i./ha As in seedling stage.</td>
</tr>
<tr>
<td>3. Vegetative</td>
<td>Beetle</td>
<td>As in seedling stage.</td>
</tr>
<tr>
<td></td>
<td>Powdery mildew, leaf spot</td>
<td>Spray Dinocap/Kanathane 100 ml/750 lit water per ha.</td>
</tr>
<tr>
<td></td>
<td>Downy mildew</td>
<td>Spray Ridomil MZ78 @ 2.5 g/lit</td>
</tr>
<tr>
<td></td>
<td>Virus infected plants and nematodes</td>
<td>Removal of alternate hosts from field Release of C. cannea @ 2 grubs/plant.</td>
</tr>
<tr>
<td></td>
<td>Pumpkin caterpillar</td>
<td>Release of C. cannea @ 2 grubs/plant.</td>
</tr>
<tr>
<td>4. Reproductive</td>
<td>Downy mildew &amp; powdery mildew</td>
<td>Field sanitation Optimum irrigation Removal of alternate hosts from field.</td>
</tr>
<tr>
<td></td>
<td>Virus infected plants</td>
<td></td>
</tr>
</tbody>
</table>

### 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. 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 caterpiller

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 dactylori)

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.
3. Pest and defender population dynamics.
4. Soil conditions.
5. Climatic factors.

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 –

<table>
<thead>
<tr>
<th>Pest</th>
<th>ETL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf webber</td>
<td>1 Larva per meter row of length</td>
</tr>
<tr>
<td>Nematodes</td>
<td>1-2 Juveniles per gm of soil</td>
</tr>
<tr>
<td>Spider mite</td>
<td>2 mites per leaf</td>
</tr>
<tr>
<td>Saw fly radish</td>
<td>1 larva per plant</td>
</tr>
<tr>
<td>Diamond backmoth</td>
<td>1 larva per plant</td>
</tr>
</tbody>
</table>

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 varities.
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 infectation.
2. Collection and destruction of infected old leave 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 Trichodema viridie @ 2 gm. per 100 gm. of seed.
5. Release Trichogramma toidea bactrea or T. chinoris 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 Beauvaria bassiana (1 x 10^6 cfu/g) @ 2 gm per litre of water after every 20 days to control lepidopteran pests.
9. Spray Entomophthora sp. (2 x 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 streptocycline 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 cabofuran 3 g. @ 0.3 to 0.6 g.a.i. per sq. meter.
6. Apply 3 sprays of Cu-oxychloride (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

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PEST</th>
<th>PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-sowing</td>
<td>Resting stages of pests, nematodes,</td>
<td>Deep summer ploughung.</td>
</tr>
<tr>
<td></td>
<td>weeds, bacterial &amp; fungal pathogens.</td>
<td>Raised nursery beds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil solarization.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treat the nursery bed with cabofuran 3 g. @</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3 to 0.6 g.a.i. per sq. meter.</td>
</tr>
<tr>
<td></td>
<td>DBM &amp; other pests</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>After land preparation leave two ridges at</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the beginning, after every 25 rows and at the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>end.</td>
</tr>
</tbody>
</table>
Weeds

| Club rot | - Use of well rotten cow dung or compost stale seed bed technique. |
| Black rot | - Add lime to the soil raise the PH to 7.0 |

Seed & Soil borne fungal pathogens

| Black rot | - Seed treatment with 100 ppm streptocycline solution for 30 minutes. |
| Seed treatment with carbendazim 2 gm. per kg. seed. |
| - Apply optimum dose of N & P fertilizers as basal dose. |
| - Adopt optimum irrigation. |
| - Timely planting, optimum spacing and balanced dose of fertilizer. |
| Black rot | - Apply 3 sprays of Copper-oxychloride (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. |
| - Two hand weedings at 20 & 40 days after transplanting in lieu of herbicide application. |
| - Use of dryland weeder is cost effective. |

Weeds

| Lepidopterran pests | Erect bird perchers. |
| Aphids | - Spray malathion 50 EC @ 1.5 ml per litre of water. |
| Black rot | - Spray 100 ppm streptocycline sulphate + mancozeb 2 – 2.5 gm.a.i. per litre of water. |
| DBM | - Destruction of old leaves affected with DBM. |
| Head borer | - Roguing of affected plants. |
| Black rot | - 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. Rabit 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.
3. Pest and defender population dynamics.
4. Soil conditions.
5. Climatic factors.

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.

II.3 Pheromones
Pheromone traps with lures are commercially available for pests like H. armigera, S. litura. Install five traps with lures for each pest; 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 juveniles/g of soil

III. IPM Strategies 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 image, 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. 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.

III.3.2. In addition to these parasites, general predators like coccinelids, syrphids, Spiders, Carabids, Stophylinids, Dragonfly, Damselfly, predatory miridbugs.

III.3.3. Since these natural enemies are highly prone for pesticides, avoiding unnecessary sprays are the best way to conserve them.

III.3.4. Grow cowpea or pulses on the bunds to build up natural enemy fauna.

III.3.5. Install bird percher @ 50 per ha.

III.3.2. Augmentation

(a) Spray of HaNPV @ 250 LE (6x10^9 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 controlling root-knot nematode 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 a 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

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pest</th>
<th>Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-sowing</td>
<td>Resting stages of insects disease</td>
<td>Deep summer ploughing, Soil solarization, Stale seed bed technique, Use of well rotten cowdung or compost</td>
</tr>
<tr>
<td></td>
<td>causing spores, nematodes, weeds</td>
<td>Application of neem cake @ 200 kg/ha, Application of bleaching power @ 15 kg/ha before planting.</td>
</tr>
<tr>
<td>2. Seed-seedlings</td>
<td>Bacterial wilt</td>
<td>Seed treatment with Carbofuran/ carbosulfan (25 ST) @ 3% W/W</td>
</tr>
<tr>
<td></td>
<td>Nematodes</td>
<td>Thrips, Grow resistant varieties-NP 46a, Pusa, Jwala, Release Chrysoperla @ 2 grubs/plant, Spray dimethoate 0.02%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthracnose, 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weeds, Apply Oxadicozen @ 0.5 kg a.i./ha. or Pendimethalin @ 1 to 1.25 kg a.i./ha as preemergence herbicide.</td>
</tr>
<tr>
<td>3. Vegetative</td>
<td>Tobacco</td>
<td>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.</td>
</tr>
<tr>
<td>4. Reproductive</td>
<td>Weeds</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Mites</td>
<td>Release C.cornea @ 2 grubs/plant. Spray Endosulfan @ 312-625 g. a.i./ha</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>As shown in vegetative stage. Install pheromone traps with replacement of lures once in 15 days. Release T.brasiliensis/T.priteossum/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 carbaryl 1000 g. a.i./ha. As shown in vegetative stage.</td>
</tr>
<tr>
<td></td>
<td>Anthracnose/Fruit rot</td>
<td>As shown in vegetative stage. As shown in vegetative stage.</td>
</tr>
<tr>
<td></td>
<td>Tobacco cut worm, fruit borer, H. armigera</td>
<td>As shown in vegetative stage. As shown in vegetative stage.</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>Mites</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thrips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthracnose/Fruit rot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weeds</td>
</tr>
</tbody>
</table>

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.
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.
   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 @ 200 kg 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 @ 2 ml/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 @ 670-980 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

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pest</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-sowing</td>
<td>Resting stages of</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>pests, soil borne</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pathogens, weeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weeds</td>
<td>Stale seed bed technique. Use of well rotten cowdung/compost.</td>
</tr>
<tr>
<td>2. Seed/ Seedling</td>
<td>Blotch</td>
<td>Seed treatment with bavistin 0.01%</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>Spray mancozeb 0.2% whenever disease symptoms noticed</td>
</tr>
<tr>
<td>3. Vegetative</td>
<td>Onion maggots</td>
<td>Removal alternate hosts, Optimum irrigation management.</td>
</tr>
<tr>
<td></td>
<td>Weeds</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>Continue sticky traps; Conserve coccinellid predators spray malathion 50EC 2 ml/l.</td>
</tr>
<tr>
<td></td>
<td>Tobacco caterpillar</td>
<td>Hand collection of different stages of the insect.</td>
</tr>
<tr>
<td></td>
<td>Mites</td>
<td>Spray Dicofol @ 450 g a.i./ha.</td>
</tr>
<tr>
<td></td>
<td>Blotch</td>
<td>Spray mancozeb 1.25-1.5 kg a.i./ha.</td>
</tr>
</tbody>
</table>
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/fruiting.

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 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 write 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:

<table>
<thead>
<tr>
<th>Eco System Analysis:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps</strong></td>
<td><strong>What to observe</strong></td>
</tr>
<tr>
<td><strong>Discuss</strong></td>
<td><strong>Do’s</strong></td>
</tr>
<tr>
<td>6. Activities in neighbours fields</td>
<td>Do neighbours spray? What was sprayed?</td>
</tr>
<tr>
<td>7. Decisions made last week</td>
<td>Was the decision made effective? Do we need to do similar action?</td>
</tr>
</tbody>
</table>

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**

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.

2. Grow only recommended varieties.

3. Sow early in the season.

4. Always treat the seeds with approved chemicals/bio products for the control of seed borne diseases/pests.

5. Sow in rows at optimum depths under proper moisture conditions for better establishment.

6. Pre-emergency herbicides should be applied immediately after sowing before the emergence of weeds and crop.

**Don’t’s**

1. Do not plough 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. Do not grow varieties not suitable for the season or the region.

3. Avoid late sowing as this may lead to reduced yields and incidence of white grubs and diseases.

4. Do not use seeds without seed treatment with biocides/chemicals.

5. Do not sow seeds beyond 5-7 cm depth.

6. Pre-emergency 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.
<table>
<thead>
<tr>
<th><strong>Do's</strong></th>
<th><strong>Don't</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Herbicides like fluchloralin should be incorporated into the soil immediately after spraying to avoid its photo degradation.</td>
<td>Soil incorporation of fluchloralin should not be delayed or avoided for achieving effective weed control.</td>
</tr>
<tr>
<td>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.</td>
<td>Pre-emergency as well as soil incorporated herbicides should not be applied in dry soils. Do not apply herbicides along with irrigation water or by mixing with soil, sand or urea.</td>
</tr>
<tr>
<td>9. Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crop weed competition.</td>
<td>Crops should not be exposed to moisture deficit stress at their critical growth stages.</td>
</tr>
<tr>
<td>10. Use NPK fertilizers as per the soil test recommendation.</td>
<td>Avoid imbalanced use of fertilizers.</td>
</tr>
<tr>
<td>11. Use micronutrient mixture after sowing test recommendations.</td>
<td>Avoid imbalanced use of fertilizers</td>
</tr>
<tr>
<td>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.</td>
<td>Do not apply chemical pesticides on calendar basis.</td>
</tr>
<tr>
<td>13. Install pheromone traps at appropriate period.</td>
<td>Do not store the pheromone lures at normal room temperature (keep them in refrigerator).</td>
</tr>
<tr>
<td>14. Release parasites only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation.</td>
<td>Do not apply chemical pesticides within seven days of release of parasites.</td>
</tr>
<tr>
<td>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.</td>
<td>Do not use the same sprayer for application of chemical pesticides and biocides.</td>
</tr>
</tbody>
</table>

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

### SAFETY PARAMETERS IN PESTICIDES USAGE

<table>
<thead>
<tr>
<th>Name of pesticide</th>
<th>Classification as per Insecticides Rules, 1971</th>
<th>Colour of Toxicity Triangle</th>
<th>WHO Classification by hazard</th>
<th>First-aid Measures</th>
<th>Symptoms of poisoning</th>
<th>Treatment of poisoning</th>
<th>Waiting period (No. of days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSECTICIDES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Chlorinated Hydrocarbons 1. Endosulfan</td>
<td>Highly Toxic</td>
<td>Yellow</td>
<td>Class II Moderately hazardous</td>
<td>Remove the person from contaminated environment; (a) Skin contact – Wash the eye with plenty of cool clean water; (b) Eye Contamination – Wash the eye with plenty of cool clean water; (c) Inhalation – Carry the oerson to the open fresh air.</td>
<td>Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death.</td>
<td>Gastric lavage with 2–4 Lit. tap water- Catherasis with 30 gm. (10 oz) sodium sulphate in one cup of water.</td>
<td>21</td>
</tr>
<tr>
<td>B. Organophosphorous Compounds 2. Chlorpyriphos</td>
<td>Highly toxic</td>
<td>Yellow</td>
<td>Class II Moderately toxic</td>
<td>In case of breathing difficulty, give mouth to mouth or mouth to nose breathing.</td>
<td>Mild-Anorexia headache, dizziness, weakness anxiety, tremors of tongue and eyelids, miosis, impairment of visual acuity.</td>
<td>For extreme symptoms of OP poisoning injection of atropine (2-4 mg. For adults, 0.5-1.0 for children) is recommended, 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 or all laxatives. Do not give any stimulants. Give calcium gluconate (10% in 10 ml. ampules) intravenously every four hours.</td>
<td>Not available</td>
</tr>
<tr>
<td>3. Dichlorvos</td>
<td>Extremely toxic hazardous</td>
<td>Red</td>
<td>Classa-la Extremely</td>
<td>External cardiac (heart) massage may be given if heart action ceases.</td>
<td>Moderate-nausea salivation, lacrimation, abdominal cramp, vomiting, sweating slow pulse muscular tremors, miosis.</td>
<td>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.</td>
<td>07</td>
</tr>
<tr>
<td>Name of pesticide</td>
<td>Classification as per Insecticides Rules, 1971</td>
<td>Colour of WHO Classification by hazard</td>
<td>First-aid Measures</td>
<td>Symptoms of poisoning</td>
<td>Treatment of poisoning</td>
<td>Waiting period (No. of days)</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------</td>
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<td>-----------------------</td>
<td>------------------------</td>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>4. Formothion</td>
<td>Highly toxic</td>
<td>Yellow</td>
<td>Medical Aid</td>
<td>Severe diarrhoea, pinpoint and nonreactive pupils, respiratory difficulty, pulmonary oedema, cyanosis, loss of sphincter, control, convulsions, coma and heart block.</td>
<td>Keep airways open. Do tracheotomy and give artificial respiration if needed. Not available.</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>5. Trichlorphon</td>
<td>Moderately toxic</td>
<td>Blue</td>
<td>If there is no specific antidote, the doctor may treat the patient symptomatically.</td>
<td></td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>6. Dimethoate</td>
<td>Highly toxic</td>
<td>Yellow</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>7. Phospha midon</td>
<td>Extremely toxic</td>
<td>Red</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>8. Quinalphos</td>
<td>Highly toxic</td>
<td>Yellow</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>75 - 110</td>
<td></td>
</tr>
<tr>
<td>9. Phorate</td>
<td>Extremely toxic</td>
<td>Red</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>05</td>
<td></td>
</tr>
<tr>
<td>10. Malathion</td>
<td>Moderately toxic</td>
<td>Blue</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>75-110</td>
<td></td>
</tr>
<tr>
<td>C. Carbonate 11. Carbofuran (Furadon)</td>
<td>Extremely toxic</td>
<td>Red</td>
<td>Medical Aid</td>
<td></td>
<td></td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>
### Name of Pesticide

<table>
<thead>
<tr>
<th>Classification as per Pesticides Rules, 1971</th>
<th>WHO Classification by Hazard</th>
<th>第一次中毒症状</th>
<th>措施</th>
<th>急救等待期 (天)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Fungicides (Thiocarbamates)</td>
<td>Slightly toxic</td>
<td>Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat, eyes and skin.</td>
<td>Treatment generally symptomatic.</td>
<td>NA</td>
</tr>
<tr>
<td>12. Mancozeb</td>
<td>Green</td>
<td>Treatment generally symptomatic.</td>
<td>Treatment generally symptomatic.</td>
<td>NA</td>
</tr>
</tbody>
</table>

#### First-Aid Measures

**If ingested:** Lavage stomach with 5% sodium bicarbonate if not vomiting. For skin contact wash with soap and water (eyes-wash with isotonic saline). Give oxygen, morphine, if needed. Opioids and antihistamines are not harmful and should be used where indicated for routine use. Do not give antihistamine to a cyanotic patient. Give artificial respiration first then administer atropine. No specific antitide. Treatment essentially symptomatic.

**If absorbed through skin:** Wear rubber gloves while washing contact area. Give oxygen, morphine, if needed. Avoid theophyllin and aminophyllin or barbiturates. 2-PAM and other oximes are not harmful and in fact contraindicated for routine usage.

**If inhaled:** Wait in hospital, do not give oxygen. Avoid theophyllin and aminophyllin or barbiturates. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.

#### 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.

---

### PROGRAMME FOR RICE FFS

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

**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

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<tr>
<th>Period</th>
<th>Crop Stage</th>
<th>Activities</th>
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| 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 lavae of *Helicoverpa*  
|           |                                 | - Installation of yellow sticky traps  
|           |                                 | - Pesticide poisoning on natural enemies.  
|           |                                 | - G.D. “Tower Building”  

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| 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 comparision 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.
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, chilies, capsicum; cole crops such as cabbage, cauliflower; root crops diseases like tuber, rhizome rot of potato, ginger, turmeric along with 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 thuriniensis 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:**
   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 pydhyedrosis 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 :**
  1. Shake the bottle properly and prepare a solution @ 1 ml. /litre of water.
  2. Spray the solution 2-3 times at 10-15 days intervals.
  3. Spray preferably in the evening and on young larval stages or on sighting of eggs laying.

4. **Beauvaria 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, seale 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 repellant, antifeedant, insect growth regulator and oviposition treatment.

**Treatments :**
- **Dose :** 1 litre / ha.
- **Method :**
  1. Prepare a solution @ 3-5 ml. / litre of water and spray at the time of hatching eggs and young stages of pests.
  2. Repeat in spray at 15 days intervals based on population.