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AESA BASED IPM PACKAGE
PEA

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Rajendranagar, Hyderabad, Telangana

Department of Agriculture and Cooperation
Ministry of Agriculture
Government of India

The AESA based IPM – Pea (*Pisum sativum* L.), was compiled by the NIPHM working group under the Chairmanship of Dr. Satyagopal Korlapati, IAS, DG, NIPHM, and guidance of Shri. Utpal Kumar Singh, IAS. JS (PP). The package was developed taking into account the advice of experts listed below on various occasions before finalization.

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FOREWORD

Intensive agricultural practices relying heavily on chemical pesticides are a major cause of wide spread ecological imbalances resulting in serious problems of insecticide resistance, pest resurgence and pesticide residues. There is a growing awareness world over on the need for promoting environmentally sustainable agriculture practices.

Integrated Pest Management (IPM) is a globally accepted strategy for promoting sustainable agriculture. During last century, IPM relied substantially on economic threshold level and chemical pesticides driven approaches. However, since the late 1990s there is conscious shift to more ecologically sustainable Agro-Eco System Analysis (AESA) based IPM strategies. The AESA based IPM focuses on the relationship among various components of an agro-ecosystem with special focus on pest-defender dynamics, innate abilities of plant to compensate for the damages caused by the pests and the influence of abiotic factors on pest buildup. In addition, Ecological Engineering for pest management - a new paradigm to enhance the natural enemies of pests in an agro-ecosystem is being considered as an important strategy.The ecological approach stresses the need for relying on bio intensive strategies prior to use of chemical pesticides.

Sincere efforts have been made by resource personnel to incorporate ecologically based principles and field proven technologies for guidance of the extension officers to educate, motivate and guide the farmers to adopt AESA based IPM strategies, which are environmentally sustainable. I hope that the AESA based IPM packages will be relied upon by various stakeholders relating to Central and State government functionaries involved in extension and Scientists of SAUs and ICAR institutions in their endeavour to promote environmentally sustainable agriculture practices.

A Srivastava

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(Avinash K. Srivastava)

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FOREWORD

IPM is a holistic approach of crop protection based on the integration of multiple strategies viz., cultural, physical, mechanical, biological, botanicals and chemical. Over the years IPM underwent several changes, shifting its focus from damage boundary, economic injury to economic threshold. Currently most stake holders rely upon economic threshold levels (ETL) and tend to apply chemical pesticides at the first instance in the event of a pest attack, though Government of India has advocated need based and judicious application of chemicals. This approach is likely to cause adverse effects on agro-ecosystems and increase the cost of agricultural production due to problems of pest resurgence, insecticide resistance and sustainability.

During the late 90s FAO started advocating Agro-Ecosystem Analysis (AESA) based IPM. Experience in different countries have since shown that AESA, which takes into account ecological principles and relies on the balance that is maintained by biotic factors in an ecosystem has also resulted in reduction in cost of production and increase in yields. AESA based IPM also takes into account the need for active participation of farmers and promotes experiential learning and discovery based decision making by farmers. AESA based IPM in conjunction with ecological engineering for pest management promotes bio-intensive strategies as against current chemical intensive approaches, while retaining the option to apply chemical pesticides judiciously as a measure of last resort.

The resource persons of NIPHM and DPPQ&S have made sincere efforts in revising IPM packages for different crops by incorporating agro-ecosystem analysis, ecological engineering, pesticide application techniques and other IPM options with the active cooperation of crop based plant protection scientists working in State Agricultural Universities and ICAR institutions. I hope this IPM package will serve as a ready reference for extension functionaries of Central/ State Governments, NGOs and progressive farmers in adopting sustainable plant protection strategies by minimizing the dependence on chemical pesticides.

(Utpal Kumar Singh)

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PREFACE

Need for environmentally sustainable agricultural practices is recognised worldwide in view of the wide spread ecological imbalances caused by highly intensive agricultural systems. In order to address the adverse impacts of chemical pesticides on agro-ecosystems, Integrated Pest Management has evolved further from ETL based approach to Agro-ecosystem Analysis based Integrated Pest Management (IPM).

In AESA based IPM the whole agro-ecosystem, plant health at different stages, built-in-compensation abilities of the plant, pest and defender population dynamics, soil conditions, climatic factors and farmers' past experience are considered. In AESA, informed decisions are taken by farmers after field observation, AESA chart preparation followed by group discussion and decision making. Insect zoo is created to enable the farmer understand predation of pests by Natural Enemies. AESA based PHM also results in reduction of chemical pesticide usage and conserves the agro-ecosystems.

Ecological Engineering for Pest Management, a new paradigm, is gaining acceptance as a strategy for promoting Biointensive Integrated Pest Management. Ecological Engineering for Pest Management relies on cultural practices to effect habitat manipulation and enhance biological control. The strategies focus on pest management both below ground and above ground. There is a growing need to integrate AESA based IPM and principles of ecological engineering for pest management.

There is a rising public concern about the potential adverse effects of chemical pesticides on the human health, environment and biodiversity. The intensity of these negative externalities, though cannot be eliminated altogether, can be minimized through development, dissemination and promotion of sustainable biointensive approaches.

Directorate of Plant Protection Quarantine and Storage (DPPQS), has developed IPM package of practices during 2001 and 2002. These packages are currently providing guidance to the Extension Officers in transferring IPM strategies to farmers. These IPM package of practices, have been revised incorporating the principles of AESA based IPM in detail and also the concept of Ecological Engineering for Pest Management. It is hoped that the suggested practices, which aim at enhancing biodiversity, biointensive strategies for pest management and promotion of plant health, will enable the farmers to take informed decisions based on experiential learning and it will also result in use of chemical pesticides only as a last resort & in a safe and judicious manner.

(K. SATYAGOPAL)

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AESA BASED IPM PACKAGE FOR PEA

Pea-Plant description:

Peas - (*Pisum sativum* L.) (2n = 14) (Hindi : Matar) the famous plant in which G.H. Mendel worked out Mendel Laws and Genetic Principles, is a noble and aristocratic vegetable. The crop is cultivated for its tender and immature pods for use as vegetable and mature dry pods for use as a pulse. In both cases, seeds are separated and used as vegetable or pulse. Peas are highly nutritive and contain high content of digestible protein (7.2 g / 100g), Carbohydrate (15.8 g), Vitamin-C (9 mg), phosphorus (139 mg) and minerals. Tender seeds are also used in soups.

Pea is a herbaceous annual plant with tap root system. Stem is upright, slender and usually single. Leaves are pinnately compound with the rachis terminating in a single or branched tendril. There are large stipules at base of leaf. Inflorescence is a raceme arising from axils of leaves and individual flowers are typical papilionaceous. Gynoecium is monocarpellary with ovules (up to 13) alternately attached to placenta. Style bends at right angle to ovary and stigma is sticky. Pods are straight or curved and seeds are smooth or wrinkled.

I. PESTS

A. Pests of National Significance

1. Insect and mite pests

1.1 Pea pod borer:

1.1.1 *Etiella zinckenella* Treitschke (Lepidoptera: Pyralidae)

1.1.2 *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae)

1.2 Stem fly: *Ophiomyia phaseoli* Tyron.(Diptera: Agromyzidae)

1.3 Pea Weevil: *Bruchus pisorum* Linnaeus (Coleoptera: Bruchidae)

2. Diseases

2.1 Powdery mildew: *Erysiphe pisi* DC. syn. *E. polygoni* DC.

2.2 **Rust: *Uromyces fabae* (Pers.) Schrot. *& Uromyces fabae* DB. f. sp. *pisisativae* Hiratsuka**

3. Nematodes

3.1 Root-knot nematode: *Meloidogyne incognita* (Kofoid & White) Chit. & *M. javanica* (Treub) Chitwood

4. Rodents:

4.1 Smaller Bandicoot: *Bandicota bengalensis* Gray.

5. Major weeds

Broad leaf weeds

5.1 Lambs quarter: *Chenopodium album* L. (Chenopodiaceae)

5.2 Sweet Clover: *Melilotus alba*L. (Fabaceae)

5.3 Common vetch: *Vicia sativa* L. (Fabaceae)

5.4 Yellow vetchling: *Lathyrus aphaca*L. (Fabaceae)

5.5 Scarlet pimpernel: *Anagallis arvensis* L. (Primulaceae)

5.6 Wild fenugreek: *Trigonella polycerata* auct. non Linn. (Fabaceae)

5.7 Fineleaf fumitory: *Fumaria parviflora* Lam. (Fumariaceae)

5.8 Asthma herb: *Euphorbia hirta* L. (Euphorbiaceae)

5.9 Congress grass: *Parthenium hysterophorus* L. (Asteraceae)

5.10 Field bindweed: *Convolvulus arvensis* L. (Convolvulaceae)

Grasses

5.11 Chinese love grass: *Eragrostis unioloides* (Retz.) Nees. Ex Steud (Poaceae)

5.12 Canary grass: *Phalaris minor* Retz. (Poaceae)

5.13 Goosegrass: *Eleusine indica* (L.) Gaertner. (Poaceae)

5.14 Wild oat: *Avena fatua* L. (Poaceae)

5.15 Bluegrass: *Poa annua* L. (Poaceae)

Sedges

5.16 Purple nut sedge: *Cyperus rotundus* L. (Cyperaceae)

B. Pest of Regional Significance

1. Insect pests

1.1 Pea aphid: *Acyrthosiphon pisum* Harris. (Hemiptera: Aphididae)

1.2 Leaf miner: *Chromatomyia horticola* Goureau. (Diptera: Agromyzidae)

2. Diseases

2.1 Downy mildew: *Peronospora viciae* (Berk.) Gäum. syn. and *Peronospora pisi* Sydow. (Indo genetic plains)

2.2 *Ascochyta* blight: *Ascochyta pisi* Lib., *Ascochyta pinodes* Jones, *Ascochyta pinodella* Jones (Himalayan Region, Chhattisgarh)

2.3 White rot: *Sclerotinia sclerotiorum* (Lib.) de Bary (Jammu & Kashmir, Himachal Pradesh)

2.4 Root rot: *Fusarium solani* (Mart.) Sacc., *Rhizoctonia solani* Kühn. (Uttar Pradesh, Bihar and West Bengal)

2.5 *Fusarium* wilt: *Fusarium oxysporum* f. sp. *pisi.* (Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu & Kashmir)

3. Nematodes:

3.1 Reniform nematodes: *Rotylenchulus reniformis* Linford and Oliveira

4. Major weeds

Broad leaf weeds

4.1Slender amaranth: *Amaranthus viridis* Hook. F. (Amaranthaceae)

4.2Giradol: *Chrozophora plicata* (Vahl) A. Juss. ex Spreng (Euphorbiaceae)

4.3Corn spurry: *Spergula arvensis* L. (Caryophyllaceae)

Grasses

4.4Egyptian crowfoot grass: *Dactyloctenium aegyptium* (L.) Willd (Poaceae)

Sedges

4.5Yellow nut sedge: *Cyperus esculentus* L. (Cyperaceae)

II AGRO-ECOSYSTEM ANALYSIS (AESA) BASED INTEGRATED PEST MANAGEMENT (IPM)

A. AESA:

The IPM has been evolving over the decades to address the deleterious impacts of synthetic chemical pesticides on environment ultimately affecting the interests of the farmers. The economic threshold level (ETL) was the basis for several decades but in modern IPM (FAO 2002) emphasis is given to AESA where farmers take decisions based on larger range of field observations. The health of a plant is determined by its environment which includes physical factors (i.e. soil, rain, sunshine hours, wind etc.) and biological factors (i.e. pests, diseases and weeds). All these factors can play a role in the balance which exists between herbivore insects and their natural enemies. Understanding the intricate interactions in an ecosystem can play a critical role in pest management.

Decision making in pest management requires a thorough analysis of the agro-ecosystem. Farmer has to learn how to observe the crop, how to analyze the field situation and how to make proper decisions for their crop management. This process is called the AESA. Participants of AESA will have to make a drawing on a large piece of paper (60 x 80 cm), to include all their observations. The advantage of using a drawing is that it forces the participants/farmers to observe closely and intensively. It is a focal point for the analysis and for the discussions that follow, and the drawing can be kept as a record.

AESA is an approach, which can be gainfully employed by extension functionaries and farmers to analyze the field situations with regards to pests, defenders, soil conditions, plant health and the influence of climatic factors and their relationship for growing a healthy crop. The basic components of AESA are

- Plant health at different stages
- Built-in compensation abilities of plants
- Pest and defender population dynamics
- Soil conditions
- Climatic factors
- Farmers past experience

Principles of AESA based IPM:

Grow a healthy crop:

- Select a variety resistant/tolerant to major pests
- Select healthy seeds/seedlings/planting material
- Treat the seeds/seedlings/planting material with recommended pesticides especially biopesticides
- Follow proper spacing
- Soil health improvement (mulching and green manuring)
- Nutrient management especially organic manures and biofertilizers based on the soil test results. If the dosage of nitrogenous fertilizers is too high the crop becomes too succulent and therefore susceptible to insects and diseases. If the dosage is too low, the crop growth is retarded. So, the farmers should apply an adequate for best results. The phosphatic fertilizers should not be applied each and every season as the residual phosphate of the previous season will be available for the current season also.
- Proper irrigation
- Crop rotation

Observe the field regularly (climatic factors, soil and biotic factors):

Farmers should

- Monitor the field situation at least once a week (soil, water, plants, pests, natural enemies, weather factors etc.)
- Make decisions based on the field situation and Pest: Defender ratio (P: D ratio)
- Take direct action when needed (e.g. collect egg masses, remove infested plants etc.)

http://www.progenellc.com/images/imagepage/wpeas/nutrigreenbrischle2.jpg

Understand and conserve defenders:

- Know defenders/natural enemies to understand their role through regular observations of the agro-ecosystem
- Avoid the use of chemical pesticides especially with broad-spectrum activity

Insect zoo:

In field various types of insects are present. Some are beneficial and some may be harmful. Generally farmers are not aware about it. Predators (friends of the farmers) which feed on pests are not easy to observe in crop field. Insect zoo concept can be helpful to enhance farmers' skill to identify beneficial and harmful insects. In this method, unfamiliar/unknown predators are collected in plastic containers with brush from the field and brought to a place for study. Each predator is placed inside a plastic bottle together with parts of the plant and some known insect pests. Insects in the bottle are observed for certain time and determined whether the test insect is a pest (feeds on plant) or a predator (feeds on other insects).

Pest: Defender ratio (P: D ratio):

Identifying the number of pests and beneficial insects helps the farmers to make appropriate pest management decisions. Sweep net, visual counts etc. can be adopted to arrive at the numbers of pests and defenders. The P: D ratio can vary depending on the feeding potential of natural enemy as well as the type of pest. The natural enemies of pea insect pests can be divided into 3 categories 1. parasitoids; 2. predators; and 3. pathogens.

Model Agro-Ecosystem Analysis Chart

Date:
Village:
Farmer:

Decision taken based on the analysis of field situations

Soil conditions :
Weather conditions :
Diseases types and severity :
Weeds types and intensity :
Rodent damage (if any) :
No. of insect pests :
No. of natural enemies :
P: D ratio :

The general rule to be adopted for management decisions relying on the P: D ratio is 2: 1. However, some of the parasitoids and predators will be able to control more than 2 pests. Wherever specific P: D ratios are not found, it is safer to adopt the 2: 1, as P: D ratio. Whenever the P: D ratio is found to be favourable, there is no need for adoption of other management strategies. In cases where the P: D ratio is found to be unfavourable, the farmers can be advised to resort to inundative release of parasitoids/predators depending upon the type of pest. In addition to inundative release of parasitoids and predators, the usage of microbial biopesticides and biochemical biopesticides such as insect growth regulators, botanicals etc. can be relied upon before resorting to synthetic chemical pesticides.

Decision making:

Farmers become experts in crop management:

Farmers have to make timely decisions about the management of their crops. AESA farmers have learned to make these decisions based on observations and analysis viz. abiotic and biotic factors of the crop ecosystem. The past experience of the farmers should also be considered for decision making. However, as field conditions continue to change and new technologies become available, farmers need to continue improving their skills and knowledge.

- Farmers are capable of improving farming practices by experimentation
- Farmers can share their knowledge with other farmers

AESA methodology:

- Go to the field in groups (about 5 farmers per group). Walk across the field and choose 20 plants/ acre randomly. Observe keenly each of these plants and record your observations:
    - Plant: Observe the plant height, number of branches, crop stage, deficiency symptoms etc.
    - Insect pests: Observe and count insect pests at different places on the plant.
    - Defenders (natural enemies): Observe and count parasitoids and predators.
    - Diseases: Observe leaves and stems and identify any visible disease symptoms and severity.
    - Rats: Count number of plants affected by rats.
    - Weeds: Observe weeds in the field and their intensity.
    - Water: Observe the water situation of the field.
    - Weather: Observe the weather condition.
- While walking in the field, manually collect insects in plastic bags. Use a sweep net to collect additional insects. Collect plant parts with disease symptoms.
- Find a shady place to sit as a group in a small circle for drawing and discussion.
- If needed, kill the insects with some chloroform (if available) on a piece of cotton.
- Each group will first identify the pests, defenders and diseases collected.
- Each group will then analyze the field situation in detail and present their observations and analysis in a drawing (the AESA drawing).
- Each drawing will show a plant representing the field situation. The weather condition, water level, disease symptoms, etc. will be shown in the drawing. Pest insects will be drawn on one side. Defenders (beneficial insects) will be drawn on another side. Write the number next to each insect. Indicate the plant part where the pests and defenders were found. Try to show the interaction between pests and defenders.
- Each group will discuss the situation and make a crop management recommendation.
- The small groups then join each other and a member of each group will now present their analysis in front of all participants.
- The facilitator will facilitate the discussion by asking guiding questions and makes sure that all participants (also shy or illiterate persons) are actively involved in this process.
- Formulate a common conclusion. The whole group should support the decision on what field management is required in the AESA plot.
- Make sure that the required activities (based on the decision) will be carried out.
- Keep the drawing for comparison purpose in the following weeks.

Data recording:

Farmers should record data in a notebook and drawing on a chart

- Keep records of what has happened help us making an analysis and draw conclusions

Data to be recorded:

- **Plant growth (weekly):** Height of plant; number of leaves
- **Crop situation (e.g. for AESA):** Plant health; pests, diseases, weeds; natural enemies; soil condition; irrigation; weather conditions
- **Input costs:** Seeds; fertilizer; pesticides; labour
- **Harvest:** Yield (Kg/acre); price of produce (Rs./Kg)

Some questions that can be used during the discussion:

- Summarize the present situation of the field.
- What crop management aspect is most important at this moment?
- Is there a big change in crop situation compared to last visit? What kind of change?
- Is there any serious pest or disease outbreak?
- What is the situation of the beneficial insects?
- Is there a balance in the field between pests and defenders?
- Were you able to identify all pests and diseases?
- Do you think the crop is healthy?
- What management practices are needed at this moment?
- When will it be done? Who will do it? Make sure that responsibilities for all activities are being discussed.
- Are you expecting any problems to emerge during the coming week such as congenial weather conditions for pest buildup?
- What are the problems? How can we avoid it? How can we be prepared?
- Summarize the actions to be taken.


Advantages of AESA over ETL:

One of the problems of the ETL is that it is based on parameters that are changing all the time, and that are often not known. The damage or losses caused by a certain density of insects cannot be predicted at all. In ETL the due recognition of the role of natural enemies in decreasing pest population is ignored. Farmers cannot base their decisions on just a simple count of pests. They will

have to consider many other aspects of the crop (crop ecology, growth stage, natural enemies, weather condition, etc.) and their own economic and social situation before they can make the right crop management decisions. In ETL based IPM, natural enemies, plant compensation ability and abiotic factors are not considered. In AESA based IPM emphasis is given to natural enemies, plant compensation ability, abiotic factors and P: D ratio.

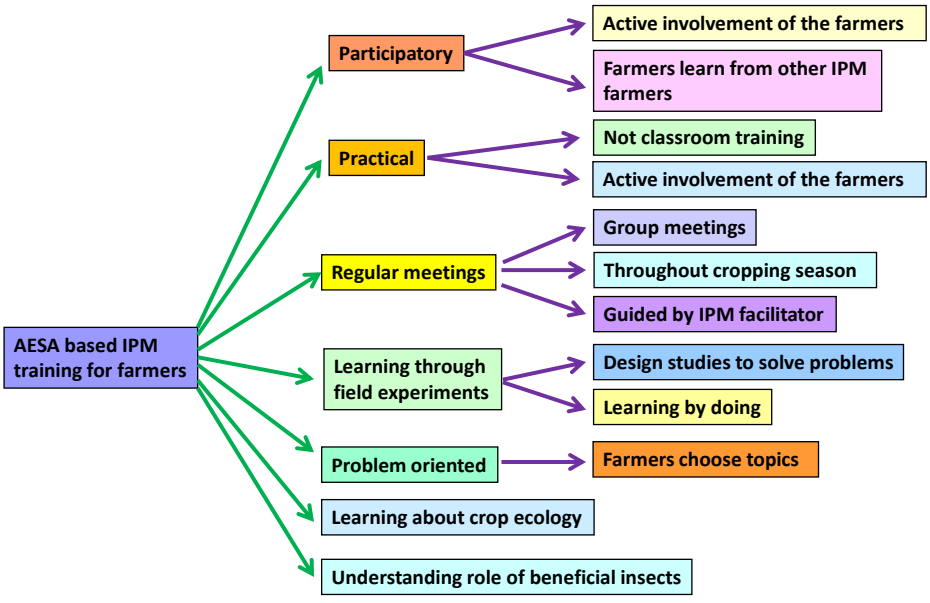
AESA and farmer field school (FFS):

AESA is a season-long training activity that takes place in the farmer field. It is season-long so that it covers all the different developmental stages of the crop and their related management practices. The process is always learner-centered, participatory and relying on an experiential learning approach and therefore it has become an integral part of FFS.

Farmers can learn from AESA:

- Identification of pests and their nature ofdamage
- Identification of natural enemies
- Management of pests
- Water and nutrient management
- Influence of weather factors on pest buildup
- Role of natural enemies in pest management

FFS to teach AESA based IPM skills



B. Field scouting:

AESA requires skill. So only the trained farmers can undertake this exercise. However, other farmers also can do field scouting in their own fields at regular intervals to monitor the major pest situation.

Surveillance on pest occurrence at the field should commence soon after crop establishment and at weekly intervals thereafter. In each field, select five spots randomly. Select five random plants at each spot for recording counts of insects as per procedure finalized for individual insects.

For Insect pests:
Aphids: Count and record the number of both nymphs and adults on five randomly selected leaves per plant.
Leaf miner: Only the number of live mines on five randomly selected leaves per plant should be counted and recorded.
Pod borer: Total number of pods, damaged pods due to pod borer and number of larvae on individual plants should be counted and recorded.

For diseases:
Whenever scouting, be aware that symptoms of plant disease problems may be caused by any biotic factors such as fungal, bacterial, viral pathogens or abiotic factors such as weather, fertilizers, nutrient deficiencies, pesticides and abiotic soil problems. In many cases, the cause of the symptom is not obvious. Close examination, and laboratory culture and analysis are required for proper diagnosis of the causal agent of disease. Generally fungal diseases cause the obvious symptoms with irregular growth, pattern & colour (except viruses), however abiotic problems cause regular, uniform symptoms. Pathogen presence (signs) on the symptoms can also be observed like fungal growth, bacterial ooze etc. Specific and characteristic symptoms of the important plant diseases are given in description of diseases section.

Root sampling: Always check plants that appear unhealthy. If there are no obvious symptoms on plants, examine plants randomly and look for lesions or rots on roots and stems. Observe the signs of the causal organism (fungal growth or ooze). It is often necessary to wash the roots with water to examine them properly. If the roots are well developed, cut them to examine the roots for internal infections (discolouration & signs). Count the total number of roots damaged/infested/infected due to rot should be counted and incidence should be recorded.

Leaf sampling: Examine all leaves of each plant for lesions. Leaf diseases cause most damage during the seedling and flowering stages of plant growth. Observe for the symptoms and signs on the infected plant parts. Determine the percent area of leaf infection by counting the number of leaves (leaf area diameter)/plant infected due to disease and incidence should be recorded.

Stem, flower and pod sampling: Carefully examine the stems, flower and pods of plants for signs of fungal material/diseases or lesions. The stems, flowers and pods should be split or taken apart and examined for discoloration caused by fungi and bacteria. Count the number of plant, flowers and pod infected due to disease and incidence should be recorded.

C. Surveillance through pheromone trap catches:

Pheromone traps for pod borer, *H. armigera* @ 4-5 traps/acre have to be installed, if available. Install the traps for each species separated by a distance of >75 feet in the vicinity of the selected field. Fix the traps to the supporting pole at a height of one foot above the plant canopy. Change of

lures should be made at 2-3 week interval (regular interval). During each week of surveillance, the number of moths/trap should be counted and recorded. The trapped moths should be removed and destroyed after each recording.

D. Yellow/blue pan water trap/sticky traps:

Set up yellow pan water trap/sticky traps 15 cm above the canopy for monitoring aphids @ 4-5 traps/acre. Locally available empty tins can be painted yellow/ and coated with grease/Vaseline/castor oil on outer surface may also be used.

E. Light traps:

Set up light traps @ 1 trap/acre 15 cm above the crop canopy for monitoring and mass trapping of nocturnal insects. Light traps with exit option for natural enemies of smaller size should be installed and operated around the dusk time (6 pm to 10 pm).

F. Nematode sampling:

Collect 100 to 300 cm^3 (200-300 g) representative soil sample. Mix soil sample and pass through a coarse sieve to remove rocks, roots, etc. Take a 600 cc subsample of soil, pack lightly into a beaker uniformly. Place soil in one of the buckets or pans half filled with water. Mix soil and water by stirring with paddle; allow to stand until water almost stops swirling. Pour all but heavy sediment through 20-mesh sieve into second bucket; discard residue in first bucket; discard material caught on sieve. Stir material in second bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 200-mesh sieve into first bucket; discard residue in second bucket. Backwash material caught on 200-mesh sieve (which includes large nematodes) into 250-ml beaker. Stir material in first bucket; allow to stand until water almost stops swirling. Pour all but heavy sediment through 325-mesh sieve into second bucket; discard residue in first bucket. Backwash material caught on 325-mesh sieve (which includes small to mid-sized nematodes and silty material) into 250-ml beaker. More than 90% of the live nematodes are recovered in the first 5-8 mm of water drawn from the rubber tubing and the sample is placed in a shallow dish for examination.

III. ECOLOGICAL ENGINEERING FOR PEST MANAGEMENT

Ecological engineering for pest management has recently emerged as a paradigm for considering pest management approaches that rely on the use of cultural techniques to effect habitat manipulation and to enhance biological control. Ecological engineering for pest management is based on informed ecological knowledge rather than high technology approaches such as synthetic pesticides and genetically engineered crops (Gurr et al. 2004 a, b).

Ecological Engineering for Pest Management – Below Ground:

There is a growing realization that the soil borne, seed and seedling borne diseases can be managed with microbial interventions, besides choosing appropriate plant varieties. The following activities increase the beneficial microbial population and enhance soil fertility.

- Crop rotations with other leguminous crops which enhance nitrogen content.
- Keep soils covered year-round with living vegetation and/or crop residue.
- Add organic matter in the form of farm yard manure (FYM), vermicompost, crop residue which enhance below ground biodiversity of beneficial microbes and insects.
- Application of balanced dose of nutrients using biofertilizers based on soil test report.
- Application of biofertilizers with special focus on mycorrhiza and plant growth promoting rhizobia (PGPR)

- Application of *Trichoderma harzianum/ viride* and *Pseudomonas fluorescens* for treatment of seed/seedling/planting materials in the nurseries and field application (if commercial products are used, check for label claim. However, biopesticides produced by farmers for own consumption in their fields, registration is not required).

Ecological Engineering for Pest Management – Above Ground:

Natural enemies play a very significant role in control of foliar insect pests. Natural enemy diversity contributes significantly to management of insect pests both below and above ground.

Natural enemies may require:

1. Food in the form of pollen and nectar.
2. Shelter, overwintering sites and moderate microclimate etc.
3. Alternate hosts when primary hosts are not present.

In order to attract natural enemies following activities should be practiced:

- Raise the flowering plants / compatible cash crops along the field border by arranging shorter plants towards main crop and taller plants towards the border to attract natural enemies as well as to avoid immigrating pest population
- Grow flowering plants on the internal bunds inside the field
- Not to uproot weed plants those are growing naturally such as *Tridax procumbens, Ageratum* sp, *Alternanthera* sp etc. which act as nectar source for natural enemies,
- Not to apply broad spectrum chemical pesticides, when the P: D ratio is favourable. The plant compensation ability should also be considered before applying chemical pesticides.
- Reduce tillage intensity so that hibernating natural enemies can be saved.
- Select and plant appropriate companion plants which could be trap crops and pest repellent crops. The trap crops and pest repellent crops will also recruit natural enemies as their flowers provide nectar and the plants provide suitable microclimate.

Due to enhancement of biodiversity by the flowering plants, parasitoids and predators (natural enemies) number also will increase due to availability of nectar, pollen and insects etc. The major predators are a wide variety of spiders, ladybird beetles, long horned grasshoppers, *Chrysoperla,* earwigs, etc.

Plants suitable for Ecological Engineering for Pest Management

Attractant plants

Cluster bean

Cowpea

Carrot

Sunflower

Buckwheat

French bean

Alfalfa

Maize

Mustard

***Coreopsis* spp.**

Cosmos

Dandelion

Anise

Caraway

Dill

Parsley

Repellent plants


***Ocimum*spp** **Peppermint**

Border plants



Sorghum **Maize** **Bajra**

Intercrops

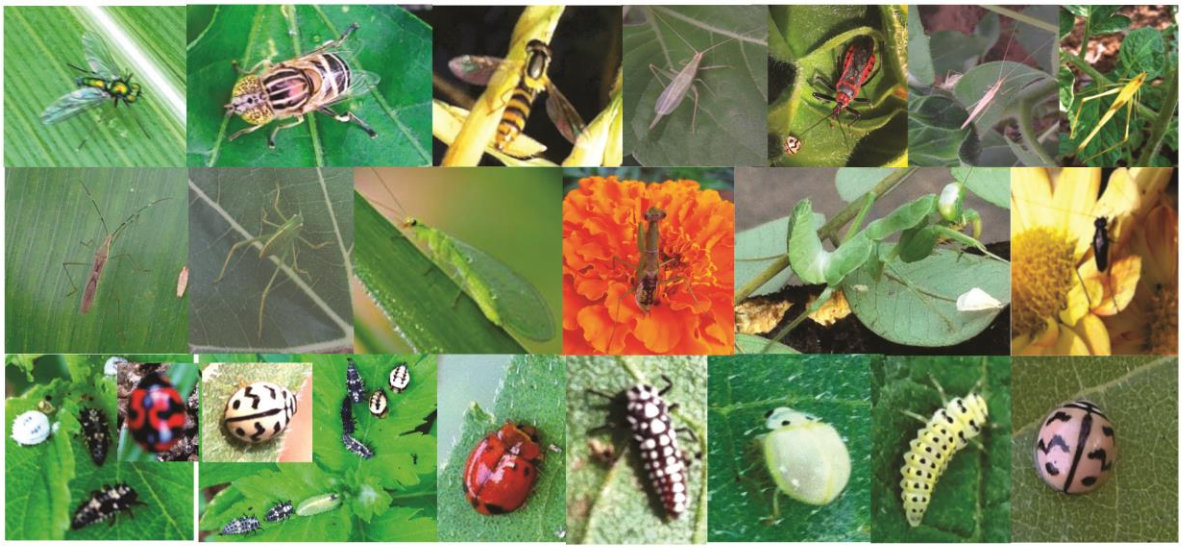

BlacKgram **Groundnut**

The flowering plants suggested under Ecological Engineering for pest management strategy are known as attractant plants to the natural enemies of the selected pests. The information is based on published research literature. However, the actual selection of flowering plants could be based on availability, agro-climatic conditions and soil types

Biodiversity of natural enemies observed in Ecological Engineering field at NIPHM

Biodiversity of natural enemies: Parasitoids

Biodiversity of natural enemies: Predators



Biodiversity of natural enemies: Spiders

IV. RESISTANT/TOLERANTVARIETIES

Disease	RESISTANT/TOLERANT VARIETIES *
Powdery mildew	Rachna, Pant P5, DMR 11, HUP 2, JP 885, KFP 103, Ambika, Shubhra, Aparna, Azad P4, Pusa Panna
Rust	Hans, DMR 11, Type 163

***For detail contact nearest SAUs, ICAR Institutes and KVKs**

A. For Chhattisgarh state Resistant Varieties:

Variety	Adaption	Special character
HFP 4 (Apama)	NWPZ	Powdery mildew resistant Dwarf
DDR 13	NEPZ and CZ	Powdery mildew resistant Dwarf
HFP 8909	NEPZ and CZ	Powdery mildew resistant Dwarf
KPMR 114-1	NEPZ	Powdery mildew resistant Dwarf
Malviya Matar 15	NEPZ	Dwarf, powdery mildew, rust resistant

NHZ: North Hill Zone (J & K and Hilly areas of Himachal Pradesh and UP)
NWPZ: North West Plain Zone (Punjab, Haryana, Western LIP.)
NEPZ: North East Plain Zone (Eastern UP., Bihar, West Bengal, Plain of Assam)
CZ: Central Zone

IV. CROP STAGE-WISE IPM

Management	Activity
Pre-sowing*	
	<u>Common cultural practices:</u> • Deep ploughing of fields during summer. Three summer ploughings at 10 days interval reduces pests population. • Timely sowing should be done. • Field sanitation, rogueing • Destroy the alternate host plants • Apply manures and fertilizers as per soil test recommendations. • Grow the attractant, repellent, and trap crops around the field bunds. • Growing tomato or marigold as a trap crop for the management of leaf miner. • Plant tall border crops like maize, sorghum for the management of aphids. • Crop rotation with non-host crops.
Nutrients	• Fertilizers should be applied on the basis of soil test report and recommendations for particular agro-climatic zone. • Apply well decomposed FYM @ 8-10 t per acre treated with *Trichoderma* at the time of field preparation.
Weeds	• Summer ploughing should be done and field is left for 15 days. • Solarisation can be done after giving light irrigation in morning

	and then covering the field by transparent polyethylene sheets for 25 days so that the weed seeds are killed due to heat effect. • At the time of field preparation, adopt stale seed bed technique i.e. pre sowing irrigation followed by shallow tillage to minimize the weeds menace in field.
Fungal pathogens, nematodes, and resting stages of insects	**Cultural control:** • Deep summer ploughing of fields to control nematodes and exposes dormant stages (pupa and larva) of insect pest and subsequently reduces their initial population build up • **Soil solarization:** Cover the beds with transparent polythene sheet of 100 gauge thickness for three weeks before sowing for soil solarization which will help in reducing the soil-borne pests including weeds.
Seed Sowing*	
Nutrients:	• Seed treatment should be done with *Rhizobium* cultures @ 250 g/acre. • Apply starter dose of 10 Kg of Nitrogen along with 28 Kg P_2O_5 and 25 Kg K_2O/acre at the time of sowing.
Weeds:	**Cultural control:** • Always use certified and weed free seeds. • Timely sowing should be done. • Line sowing should be done to facilitate inter-culture operations. • Plant population should be maintained to its optimum right from its beginning to minimize the crop weed competition. **Chemical control:** • Apply linuron 50% WP @ 0.5 to 0.8 Kg per acre in 200 l of water as pre emergence to control *Anagallis arvensis, Chenopodium album, Chenopodium murale, Portulaca oleracea, Mielilotus indica, Melilotus alba, Medicago denticulate, Fumeria parviflora, Echinochloa crusgalli, Poa annua.*
Soil-borne pathogens, nematodes, and resting stages of insects	• Use resistant/tolerant varieties. • Avoid late sowing of the crop.
*Apply *Trichoderma viride/ harzianum* and *Pseudomonas fluorescens* as for treatment of seed tubers and soil application (If Commercial products are used, check for label claim. However, biopesticides produced by farmers for own consumption in their fields, registration is not required).	
Vegetative stage	
	Common cultural practices: • Collect and destroy diseased and insect infected plant parts. • Provide irrigation at critical stages of the crop • Avoid water stagnation. • Enhance parasitic activity by avoiding chemical spray, when 1-2 larval parasitoids are observed **Common mechanical practices:** • Collection and destruction of eggs and early stage larvae • Handpick the older larvae during early stages

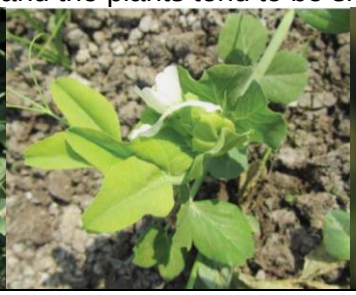
	• The infested pods may be collected and destroyed • Handpick the gregarious caterpillars and the pupae which are found on leaves and destroy them in kerosene mixed water. • Use yellow sticky traps for aphids @ 4-5 trap/acre. • Use light trap @ 1/acre and operate between 6 pm and 10 pm • Install pheromone traps @ 4-5/acre for monitoring adult moths activity (replace the lures with fresh lures after every 2-3 weeks) • Erecting of bird perches @ 20/acre for encouraging predatory birds such as King crow, common mynah etc. • Set up bonfire during evening hours at 7-8 pm **Common biological practices:** • Conserve natural enemies through ecological engineering • Augmentative release of natural enemies
Nutrients:	• In case of stunted/ slow crop growth, use top dressing of N fertilizers @ 5-10 Kg per acre. • Correct micronutrient deficiency if any in standing crop.
Weeds:	• Legumes suffer severe competition with weeds in initial stages and 30-45 days is the critical period of weed crop competition • One to two hands weeding at 25-30 days and/ or 45 days after sowing should be done as per the requirement.
Pea pod borer	**Cultural control:** • Deep ploughing is likely to kill the diapausing pupae. • Hand picking of the caterpillar and pupae during the early stages of infestation reduces the pest damage. **Biological control:** • Follow common biological practices **Chemical control:** • Malathion 50%EC @ 600 ml in 200- 400 l water per acre.
Stem fly	**Cultural control:** • Mulching with the rice straw. • Apply balanced fertilizers having adequate N and P to promote better plant growth **Biological control:** • Follow common biological practices **Chemical control:** • Carbofuran 3% CG @ 400 g per acre.
Pea aphid**	**Cultural control:** • Judicious use of nitrogenous fertilizers • Regular field monitoring for pest & defender population, barrier crops like mustard crop around the field. • Plant tall border crops like maize, sorghum or millet to reduce pest population. **Biological control:** • Release 1st instar larvae of green lacewing (*Chrysoperla zastrow sillemi*) @ 4000/acre • Follow common biological practices **Chemical control:** • Carbofuran 3% CG @ 400 g per acre.

Leaf miner**	**Cultural control:** • Remove and destroy the infested leaves identified by the mines and blotches. • Use yellow sticky traps/ cards for leaf miners adult fly. **Biological control:** • Follow common biological practices •.
Powdery mildew	**Cultural control:** • Use resistant varieties. • Burn infected pea stubble soon after harvest where practicable. • Avoid sowing field pea crops adjacent to last season's stubble. • Control volunteer field peas which can harbour disease. • Adopt bower system. **Chemical control:** • Benomyl 50 % WP @ 80g in 240 l water per acre or carbendazim 50% WP@ 100g in 240 l water per acre ordinocap 48% EC @ 120g in 300 l water per acre or Fenarimol 12% EC @ 0.04% (40 ml/100 lts of water) as required depending on stage of crop. Second spray after 15 days of interval or sulphur 40% WP 2.26- 3.00 Kg in 300- 400 l of water per acre or sulphur 52% SC 800 ml in 120- 160 l of water per acre or Sulphur 80% WG @ 750 gm – 1.0 Kg in in 300- 400 l water per acre or sulphur 85%DP @ 6 – 8 Kg per acre or triadimefon 25% WP @ 0.1 % in 300 l water per acre. Second spray after 25 days of interval.
Rust	**Cultural control:** • Destroy all diseased plant debris after harvest. • Follow suitable crop rotation with non-leguminous crops. • Mixed cropping. **Chemical control:** • Sulphur 80% WP @ 1.252 Kg in 300- 400 l water per acre or .sulphur85%DP @ 6 – 8 Kg per acre or triadimefon 25% WP @ 0.1 % in 300 l water per acre. Second spray after 25 days of interval.
Downy mildew**	**Cultural control:** • The diseased plants should be removed and burnt soon after detecting in the field.
Ascochyta blight**	**Cultural control:** • Plantation of tall plant crop as a barrier for air borne inoculum
White rot**	**Cultural control:** • Follow common cultural practices
Root rot**	**Cultural control:** • Keep wider spacing. • Maintain irrigation • Follow common cultural practices
Fusarium wilt**	**Cultural control:** • Follow common cultural practices

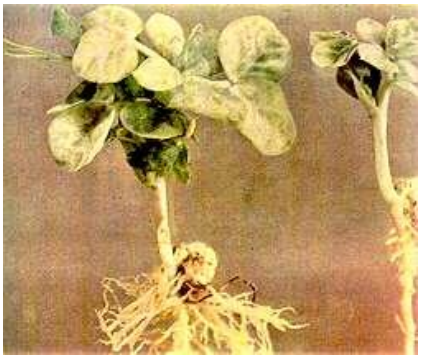
Pea Weevil/ bruchid	**<u>Cultural control:</u>** • Early harvest of peas also reduces pod shatter and pea splitting losses. • Cut the volunteer and weed plant. • Proper sanitation of godown store house. • Disinfect the gunny bags that carry the pea grains. **<u>Biological control:</u>** • Follow common biological practices
Reproductive stage	
Nutrient	• Incorporate crop residues in soil immediately after harvest.
Weed	• Remove left over weeds before shedding of their weed seeds to prevent further spread.
Diseases & pests	• Same as in vegetative stage

** Regional Insect pest and diseases

VII. NUTRITIONAL DEFICIENCIES/DISORDERS

Sr. no.	Deficiency symptoms
1.	**Nitrogen deficiency**
	The common symptoms of nitrogen deficiency are general yellowing of entire plant. The plants appear stunted and have small leaves. The deficiency symptoms typically appear first on lower leaves. Initially, the whole plant appears light green. The lower leaves gradually turn pale yellow to yellow while the young leaves appear light green. Subsequently the lower leaves become white then brown necrotic. 
2.	**Potassium deficiency:**
	Leavesbecome dark green with yellowing and fining of the lower leaves at margins. The leaflets are cupped downward, the pods are poorly filled and growth generally is retarded.  
3.	**Sulphur deficiency:**
	Younger leaves including the veins turn yellow, in severe deficiency situations the older leaves also turn yellow, and the plants tend to be small and slender.   
4.	**Iron deficiency:**
	Iron deficiency causes yellowing between the veins, progresses to severely yellowed or chlorotic leaves, caused by complete absence of green chlorophyll. Crops growing on high pH black clay soils may develop both iron and manganese deficiencies. Foliar sprays have been used to treat both deficiencies successfully.

	
5.	**Boron toxicity:**
	Boron toxicity occurs on many of the alkaline soil cropping areas. The most characteristic symptom of boron toxicity in pea is chlorosis, and some necrosis if severe, at the tips or margins of the leaves. The older leaves are usually more affected.  http://books.google.co.in/books?id=S6ANAwAAQBAJ&pg=PA123&lpg=PA123&dq=nutrient+deficiency+symptoms+in+pea&source=bl&ots=0Xg-YESNyP&sig=Hdw2nHEPhfEX9deh9B5x5-3m270&hl=en&sa=X&ei=BD3PU84ZIJa4BMvGgcAE&ved=0CFkQ6AEwDA#v=onepage&q&f=true http://www.grdc.com.au/uploads/documents/4%20Nutrition.pdf
6	**Magnesium deficiency**
	Leaves displaying signs of magnesium deficiency, with the characteristic 'interveinal chlorosis' – the area between the leaf veins losing its green. This generally happens with the older leaves of the plant. **In p**eas, central intervenal chlorosis and green marginal band are observed.  http://customers.hbci.com/~wenonah/min-def/peas.htm
7	**Manganese deficiency**
	Yellow to white colored leaves, but with green veins. First noted on new growth. May have a typical 'grey speck' symptom. Each new leaf becomes more chlorotic. Brown lesions in centers of cotyledons ("Marsh spot") in pea seeds.

	 http://www.gardensalive.com/article.asp?ai=57
8.	**Boron deficiency**
	Stems thickened and stiff, growth squat and bushy habit; foliage chlorotic, young leaflets small and tips brown; growing points die.  http://customers.hbci.com/~wenonah/min-def/peas.htm

VII. DESCRIPTION OF WEEDS

1. Lambs quarter: *Chenopodium album* L. (Chenopodiaceae)

2. White Sweet Clover: *Melilotus alba*L. (Fabaceae)

3. Common vetch: *Vicia sativa* L. (Fabaceae)

4. Yellow vetchling *Lathyrus aphaca*L. (Fabaceae)

5. Slender amaranth: *Amaranthus viridis* Hook. F. (Amaranthaceae)

6. Scarlet pimpernel: *Anagallis arvensis* L. (Primulaceae)

7. Wild fenugreek: *Trigonella polycerata* auct. non Linn. (Fabaceae)

8. Fineleaf fumitory: *Fumaria parviflora* Lam. (Fumariaceae)

9. Chinese lovegrass: *Eragrostisunioloides*(Retz.) Nees. Ex Steud (Poaceae)

10. Goosegrass:
***Eleusine indica* (L.)Gaertner (Poaceae)**

11. Giradol:
***Chrozophora plicata* (Vahl) A. Juss. ex Spreng (Euphorbiaceae)**

12. Wild oat:
***Avena fatua* L. (Poaceae)**

13. Field bindweed:
***Convolvulus arvensis* L. (Convolvulaceae)**

14. Purple nutsedge:
***Cyperusrotundus*L. (Cyperaceae)**

15. Congress grass:*Partheniumhysterophorus*L. Asteraceae

16. Egyptian crowfoot grass:
***Dactylocteniumaegyptium* (L.) WilldPoaceae**

17. Asthma herb:
***Euphorbia hirta*L. Euphorbiaceae**

18. Bluegrass:
***Poaannua*L. Poaceae**

19. Canary grass:
***Phalaris minor* Retz.**
Poaceae

20. Corn spurry
***Spergulaarvensis* L.**
Caryophyllaceae

VIII. DESCRIPTION OF INSECT PESTS

1) Pea pod borer: *Etiella zinckenella* Treitschke

Biology:

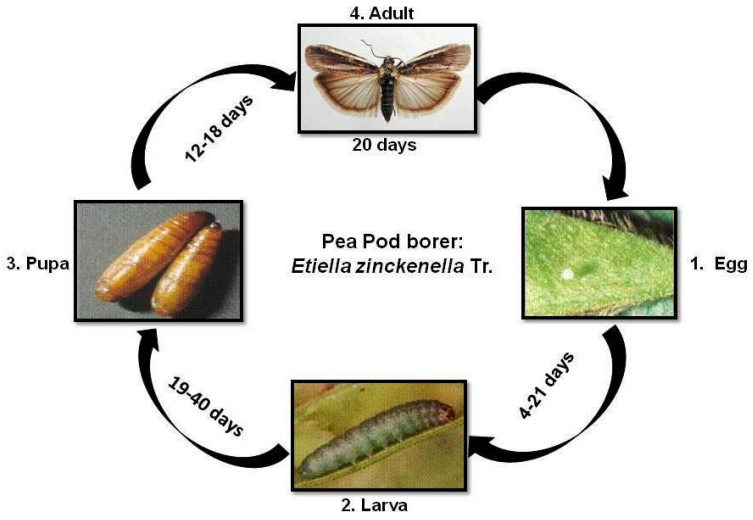
Eggs: Development of egg lasts 4-21 days depending on weather conditions. Average fecundity is about 100-300, maximum 600 eggs.

Larva: Coloration of larvae is variable, from dirty greenish-gray to reddish; body length 15-22 mm and larval period is about 19-40 days depending upon weather conditions.

Pupa: Pupa is brilliant, brown, fine punctured, to 7-10 mm in length; cocoon is thick, white, and usually covered with soil particles. Pupal period is about 12-18 days. Number of generations per year reaches three, though the third generation can be facultative. Overwinters as larva.

Adults: Body length 8-11 mm, wingspan 19-27 mm. Wings longer than abdomen, folding as roof. Forewing is yellow- or greyish-brown with characteristic light stripe along fore edge, with orange spot on basal third, and with dark fringe. Hind wings are light gray, with dark venation and dark double line near fringe; the fringe is long and light in colour. Top of abdomen with a tuft of golden-yellow hairs. Life span of adult is 20 days

Life cycle:



Damage symptoms:

- Dropping of flowers and young pods
- As the larva develops within the pod, faeces accumulate causing soft, rotten patches on the pod.
- Seeds are either partially or entirely eaten, and considerable frass and silk are present.
- Older pods marked with a brown spot where a larvae has entered



http://www.nbaii.res.in/insectpests/images/Etiella-zinckenella14.jpg
http://www.nbaii.res.in/insectpests/images/Etiella-zinckenella3.jpg
http://tnau.ac.in/eagri/eagri50/ENTO331/lecture06/006_clip_image004.png

Parasitoids:
Eggparasitoids:*Trichogrammatoidea armigera..,*
Larval parasitoids: *Bracon hebetor,* *Phanerotoma* sp., *Tetrastichus* sp, *Phanerotoma planifrons*

2) Pod borer: *Helicoverpa armigera* Hübner

Biology:

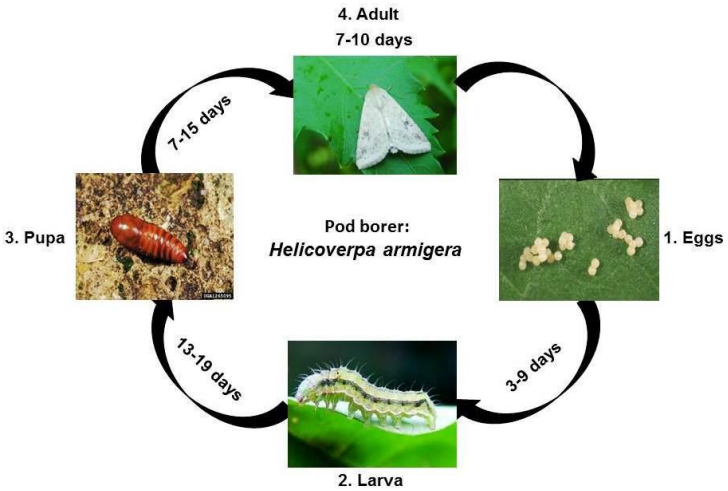
Egg: Gravid females lay eggs singly mostly on tender parts of the plants. Eggs are globular and shinning greenish yellow in colour. Incubation period ranges from3- 9 days depending upon weather conditions.

Larva: Full grown larva is about 3.5 cm long. Larvas vary in colour, initially brown and later turn greenish with darker broken lines along the side of the body. The larval period lasts for 13- 19 days. Body covered with radiating hairs.

Pupa: The full grown caterpillar pupates in the soil in an earthen cell and emerges in 16-21 days. Pupation takes place inside the soil. Pupal stage lasts 7-15 days.

Adult: Moth is stout, medium sized with brownish/grayish forewings with a dark cross band near outer margin and dark spots near costal margins, with a wing expense of 3.7cm.

Life cycle:



Damage symptoms:

- At early stage they feed on the foliage and sometime cause serious defoliation.
- During reproductive stage they bore the developing pod and feed on the seeds with its head typically thrust inside and most of the part of the body outside.
- Damaged pods are unfit for human consumption.

3) Stem fly:

Biology:

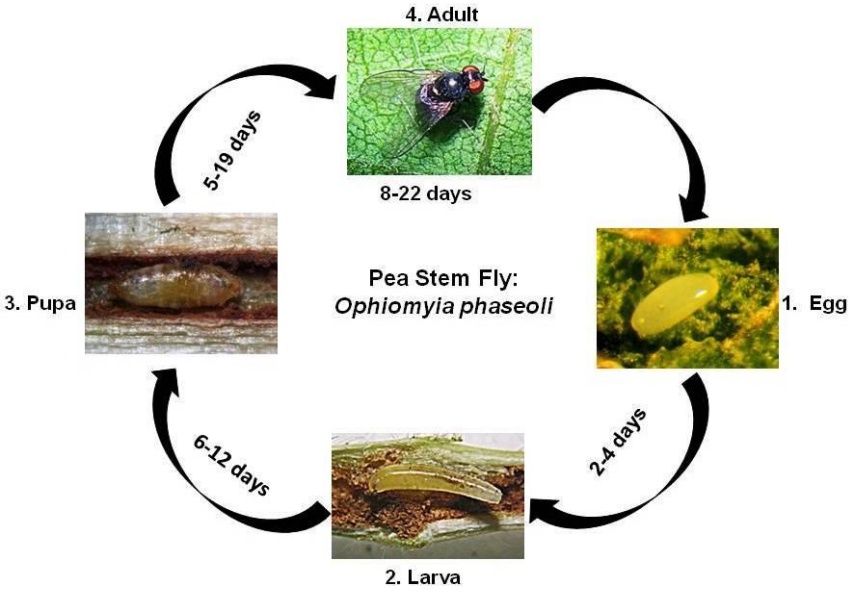
Egg: The female lays 14-64· elongate, oval and white eggs singly into the leaf tissue with the help of its elongated ovipositor. The eggs hatch in 2-4 days

Larva: Larva pass through three instars and the larval development is completed in 6-12 days.

Pupa: The larva pupates within its gallery and the pupal period lasts 5-19 days.

Adult: The adult flies are metallic black. They are active in summer and mate 2-6 days after emergence The female flies live for 8-22 days and the males for 11 days. The pest completes 8-9 generations.

Life cycle:



Damage symptoms:

- The maggots bore into the stem thereby causing withering and ultimate drying of the affected shoots, thus reducing the bearing capacity of the host plants.
- The adults also cause damage by puncturing the leaves, and the injured parts turn yellow.
- The damage is more severe on seedlings than on the grown up plants.

Parasitoids of stem fly: Braconid wasp

4) Pea Weevil:

Biology:

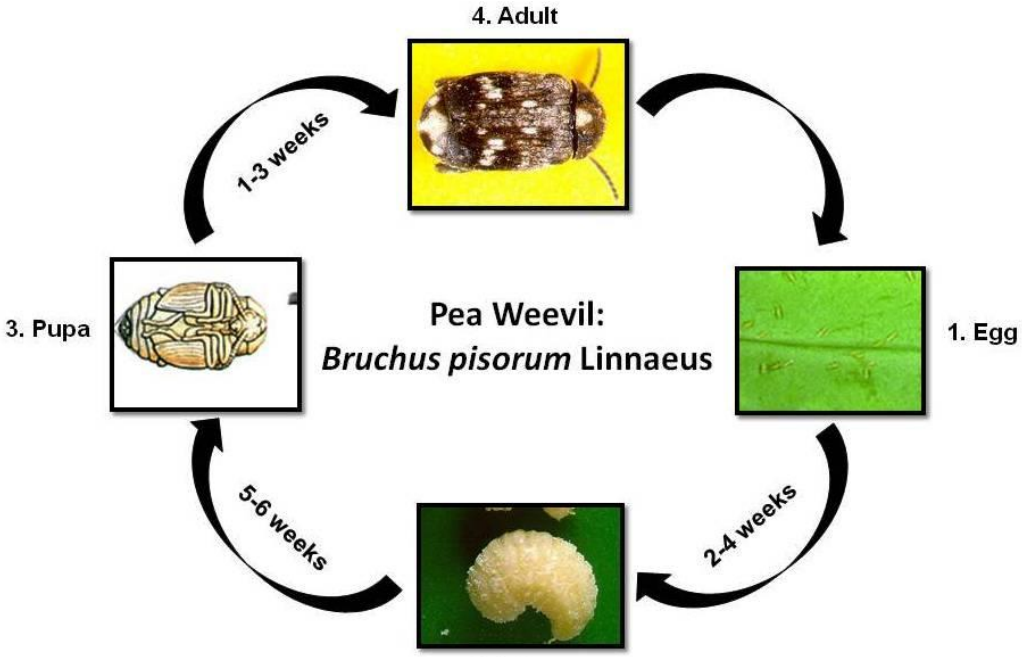
Egg: The egg is yellow, cigar-shaped and measures 1.5 mm by 0.6 mm.

Larva: The larva is a legless, curled, cream grub which grows to about 5- 7 mm long.

Pupa: Pupation takes place in inside the pods. The pupal stage lasts1-3 weeks depending upon season.

Adult: The adult is a chunky beetle about 5 mm long, generally brownish flecked with white, black and grey patches. The tip of the abdomen extends beyond the wing covers and is white marked with two black oval spots.

Life cycle:



http://www.sardi.sa.gov.au/__data/assets/image/0005/45563/peawee.jpg
http://www.sardi.sa.gov.au/__data/assets/image/0011/45488/larvae.jpg
http://insects.tamu.edu/extension/youth/bug/images/peaweevil_uiuc_daveschulz.gif

Damage symptoms:

- The larvae burrow straight through the pods to feed on the seed, so are not readily found for identification until seed is mature (above) and it is too late for control.

http://www.sardi.sa.gov.au/__data/assets/image/0016/45601/peapod.jpg
http://www.sardi.sa.gov.au/__data/assets/image/0005/45464/lareggs.jpg
http://www.sardi.sa.gov.au/__data/assets/image/0008/45458/peaweevil_damage1.jpg

Parasitoids

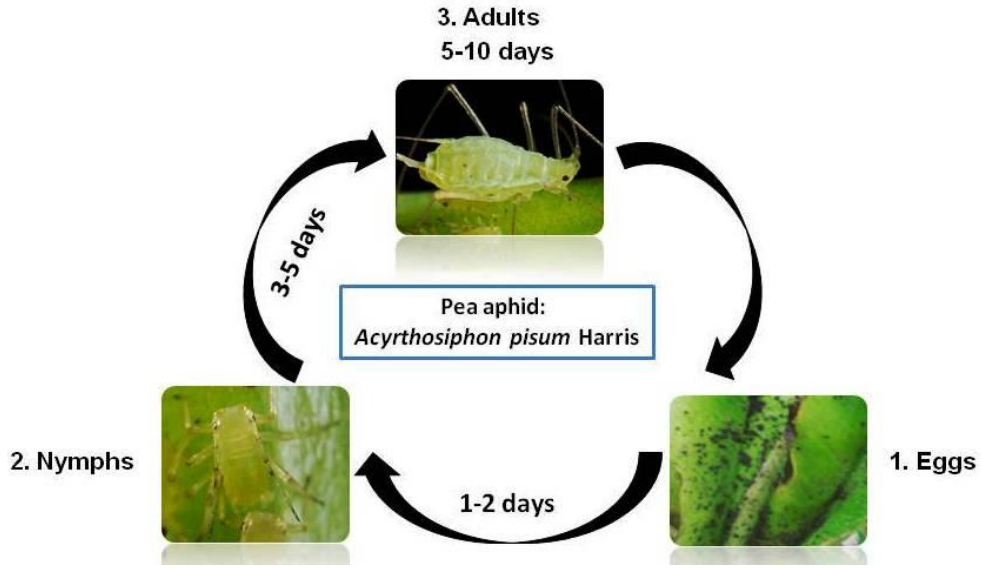
Larval parasitoid: *Dinarmus basalis*

5) Pea aphid

Biology:

- Adult aphids are soft bodied, long legged, pear-shaped, green yellow or pink in colour with long conspicuous cornicles Both alate as well as apterous forms are present and these are generally females; males are rare.
- Reproduction is parthenogenetic and viviparous. It takes about a week to complete one generation and there are several overlapping generations in a year.

Life cycle:



http://upload.wikimedia.org/wikipedia/commons/2/20/Acyrthosiphon_pisum_%28pea_aphid%29-PLoS.jpg

Damage symptoms:

- Both nymphs and adults suck the sap from young shoots, ventral surface of tender leaves, inflorescence and even on stems.
- Curling and distortion of leaves, stunting and malformation shoots occur.
- Leaves turn pale and dry. Honeydew secretion of aphids leads to sooty mould which hinders the photosynthetic activity of the plants.

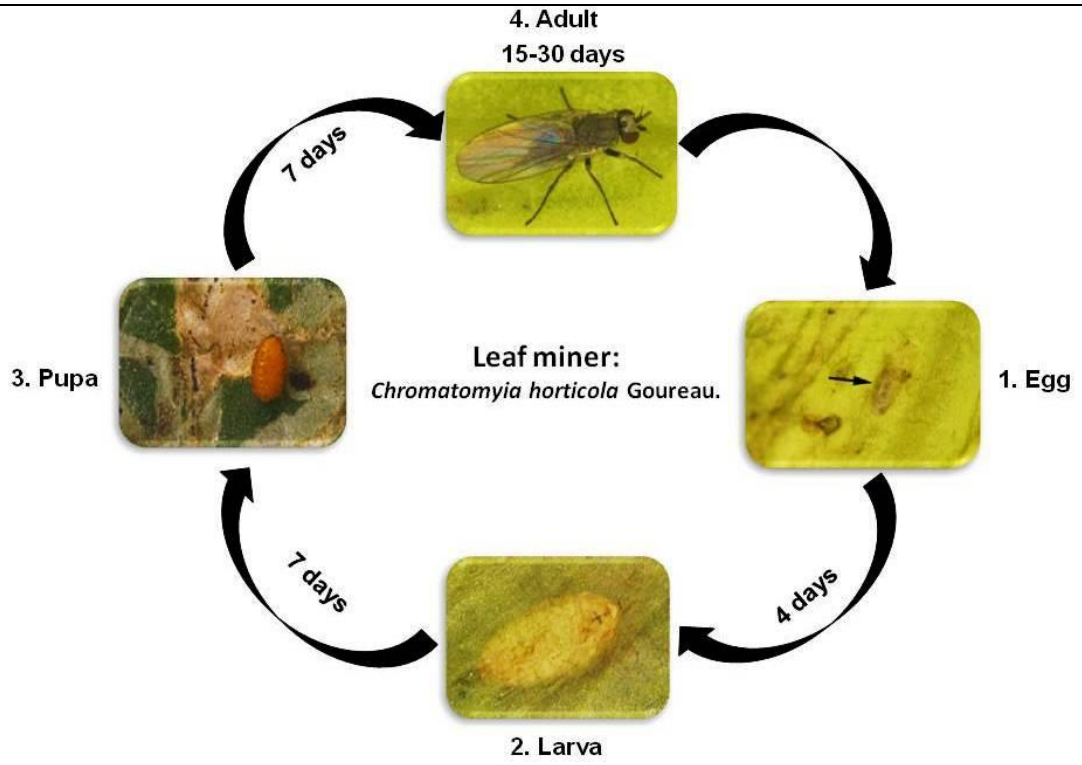
Parasitoids of aphids: Parasitic wasp, *Aphadius* sp., *Aphalinus* sp., *Diaeretiella rapae*
Predators of pea aphids : Lacewing, ladybird beetles Predatory mite, Syrphid fly
*For management refer to page number----------

6) Leaf miner:

Biology:

Egg: Eggs are minute in size and orange yellow in colour. The egg hatches in 4 days.
Larva: Apodous maggot feeds on chlorophyll mining in between epidermal layers. Full grown maggot measures 3 mm. Larval duration is about 7 days.
Pupa: Pupation takes place inside a thin loose mesh of silken cocoon. Pupal period is about 7 days.
Adult: It is a pale yellowish fly, measuring 1.5 mm in length. The female fly punctures upper surface of leaf to lay eggs singly. Total life cycle takes 3 weeks.

Life cycle:



1.http://www.nbaii.res.in/insectpests/images/Chromatomyia-horticola3.jpg
2. http://www.nbaii.res.in/insectpests/images/Liriomyza-trifolii3.jpg
3.http://www.nbaii.res.in/insectpests/images/Chromatomyia-horticola8.jpg
4.http://www.nbaii.res.in/insectpests/images/Chromatomyia-horticola1.jpg

Damage symptoms:

- The large number of tunnels made by the larvae between the lower and upper epidermis interferes with photosynthesis and proper growth of the plants, making them look unattractive.
- Leaves with serpentine mines
- Drying dropping of leaves in severe cases

Mining on leaves

1 2 3.

1. http://www.forestryimages.org/images/768x512/5368109.jpg
2. http://www.leafmines.co.uk/Leaf%20mines%20CD/Diptera/Chromatomyia%20horticola1.jpg
3. http://www.infonet-biovision.org/res/res/files/1858.400x400.jpeg

Favourable conditions:

Warm weather conditions are favourable for multiplication.

Parasitoids:

Larval parasitoids: *Chrysocharis pentheus, Diglyphus isaea,*
Larval and pupal parastioids: *Gronotoma micromorpha, Neochrysocharis formosa*
Predators: Green lacewing, ladybird beetle, spider, red ant

*For management refer to page number----

Parasitoids

Egg parasitoids:

1. Trichogrammatoidea armigera

Larval parasitoids:

2. *Chrysocharispentheus*3. *Diglyphusisaea*
4Parasitic wasp

5. Braconidaewasp **6.*Dinarmusbasalis*** ***7.Braconhebetor***

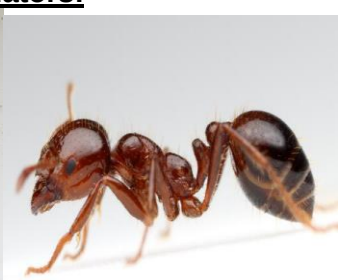
8. *Tetrastichus* sp. **9. *Phanerotoma*sp.** ***10. Phanerotomaplanifrons***

Larval and pupalparastioids:


11.*Gronotoma micromorpha*12. Pristomerus vulnerator

Predators:





13. Lady beetle **14. Spider** **15. Fire ant**


16. Predatory mite **17. Lacewing**

1. http://www.nbaii.res.in/Featured_insects/images/trichogrammatoidea-bactrae7.jpg
2. http://baba-insects.blogspot.in/2012/05/blog-post_21.html
3. http://www.evergreengrowers.com/diglyphus-isaea-114.html
4. http://www.shutterpoint.com/Photos-ViewPhoto.cfm?id=94159
5. http://upload.wikimedia.org/wikipedia/commons/5/53/Braconidae_Richard_Bartz.jpg
6. http://www.agroscope.admin.ch/biosicherheit/06534/06536/06859/index.html?lang=en&image=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1ad1IZn4Z2qZpnO2Yuq2Z6gpJCEe4B8gGym162bpYbqjKbNpKCVm67p
7. http://www.gipsa.usda.gov/VRI/Images/Insects/IN-BRACON-HEBETER-(PARASITOID).jpg
8. http://m7.i.pbase.com/o3/94/339594/1/125304607.y6JzXmeU.IMG_5714.JPG
9. http://bugguide.net/images/raw/KLGZHL9Z7LVZGL9ZPH3HUHAZPH9ZIL8Z4HAHSLOHZLDH7HVH7HVHIHCHQLVHKL1HXH4ZSL4ZIH6Z0L.jpg
10. http://gaga.biodiv.tw/9602/841.jpg
11. http://www.ento.csiro.au/science/Liriomyza_ver3/key/Eucoilidae_Key/Media/Html/gronotoma_sp.html
12. http://www.biolib.cz/IMG/GAL/92686.jpg
13. http://llladybug.blogspot.in/
14. http://en.wikipedia.org/wiki/Wolf_spider

15. http://www.couriermail.com.au/news/queensland/queensland-launched-a-war-against-the-fire-ant-invasion-but-12-years-later-they8217re-still-on-the-march/story-fnihsrf2-1226686256021
16. http://www.macro-world.cz/image.php?id_foto=514&gal=29
17. http://www.eduwebs.org/bugs/predmite.gif

IX. DESCRIPTION OF DISEASES

1)Downy mildew:

Disease symptoms:

- A grayish white, moldy growth appears on the lower leaf surface, and a yellowish area appears on the opposite side of the leaf.
- Infected leaves can turn yellow and die if weather is cool and damp.
- Stems may be distorted and stunted.
- Brown blotches appear on pods, and mold may grow inside pods.

Gray mildew of this fungus on the underside of the leaf.

1. http://pnwhandbooks.org/plantdisease/sites/default/files/imagecache/image_on_page/images/PeaDownyMildew.jpg
2. httpwww.pulseaus.com.aupdfField%20pea%20Disease%20Management%20Strategy%20Southern%20&%20Western%20Region.pdf
3. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm7819/$FILE/fieldpea_dm3_l.jpg

Favourable conditions:

- High humidity and low temperatures (5- 15°C) for few days are ideal for infection and development of disease.

Survival and spread:

Primary infection by soil, seed and water
Secondary infection by sporangia through rain splash or wind

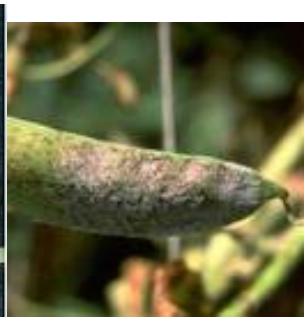
*For management refer to page number----------

2) Powdery mildew:

Disease symptoms:

- It attacks leaves first producing faint, slightly discolored specks from which grayish white powdery growth of mycelium develop.
- Powdery growth spread over leaf, stem and pod.
- The leaves turn yellow and die.
- The fruits do not either set or remain very small.
- It causes defoliation.
- Later stages, powdery growth also covers the pods.





1. httpwww.pulseaus.com.aupdfField%20pea%20Disease%20Management%20Strategy%20Southern%20&%20Western%20Region.pdf
2. http://www.depi.vic.gov.au/__data/assets/image/0006/227985/AG0147_image_one.jpg
3. http://www.ipm.ucdavis.edu/PMG/IMAGES/E/D-SP-EPOL-FR.001h.jpg

Survival and spread:

- Powdery mildew spores are carried by air and once active, will continue to spread in dry conditions.

Favourable conditions:

- Warm (temperature 15-25°C), humid (over 70% relative humidity) conditions for 4-5 days late in the growing season, during flowering and pod filling, favour disease development.

*For management refer to page number----------

3) Pea rust:

Disease symptoms:

- Leaves of infected plants exhibit many small, orange-brown pustules usually at the lower surface.
- Severely infected leaves wither and may drop from the plant.
- Larger pustules occur on the stems and isolated pustules may be found on the pods.
- Severe infection may result in reduced seed size and may cause yield losses of up to 30%,



http://www.discoverlife.org/mp/20p?img=I_MWS80534&res=640
http://www.discoverlife.org/mp/20p?img=I_MWS84829&res=mx
http://www.discoverlife.org/mp/20p?img=I_MWS84824&res=640

Survival and spread:

- Euphorbia and infected vegetation residues are sources of the infection.
- The agent is not transferred by seeds.

Favourable conditions:

- Frequent precipitations, plentiful dews and air temperature of 20-25°Cpromote development.
- Dry and hot weather restrains the disease development.

*For management refer to page number----------

4) *Ascochyta* blight:

Disease symptoms:

- Early symptoms are most commonly observed under the plant canopy, on lower leaves,

stems, and tendrils, where conditions are more humid.

- Symptoms first appear as small, purplish-brown and irregular flecks.
- Under continued humid conditions, the flecks enlarge and coalesce, resulting the lower leaves becoming completely blighted.
- Severe infections may lead to girdling of the stem near the soil line, which is known as foot rot.
- Foot rot lesions are purplish-black in colour and may extend above and below the soil line.
- Foot and stem lesions girdle and weaken the stem, leading to crop lodging and yield loss.
- Disease lesions develop on pods under prolonged moist conditions or if the crop has lodged.
- Pod lesions are initially small and dark, but may become extensive and lead to early pod senescence.
- Severe pod infection may result in small, shrunken or discoloured seed; or alternatively, seed may show no symptoms

http://www.agriculture.gov.sk.ca/Acoshyta_blight_6
http://www.2020seedlabs.ca/sites/default/files/Ascochyta%20-%20field%20pea%20pod.jpg
http://www.vffarms.com/images/resources/crop_health/peas/ascochyta_peas.pdf

Survival and spread:

- Ascospores carried long distances by wind.
- The asexual conidia travel short distances to new hosts via water splashes from rain.
- Infection originates from diseased seed or from spores growing on debris in the soil near pea plants.

Favourable conditions:

- Favorable conditions are warm humid conditions with a temperature is about 15^{o}C to 25^{o}C.

*For management refer to page number----------

5)White rot:

Disease symptoms:

- The infection may occur at any part of the foliage, mainly the stem or branches.
- The maximum infection develops at the flowering stage of the crop, when petals fall on

ground and these catch infection immediately and mycelial growth of fungus invades the stem and branches.

- At the point of infection, a dry discolored spot develops.
- It gradually girdles the entire stem and also progresses up and down.
- As a result of tissue necrosis, the portion of the plant beyond the point of infection wilts
- If the infection is at the base of the main stem, the entire plant wilts.
- If it occurs on branches, partial wilting occurs.
- The diseased tissues become whitish and may be shredded.

https://www.apsnet.org/edcenter/K-12/NewsViews/Article%20Images/2003_may_fig1.jpg
http://extension.oregonstate.edu/umatilla/mf/sites/default/files/Lyndon_Porter_Green_Pea_2010.pdf

Survival and spread:

- The infection caused by hard sclerotia left in soil or in plant debris.

Favourable conditions:

- When adequate moisture is available and temperature ranges between 4 and 20°C. However, light is essential for stimulation of apothecial production.

*For management refer to page number----------

6) Root rot:

Damage symptoms:

- Reddish brown to black streaks appear on primary and secondary roots.
- These streaks coalesce at later stages, leading to girdling of lower stem.
- Red discoloration of the vascular system can be seen, especially near cotyledon attachment.
- Stunted growth, yellowing and necrosis appear on the basal foliage.

http://www.ndsu.edu/pubweb/pulse-info/images/fieldpeapic/pea%20close.jpg
http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/crop14324/$FILE/au-2013-chatterton-fusarium-root-rot-in-peas.pdf

Survival and spread:

- Primary infection by soil, seed and water
- Secondary infection by conidia through rain splash or wind

Favourable conditions:

- Cool, wet weather conditions.
- Favourable conditions are higher soil temperatures 25° to 30°C and moderate soil

moisture.

*For management refer to page number----------

7. Wilt:

Disease symptoms:

- Symptom of the disease is more pronounced in 3 to 5 week old plants. In young seedlings, cotyledons droop and wither.
- Yellowing of lower leaves and stunting of plants.
- The xylem vessels develop brown discoloration and get distorted.
- Leaflet margins curl downward and inward.
- The stem may be slightly swollen and brittle near the soil.
- Internal woody stem tissue often is discolored, turning lemon brown to orange brown.
- Externally, the root system appears healthy; however, secondary root rots are likely to occur on plants wilted for long periods.
- Eventually, wilted plants may die.

http://agropedia.iitk.ac.in/sites/default/files/fusarium%20wilt1.jpg
http://www.mofga.org/Portals/2/Agricultural%20Services/Pest%20Reports/Fusarium%20wilt%20in%20peas.jpg
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/228036/Management-options-for-Fusarium-wilt-of-snow-peas.pdf

Survival and spread:

- Primary infection by Soil, Seed, Water
- Secondary infection by Conidia through rain splash.

Favourable conditions:

- A soil temperature of 23° to 27°C is most favourable for *Fusarium* wilt.
- Hot weather and warm soils.

1. Root-knot nematodes:

Damage symptoms:

- Root-knot nematode feed on tender roots and base of pseudostem causing stunting, chlorosis, poor tillering and necrosis of leaves are the common aerial symptoms.
- Characteristic root galls and lesions that lead to rotting are generally seen in roots.
- The infested roots have brown, water soaked areas in the outer tissues.
- Nematode infestation aggravates root rot disease.

1. http://extension.udel.edu/kentagextension/wp-content/blogs.dir/11/files/blogger/_8xC9bwq6AVU/Slht-k9RXvI/AAAAAAAAIZ8/GabXgkw56Jo/s1600/pearootknot.JPG
2. http://visualsunlimited.photoshelter.com/img/pixel.gif

1. Root Knot Nematode on pea roots **2. Pea crop damaged by root knot nematode**

Survival and spread:

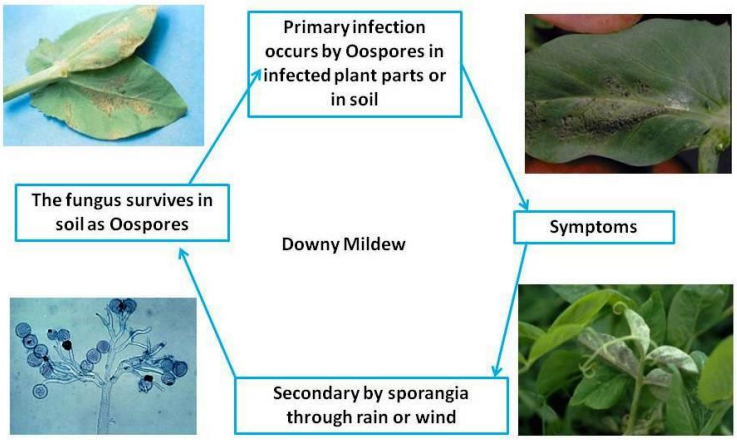
- Nematodes survive in soil and infected roots as primary inoculums.
- Therefore, tissues from infected crops remaining in the field serve as a reservoir of the fungus.
- It spreads from infected plants or through soil.

Favourable conditions:

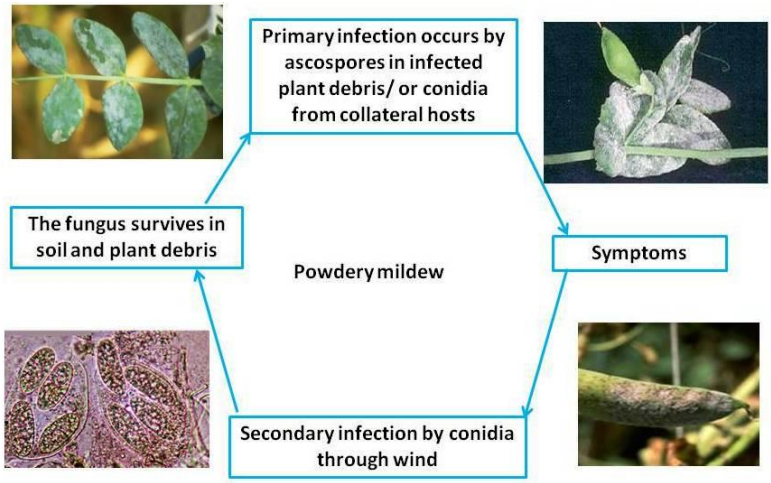
- Warm, moist soil are favourable conditions

*For management refer to page number----------

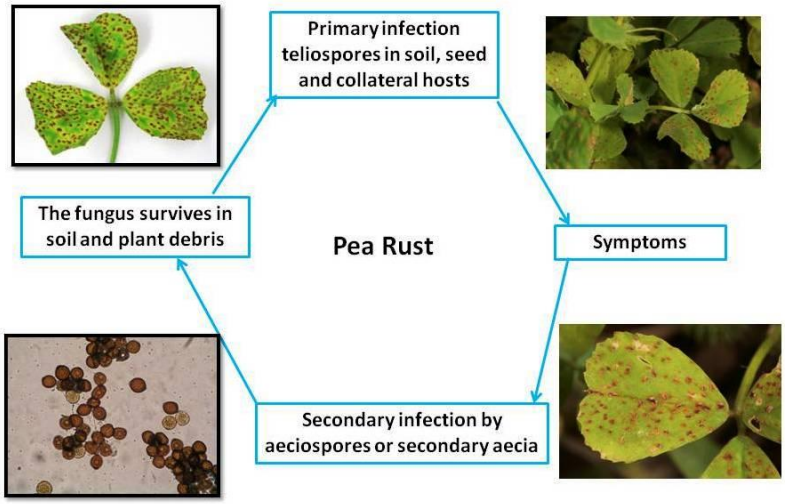
1. Downy mildew:



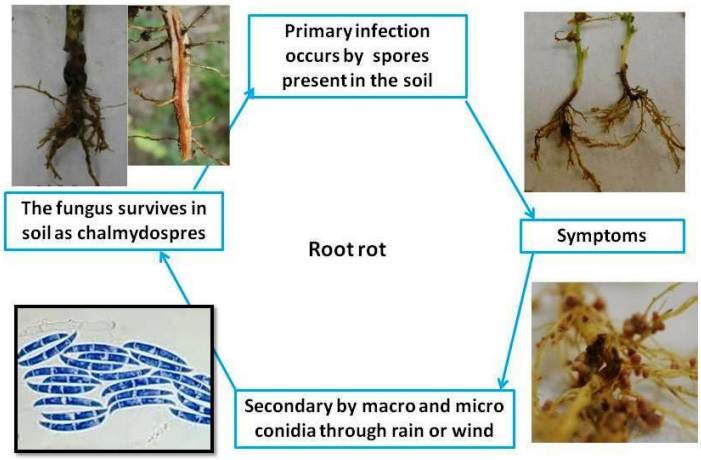
2. Powdery mildew:



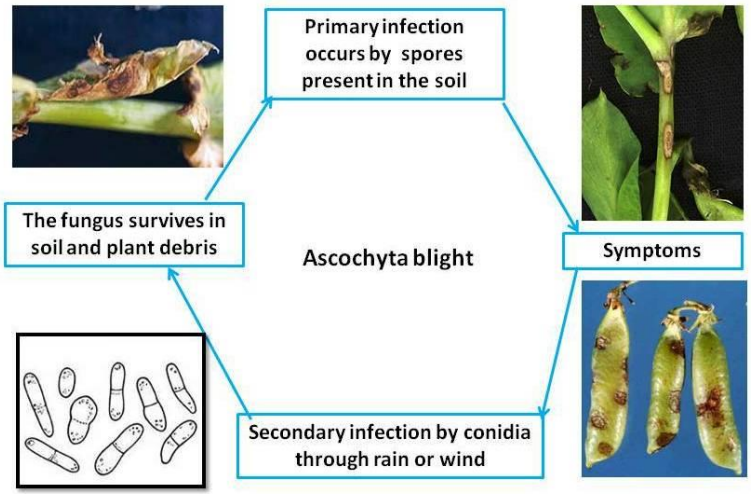
3. Pea rust:



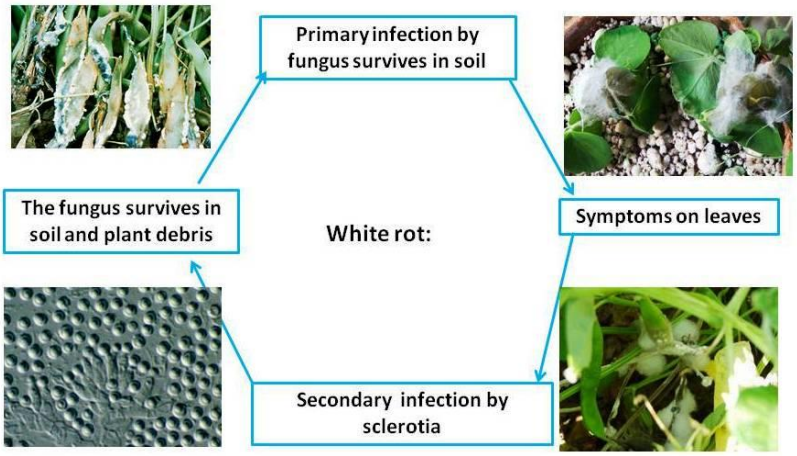
4. Root rot:



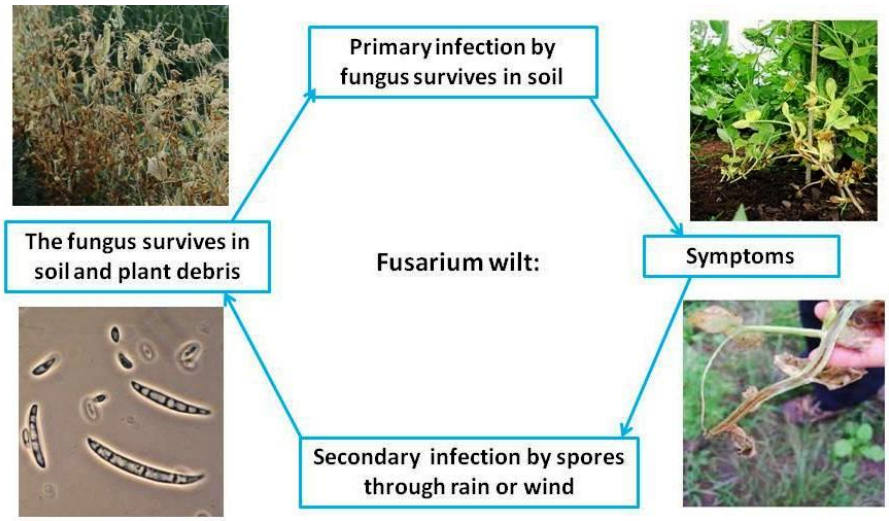
5. *Ascochyta* blight:



6. White rot:

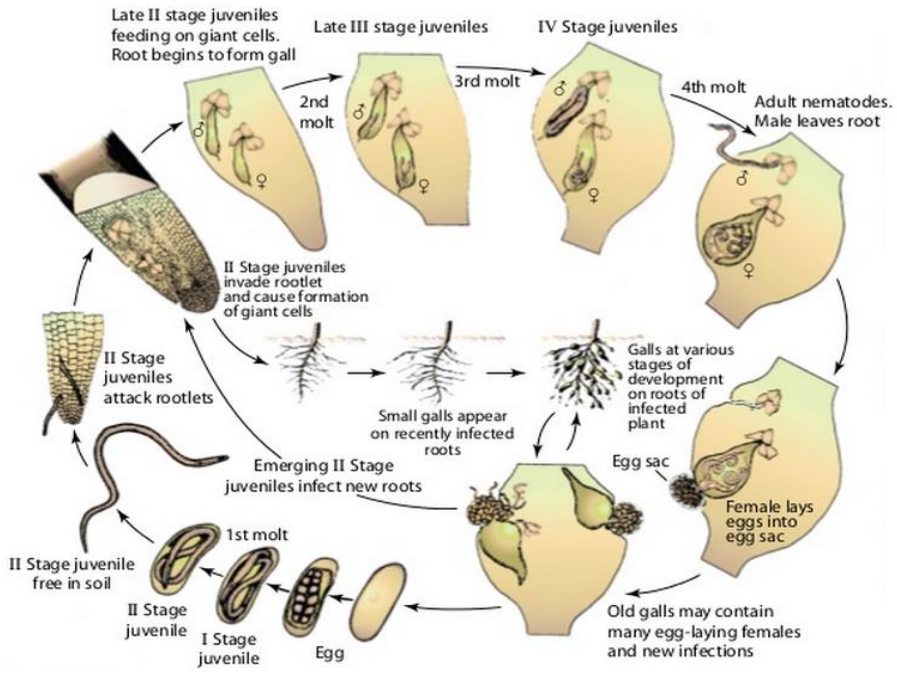


7. *Fusarium* wilt:



http://www.doctorfungus.org/imageban/images/init_images/241MIKE.JPG

8. Root knot nematode



http://www.slideshare.net/fitolima/agrios-gn-plant-pathology-5a-ed-academic-press-2005-922p

XI. DESCRIPTION OF RODENT PESTS

1) Smaller bandicoot:

Distribution and Identification:

Distributed throughout India and infests almost all crops. It is a robust rodent (200 to 300 g body weight) with a rounded head and a broad muzzle. Dorsum covered with grey-brownish rough hairs. Tail is naked, shorter than head and body. Breeds throughout the season and litter size 6-8 in normal conditions.

Burrows are characterized by the presence of scooped soil at the entrance and mostly burrow openings are closed with soil.

Damage symptoms:

Mostly damage occurs at fruiting stage. Bandicoots cut the raw and ripened fruits and hoard them in their burrows.

XII. SAFETY MEASURES

A. At the time of harvest:

Processing Peas: Approximately three weeks following full bloom, peas are ready for harvest. Quality of peas deteriorates with maturity. Hot dry weather during harvest speeds up maturity without corresponding increases in yield. Soils adequately supplied with nitrogen and/or organic matter result in increases in yield and mature less rapidly than those lacking sufficient amounts of these nutrients. For this reason peas produced on fertile soils remain at peak quality for a longer period, thus providing a greater opportunity for orderly harvest of peas. Transportation to the processing plant and processing should be immediate so this limits distance peas can be grown from the processing plant.

Green Peas: The pods are harvested when they are well filled, but still succulent, before they harden and fade in colour. The peas should not be hard and starchy. Peas are best picked and shelled just before cooking as the sugar content decreases rapidly after harvest. Two or three pickings are made as all the pea pods do not mature at the same time. The pods should be carefully pulled from the vine to prevent the plants from being uprooted. At the last harvest, the plant may be pulled up and all the pods picked.

Edible Podded Peas: These peas are picked when the pods are long and the peas just developing .Pods, three to five inches long, are produced five to seven days after flowering, and the pea seeds are slim and small. Pods need to be picked every other day to prevent them from developing large seeds and fibrous pods. If the seeds develop, they may be used similar to garden peas.

B. Post-harvest storage:

Unshelled peas can be held a week or two if cooled to 0°C immediately after harvest, and held at0°C with a relative humidity of 95%. Peas can be hydro cooled or wetted and vacuum cooled to remove field heat. Package ice is effective in keeping peas cold and minimizing wilting.

http://www.nr.gov.nl.ca/nr/agrifoods/crops/veg_pdfs/peas.pdf

XIII. DO'S AND DON'TS IN IPM

S. No.	Do's	Don'ts
1.	Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be kept exposed to sun light at least for 2-3 weeks	Do not plant 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.	Adopt crop rotation.	Avoid mono cropping.
3.	Grow only recommended varieties.	Do not grow varieties not suitable for the season or the region.
4	Sow early in the season	Avoid late sowing as this may lead to reduced yields and incidence of white grubs and diseases.
5	Always treat the seeds with approved chemicals/bio products for the control of seed borne diseases/pests.	Do not use seeds without seed treatment with biocides/chemicals.
6.	Sow in rows at optimum depths under proper moisture conditions for better establishment.	Do not sow seeds beyond 5-7 cm depth.
7.	Apply only recommended herbicides at recommended dose, proper time, as appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.	Pre-emergent 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.
8.	Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crop weed competition.	Crops should not be exposed to moisture deficit stress at their critical growth stages.
9	Use NPK fertilizers as per the soil test recommendation.	Avoid imbalanced use of fertilizers.
10	Use micronutrient mixture after sowing based on test recommendations.	Do not apply any micronutrient mixture after sowing without test recommendations.
11	Conduct AESA weekly in the morning preferably before 9 a.m. Take decision on management practice based on AESA and P: D ratio only.	Do not take any management decision without considering AESA and P: D ratio
12	Install pheromone traps at appropriate period.	Do not store the pheromone lures at normal room temperature (keep them in refrigerator).
13	Release parasitoids only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation	Do not apply chemical pesticides within seven days of release of parasitoids.
16	Spray pesticides thoroughly to treat the undersurface of the leaves.	Do not spray pesticides only on the upper surface of leaves.
17	Apply short persistent pesticides to avoid pesticide residue in the soil and produce.	Do not apply pesticides during preceding 7 days before harvest.
18	Follow the recommended procedure of trap crop technology.	Do not apply long persistent on trap crop, otherwise it may not attract the pests and natural enemies.

XIV. SAFETY PARAMETERS IN PESTICIDE USAGE

S. No.	Pesticide	Classification as per insecticide rules	Colour of toxicity triangle	WHO classification of hazard	First Aid measures	Symptoms poisoning	Treatment of poisoning	Waiting period from last application to harvest (days)
Insecticides								
1.	Melathion	Moderately toxic		Class III slightly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	6
2.	Carbofuran	Extremely toxic		Class I b highly hazardous		Constriction of pupils, salivation, profuse sweating, muscle incordination, nausea, vomiting,diarrhea , epigastric pain, tightness in chest	Atropine injection- 1-4 mg. repeat 2 mg when symptoms begin to recur (15-16 min interval) excessive salivation- good sign, more atropine needed	--
3.	Monocrotophos	Extremely toxic		Class I b highly hazardous		Constriction of pupils, salivation, profuse sweating, muscle incordination, nausea,	Atropine injection- 1-4 mg. repeat 2 mg when symptoms begin to recur (15-16 min interval) excessive salivation- good	--

						vomiting,diarrhea, epigastric pain, tightness in chest	sign, more atropine needed	
Fungicides								
1.	Benomyl	Slightly toxic		Unlikely produce acute hazard		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	10
2.	Carbendazim	Slightly toxic		Unlikely produce acute hazard		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	10
3.	Dinocap	Moderatel y toxic		Class III slightly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	6
4.	Fenarimol							
5.	Sulphur	Slightly toxic		Unlikely produce acute		Headache, palpitation, nausea,	No specific antidote. Treatment is	10

				hazard		vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	essentially symptomatic	
6.	Triadimefon	Moderatel y toxic		Class III slightly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose,throat, eyes and skin etc.	No specific antidote. Treatment is essentially symptomatic	6

XV. BASIC PRECAUTIONS IN PESTICIDES USAGE

A. Purchase

1. Purchase only just required quantity e.g. 100, 250, 500, 1000 g/ml for single application in specified area.
2. Do not purchase leaking containers, loose, unsealed or torn bags; Do not purchase pesticides without proper/approved labels.
3. While purchasing insist for invoice/bill/cash memo

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; Do not expose to sunlight or rain water; Do not store weedicides along with other pesticides.
4. Never keep them together with food or feed/fodder.
5. Keep away from reach of children and livestock.

C. Handling

1. Never carry/ transport pesticides along with food materials.
2. Avoid carrying bulk pesticides (dust/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 the spray solution as per requirement
7. **Do not** mix granules with water; **Do not** eat, drink, smoke or chew while preparing solution
8. Concentrated pesticides must not fall on hands etc. while opening sealed container. Do not smell pesticides.
9. Avoid spilling of pesticides while filling the sprayer tank.
10. 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 and defective equipment
3. Select right kind of nozzles
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; **Do not** apply just before the rains and after the rains; **Do not** apply against the windy direction
3. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer

4. Wash the sprayer and buckets etc. with soap water after spraying
5. Containers buckets etc. used for mixing pesticides should not be used for domestic purpose
6. Avoid entry of animals and workers in the field immediately after spraying
7. Avoid tank mixing of different pesticides

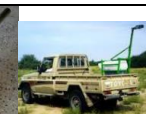
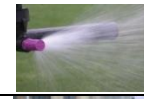
G. Disposal

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 reuse empty pesticides container for any other purpose.

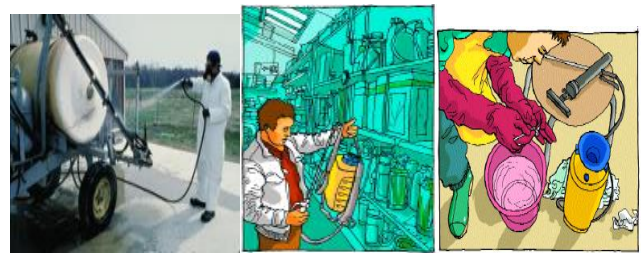
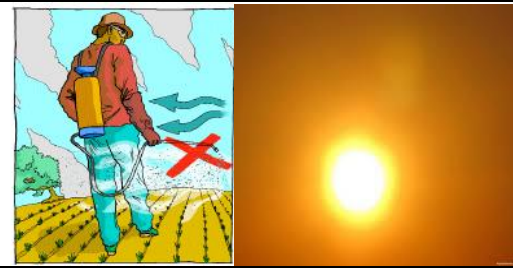
XVI. PESTICIDE APPLICATION TECHNIQUES

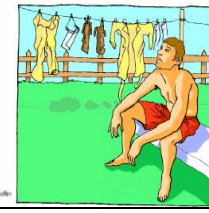
<table>
<tr><td colspan="4">Equipment</td></tr>
<tr><td colspan="4">Category A: Stationary, crawling pest/disease</td></tr>
<tr><td rowspan="2">Vegetative stage
i) for crawling and soil borne pests

ii) for small sucking leaf borne pests</td><td rowspan="2">Insecticides and fungicides</td><td rowspan="2">• Lever operated knapsack sprayer (Droplets of big size)
• Hollow cone nozzle @ 35 to 40 psi
• Lever operating speed = 15 to 20 strokes/min
or
• Motorized knapsack sprayer or mist blower (Droplets of small size)
• Airblast nozzle
• Operating speed: 2/3rd throttle</td><td> 
  </td></tr>
<tr><td>Reproductive stage</td><td>Insecticides and fungicides</td><td>• Lever operated knapsack sprayer (Droplets of big size)
• Hollow cone nozzle @ 35 to 40 psi
• Lever operating speed = 15 to 20 strokes/min</td><td>  </td></tr>
<tr><td colspan="4">Category B: Field flying pest/airborne pest</td></tr>
<tr><td>Vegetative stage
Reproductive stage
(Field Pests)</td><td>Insecticides and fungicides</td><td>• Motorized knapsack sprayer or mist blower (Droplets of small size)
• Airblast nozzle
• Operating speed: 2/3rd throttle
Or
• Battery operated low volume sprayer (Droplets of small size)
Spinning disc nozzle</td><td> 
  </td></tr>
</table>

Mosquito/ locust and spatial application *(migratory* Pests)	Insecticides and fungicides	• Fogging machine and ENV (Exhaust nozzle vehicle) (Droplets of very small size) • Hot tube nozzle	 
Category C: Weeds			
Post-emergence application	Weedicide	• Lever operated knapsack sprayer (Droplets of big size) • Flat fan or floodjet nozzle @ 15 to 20 psi • Lever operating speed = 7 to 10 strokes/min	 
Pre-emergence application	Weedicide	• Trolley mounted low volume sprayer (Droplets of small size) • Battery operated low volume sprayer (Droplets of small size)	  

XVII. OPERATIONAL, CALIBRATION AND MAINTENANCE GUIDELINES IN BRIEF

1.	For application rate and dosage see the label and leaflet of the particular pesticide.	
2.	It is advisable to check the output of the sprayer (calibration) before commencement of spraying under guidance of trained person.	
3.	Clean and wash the machines and nozzles and store in dry place after use.	
4.	It is advisable to use protective clothing, face mask and gloves while preparing and applying pesticides. Do not apply pesticides without protective clothing and wash clothes immediately after spray application.	
5.	Do not apply in hot or windy conditions.	

6.	Operator should maintain normal walking speed while undertaking application.	
7.	Do not smoke, chew or eat while undertaking the spraying operation	 
8.	Operator should take **properbath with soap** after completing spraying	  
9.	Do not blow the nozzle with mouth for any blockages. Clean with water and a soft brush.	

XVIII. REFERENCES

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