HORTICULTURAL CROPS PRODUCTION

Level-III

Learning Guide-64

Unit of Competence: Control Weeds, Plant Insects, Diseases and Disorders

Module Title: Controlling Weeds, Plant Insects, Diseases and Disorders

LG Code: AGR HCP3 M15 LO1-LG-64

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LO1. Assess weed infestation and/ or plant pests, diseases and disorders infection

Instruction Sheet	Learning Guide 64

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Assessing scope and size of the infestation or infection
- Identifying and reporting weeds, plant pests, diseases and disorders and beneficial organisms
- Identifying levels of weed infestations and plant pests, diseases and disorders
- Identifying infestation or infection levels
- Obtaining professional advice

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Assess scope and size of the infestation or infection
- Identify and report weeds, plant pests, diseases and disorders and beneficial organisms
- Identify levels of weed infestations and plant pests, diseases and disorders
- Identify infestation or infection levels
- Obtain professional advice

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, 2, 3, 4 and 5”.
4. Accomplish the “Self-check 1, 2, 3, 4 and 5”.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, and 2.
6. Do the “LAP test” for each operation sheet.

Information Sheet-1	Assessing Scope and Size of the Infestation or Infection

1.1 Assess the Scope and size of the infestation and the level of damage present

Regular field and crop inspection is necessary to detect and monitor the development of infection or infestation of crops in the field. Accurate information about what pests is present, how fast the infections or infestations are spreading and how serious / how much crop damage is being caused is essential if control measures are to be taken as necessary and on time.

The process of crop inspection is called **scouting and is carried out by crop scouts.**

Crop scouts are personnel trained to:

- Examine crops
- Identify pests, diseases and disorders
- Estimate the severity of infection/infestation and or amount of crop damage caused
- Record and report findings

So, you will be expected to be able to carry out crop scouting and contribute to the planning of a control programme as necessary or to train and supervise the work of crop scouts.

Crop Inspection / Crop scouting procedure:

The procedure has several stages:

- Collect tools and equipment
- Gather basic data about the field
- Take an overview of the field situation and draw a basic plan for the field showing scouting pattern and inspection sites
- Inspect the crop
- Record findings and prepare a crop scout report

i. Collect tools and equipment

You will need:

- Note book and pen
- A few sample bags and labels

- Loop lens x10 magnification (useful but not essential)
- Stick Traps and pheromone traps these may also be set up to monitor pest presence and/or increase in population


Fig 1.1 Pest scouting

ii. Gather basic data about the field

Record:

- Field and or plot identity and field or plot size
- Crop and variety
- Planting date and stage of crop growth
- Irrigation availability and type, nutrition & previous pest treatments applied.

iii. Take an overview of the field situation

Observe and Record:

- Type and status of crops in neighboring plots/fields
- Recent weather; e.g. heavy rain, hot and dry
- Evidence of poor drainage, or flooding
- Weeds; type, density and probable effect on crop growth and yield.
- Access by and damage caused by animals
- Plant population; planned and actual

iv. Draw a basic plan for the field showing scouting pattern and inspection sites

To examine the crop you need to:

- Take a walk around the margin of the crop …..
- Pests often move into the crop from the field margins or are blown in on the wind.

- Walk through the crop to take an overview and stop to examine several **1m^2** areas of crop selected at random to represent the field.

  Random sample sites are often selected in a **zigzag pattern** and each sample site is allocated a number.

  Inspection plan:

  Walk around the edge of the plot and record your findings →

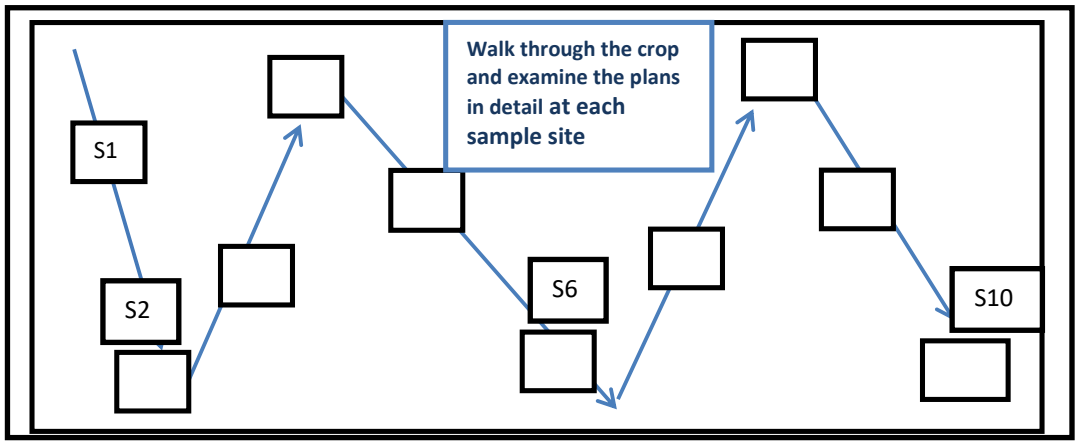

Table 1.1 Ways of assessing weeds, plant pests, diseases and disorders

v. Inspect the crop

At each sample site (marked **S** in diagram above):

- **Examine the whole crops or all crops in one m^2**

  Check carefully and often it is too late to apply effective treatment by the time signs and symptoms of infection and infestation become very obvious.

- **Check**:

  Old, middle and young leaves in addition observe upper and lower surface

  Look for insects and mites (all stages of life cycle), holes, feeding marks, honey dew and skins, mines, discoloration, distortion and signs of fungal growth.

  For flowers look for abortion, distortion, presence of Thrips (shake flower over white paper).

  Stems and roots check dead, dying and wilting plants (do not dig up or break the stems of healthy plants).

Look for, damping off in seedlings and necrosis of the stems in older plants, check for discoloration of the vascular system, nodules on the roots and signs of root death. Take particular note when you find these symptoms of signs of over watering and flooding.

- **Estimate the severity of infestation/infection and amount of crop damage**

  This is more difficult and there are several methods in use, including:

✓ **Number, (%age)** of plants in the sample site that are affected.

✓ **Level of infection on the infected plants:** Usually measured using an agreed scale: e.g. Low <5 insects/plant, Medium < 10 insects/plant and High, > 10 insects/plant

How this quantification is done in practice depends on crop type, crop age/growth stage and type of pest or disease. Thus, data collected during the crop inspection will give you an overview of the size, scope and ddistribution of the infestations /infections present in the crop.

Size: Proportion / percentage of the crop affected

Scope: Types of pests, diseases and disorders that are present

Distribution: How the infection / infestation is distributed throughout the plot

vi. Record findings in your field note book or on the reporting forms provided by the farm.

At each sample site record your findings clearly

- If you know the identity of the pest or disease note this in your findings
- If you do not know the identity of the pest or disease that you have found, make a written description of the signs and symptoms, using the terminology listed in section1.2, below, and collect a sample. If you have a phone, pictures are also useful. Show your sample to your line manager or consultant or take it to the local government plant clinic.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Define scouting and why needed. (10points).
2. What are possible procedures for scouting? (10points).
3. Explain each scouting procedures (10 points).
4. What are advantages of scouting by using zigzag methods (10 points).

Note: Satisfactory rating - 50 points and above Unsatisfactory - below 50 points

You can ask your teacher for the copy of the correct answers.

Operation Sheet-1	**Assessing scope and size of the infestation or infection (Field Scouting)**

Objective

- Detect and identify pests and/or diagnosis of the cause of crop damage
- Establish level of infestation
- Evaluate possible crop losses if not treated
- Decide if the situation is over or under the treatment threshold

Materials needed: Rope, small pieces of cloth (that can be wrapped around a plant or branch when scouting), insect net, paper and pen to take note, pocket knife, old newspaper or paper towel and hand lens

Procedures

1) Prepare the necessary equipment necessary equipments.
2) Gather background information for the field including previous season crop, adjacent crops and non-crop areas and chemicals applied on the crop or on neighboring crops
3) Apply basic scouting procedures. Look at the problem at field level. Search for a pattern
4) Scattered problem randomly through the field or occurring in a pattern?
5) Look problem visibility along the edge, entrance of a field or following a waterway?
6) Observe problem in the affected area more severe in low areas o r exposed slopes?
7) Observe pattern matches with a certain filed activity like tillage, spraying or harvesting?

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: You are required to perform the following as directed

Task 1. Assessing scope and size of the infestation or infection?

Information Sheet-2	Identifying and Reporting Weeds, Plant Pests, Diseases and Disorders and Beneficial Organisms

2.1. Identifying weeds, plant pests, diseases and disorders and beneficial organisms

2.1.1. Identifying weeds

About 30,000 species of weeds are found in the world, of which about 1,800 species cause serious loss to the crops. Many of this species resemble in some way or other. Based on common characteristics, weeds have been classified into different groups.

Classification of weeds

i) Weed classification based on morphology

Weeds are classified into three groups based on their morphology.

a) **Broad leaved weeds (BLW)**: these weed species are mostly dicotyledonous plants. The leaves are usually broad with netted veins. E.g. E.g. *Amaranthus spp. Chenopodium album, Convoulus arvensis.*

b) **Grasses**: grasses are, botanically, plants of the family Poaceae (Gramineae). Grasses are monocots and propagate by seeds, rhizomes, stolons and stem cuttings, e.g. Pennisetum polystachion (mission grass), Wild oat (Avena fatua), tropical finger grass (Digitaria ciliaris), Sourgrass (Paspalum conjugutum), etc.

c) **Sedges**: sedges are also monocots and the stems are solid and triangular in cross section. E.g. Nutgrass (Cyperus rotuadus), small-flowered nutsedge (Cyperus difformis L.), etc.

ii) Types of weeds based on life span

Based on their life span (duration of life cycle) weeds are classified into three groups

a) ***Annual weeds****:* these weeds compete their life cycle in one season. Such as pigweed, crabgrass, ragweed, foxtail, downy brome, field pennycress, and tansy mustard.

b) ***Biennial weeds****:* biennial weeds complete their life cycle in two seasons. In the first season they remain in vegetative phase, whereas in the second season they produce flowers and seeds. The common biennial weeds are sweet clover, burdock, bull thistle, and wild parsnip.

c) ***Perennial weeds****:* perennial weeds live in more than two seasons.. Field bindweed, leafy spurge, Johnsongrass, and quackgrass are some of the perennials.

iii) Special weeds

a) **Parasitic weeds***:* weeds that depend entirely or partly on their hosts for their existence are called parasitic weeds. most of them have no roots and depend on their hosts for water and all minerals. But dodders have little or no chlorophyll and no true roots, so entirely depend on their hosts. The common and serious parasitic weeds are:*Cuscuta spp*. (dodders), *Orobanche spp* (broomrape) and *Striga spp*. (witchweed).

b) **Poisonous weeds***:* weeds those able to reduce the milk yield/quality in cow and are poisonous to both human and animals. E.g. *Datura stramonium* (Jamestown-weed), *S. halepense* (Johnson grass) - containing at its tillering stage enough prussic acid to poison cattle.

c) **Noxious weeds / Problem weeds***:* Their common characteristics are that they are persistent in adverse condition, hard to control and cause serious economic loss.

Some of noxious weeds that exist in Ethiopia are:

	Scientific name of weed	**Common name**	**Local name**	**Morphological Class**	**Life cycle**
1	*Amaranthus spinosus*	Spiny amaranthus			

2	*Amaranthus hybridus*			*BLW*	Annual
3	*Avena fatua*	wild oat		**Grass**	//
4	*Convolvulus arvensis*	bind weed		**BLw**	Perennial
5	*Chenopodian album*	fat hen			
6	*Convolvulus arvensis*			BLW	Perennial
7	*Cynodon dactylon*			*Grass*	//
8	*Cyperus rotundus*			*Sedge*	//
9	*Cyperus esculentus*			*Sedge*	//
10	*Datura Stramonium*	Jamestown-weed		**BLW**	Annual
11	*Digitaria adscendens*	tropical finger grass		**Grass**	Perennial
12	*Digitaria sanguinalis*			*Grass*	//
13	*Eichhornia crassipes*	water hyacinth		**BLW**	//
14	*Echinochloa crusgalli*			*Grass*	
15	*Echinochloa colonum*			*Grass*	
16	*Eleusine indica*			**Grass**	
17	*Eichhornia crassipes*			*Grass*	
18	*Imperata cylindrical*	cogon weeds		*Grass*	
19	*Portulaca oleracea*	purslane		BLW	
20	*Parthenium hysterophorus*	Congress weed		***II***	Annual
21	*Paspalum conjugatum*			*Grass*	
22	*Rottboellia exaltata*			*Grass*	
22	*Sorghum halepense*	Johnson grass			Annual

Table 2.1 some weeds classification in Ethiopia based on morphology and life cycle

iv) Beneficial weeds

a) Medicinal plants

b) Legume weeds & Forage species: eg. *Trifolium* spp. *Medicago truncatula*

c) Edible weeds: e.g *Amarantus* spp

v) Based on their habitat

a) Terrestrial weeds

- Economic important weeds;
- Found in cultivated and uncultivated fields where the soils are not waterlogged

E,g *Amaranthus spp*

b) Aquatic weeds

Weeds of this group grow and complete a part of their life cycle in water.

Characteristics of Weeds

- grow faster than crops
- thrive well under adverse condition. even under in soils and droughttime
- weeds are hardy
- weeds are persistent
- they produce enormous number of seed: some weeds produce 750,000 seeds per plant *Striga* producing as many as 380,000 seeds per plant and *Oroba nche* produce 230,000 seeds per plant.
- they have efficient use of growth resources
- have long period of seed dormancy
- some weeds have allelopathic effect on crops. They affect crop growth by secreting allelochemicals.

Problems of Weeds: How do weeds affect crop production?

a) Competition with crops for nutrients and water
b) Harbor insect pests and crops diseases
c) Obstruct harvesting operation
d) Increase cost of production
e) Reduce quality of produces/harvest

2.1.1. Identifying plant pests

A. Insects

Insects are a small animal which belongs to Anthropoid phylum; their body part is divided into three sections, head, thorax and abdomen. Their small size, remarkable range of adaptation, rapid rate of reproduction, great mobility and efficient water conservation enable them to colonize nearly every habitat, including all the types in which crop production takes place. These features of insects contribute towards making their control of paramount importance to the farmer. Some insects are beneficial as pollinators of flowers and as predators which feed on destructive insects. Other types of

insects are directly harmful as pest of crops, as carriers of diseases and as destroyers of stored food. Insect damages on crops can be direct or indirect damages. The direct damages of insects are leaf defoliation, distraction growing points, boring tunneling of the stem of the plants, suck for the phloem sap. Indirect damages of insects may be transmitting diseases from crops to crops.

Common features of insects

All adult insects have two physical characteristics in common. They have three pairs of jointed legs, and they have three body regions -- the head, thorax, and abdomen.

Head

The head has antennae, eyes, and mouthparts. Antennae vary in size and shape and can be a help in identifying some pest insects. Insects have compound eyes made up of many individual eyes. These compound eyes enable insects to detect motion, but they probably cannot see clear images.

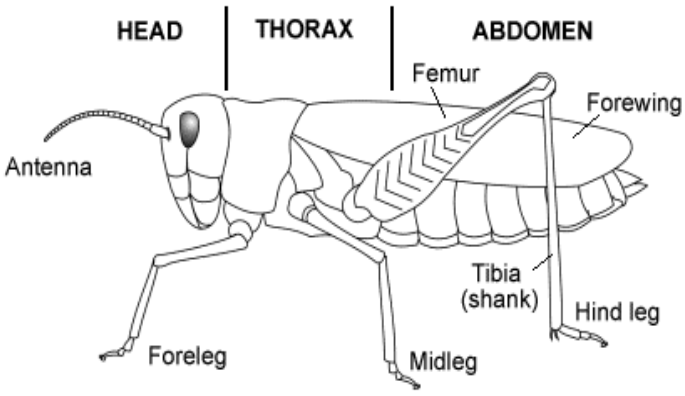

Fig 2.1 Anatomy of Grass hopper

The four general types of mouthparts are: Chewing-biting, piercing-sucking, sponging, siphoning.

Chewing mouthparts contain toothed jaws that bite and tear. Cockroaches, ants, beetles, caterpillars, and grasshoppers are in this group.

Piercing-sucking mouthparts consist of a long slender tube that is forced into plant or animal tissue to suck out fluids or blood. Insects with these mouthparts include stable flies, sucking lice, bed bugs, mosquitoes, true bugs, and aphids.

Sponging mouthparts are tubular tongue-like structures with a spongy tip to suck up liquids or soluble food. This type of mouthpart is found in flesh flies, blow flies, and house flies.

Siphoning mouthparts are formed into a long tube for sucking nectar. Butterflies and moths have this type.

Thorax

The thorax contains the three pairs of legs and (if present) the wings. The various sizes, shapes, and textures of wings and the pattern of the veins can be used to identify insect species. The forewings take many forms. In the beetles, they are hard and shell-like; in the grasshoppers, they are leathery. The forewings of flies are membranous; those of true bugs are part membranous and part hardened. Most insects have membranous hind wings. The wings of moths and butterflies are membranous but are covered with scales.

Abdomen

The abdomen is usually composed of 11 segments, but 8 or fewer segments may be visible. Along each side of most of the segments are openings (called spiracles) through which the insect breathes. In some insects, the tip end of the abdomen has tail-like appendages.

Life Cycles of Insects

Most insect reproduction results from the males fertilizing the females. The females of some aphids and parasitic wasps produce eggs without mating. In some of these insect species, males are unknown. A few insects give birth to living young; however, life for most insects begins as an egg. The series of changes through which an insect passes in its growth from egg to adult is called **metamorphosis**. There are two types of metamorphosis: incomplete and complete.

Incomplete metamorphosis: Insects in this group pass through three different stages of development before reaching maturity: egg, nymph, and adult. The nymphs resemble

the adult in form, eat the same food, and live in the same environment. The wings become fully developed only in the adult stage. E.g. locust, aphid, etc

Complete metamorphosis: The insects with complete metamorphosis pass through four stages of development: egg, larva, pupa, and adult. The young, who may be called larvae, caterpillars, maggots, or grubs, are entirely different from the adults. They usually live in different situations and in many cases feed on different foods than adults. Examples are the beetles, butterflies, flies, mosquitoes, fleas, bees, and ants.

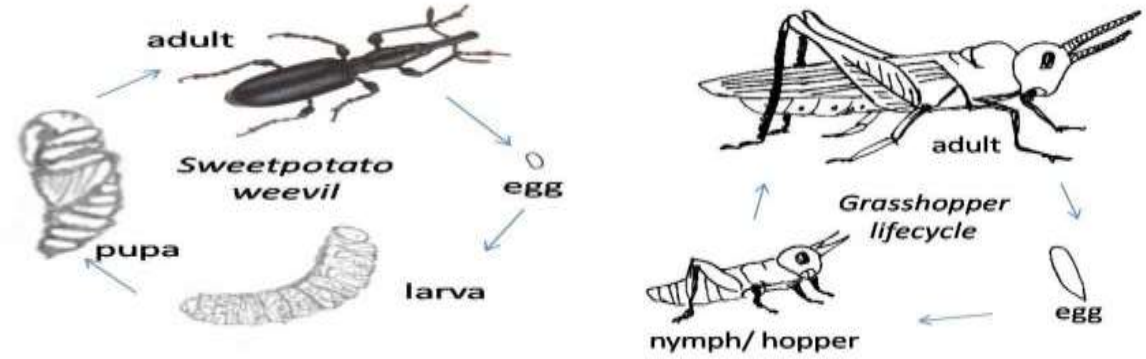

Fig 2.2 Complete and incomplete metamorphosis of weevil and grass hopper

Classification of insect order

Classification means arranging insect groups in a coherent order, which reflects their evolution and relatedness. Insect's classification categories are: kingdom, phylum, order, family, genus, and species. An example of the classification of an insect:

Musca domestica (house fly)

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Diptera
Family	Muscidae

Genus Musca

Specific Domestica

Features of Arthropoda and Insecta

- **Arthropoda:** Characterized by the possession of an external jointed skeleton, segmented body and jointed legs. E.g. insects, spiders, centipedes, millipedes and the crustaceans (crabs etc)
- **Insecta:** body divided into head, thorax and abdomen, three pairs of legs and single pair of antennae, two pair of wings in adult stage.

Insect's classification system and important orders

As for Insecta Class, there are several classification systems, ranging from 26-33 orders; here we adopt the systems of dividing Insecta class into 30 orders.

There are about 9 major groups (Orders) of insect pests that are known to damage crops

a) Butterflies and moths (Order Lepidoptera)

- they are the **most dangerous group** of pests in crop production
- they have complete metamorphosis (have four developmental stages)
- only the larval stage damages crops (have cutting mouth type)
- most of them have nocturnal feeding habit
- the adult moths are nectar feeders (absorb nectar from flowers)

  some of these group include:
  - Maize stalk borer, American fall army worm, Cut worm, Ball worm, Cabbage worm

Butter flies adult and larval stage

Fig 2.3 Different moth species

b) Beetles (order Coleoptera)

- they have complete metamorphosis (have four developmental stages)
- in most cases both the adult beetle and the larva (grab) damage crops
- the larva are mostly root feeders
- both the adult and the larva have cutting mouth type

They affect both underground plant parts (root) and above ground parts

Examples: garden beetles , grain weevil, sweet potato weevil etc

Fig 2.4 Beetles

c) Grasshoppers, locusts, and crickets(Orthoptera)

- they have incomplete metamorphosis (have three developmental stages)
- both the adult nymph damage crops
- have cutting mouth type
- they are known grass feeders (cereal crops)

Fig 2.5 grasshoppers

d) Aphids (Homoptera)

- they have incomplete metamorphosis (have three developmental stages)
- both the adult nymph damage crops
- have sucking mouth type and damage crops by absorbing the plant sap
- they damage cabbage, maize, pea, apple,

Fig 2.6 Cabbage aphid

e) Flies (Diptera)

- they have complete metamorphosis
- only the larva damages crops (have sucking mouth)
- the adult flies are feeders of liquid waste
- they are known to damage fruits crops, wheat, cabbage

Fig 2.6 Different species of flies

f) Ants (Hymenoptera)

- they are soil insects (damage plant roots)
- they damage roots and stems of plants
- they have cutting mouth
- they are social insects

Fig 2.7 Order Hymenoptera

g) Plant bugs (Homoptera)

- they have cutting mouth
- they have incomplete metamorphosis
- they damage vegetable crops

Fig2.8 plant bugs

h) Termites (**Isoptera)**

- they are soil insects (they damage plant roots)
- they damage roots and stems of plants
- they have cutting mouth
- they are social insects

i) **Thysanoptera** (thrips) about 4000 species worldwide

- Small slender insects with two pairs of long strap-like wings with few veins and fringed with long hairs. Some species winless.
- Prominent prothorax.
- Legs terminate in small bladder-like structures rather than claws.
- Antennae short and 6-10 jointed.
- Rasping-sucking mouthparts
- Development incomplete metamorphosis.

Fig 2.9 thrips

Table 1.3 Summary of insect orders

	Major groups of insects	Examples	Number of species	Metamorphosis	Crop damaging Stage
1	Moths & butterflies (Order **Lepidoptera)**	American army worm, army worm, stalk borer, cut worms, ball worms, cabbage worms	112,000	Complete	Only larva
2	Beetles (Order Colleoptera)	Root beetle, garden beetle, dung beetles, grain weevil, sweet potato weevil	320,000	Complete	Both adult and larva
3	Grasshoppers & Locusts (Order orthopthera	Desert locust, cricket	20,000	Incomplete	Both adult and nymph
4	Ahids, scale insects,leaf hoppers (Order Homopthera)	Cabbage aphid, maize aphid, pea aphid	40,000	Incomplete	adult and nymph
5	Thrips (Order Thysanoptera)		4000	Incomplete	Both adult and nymph
6	Flies (Order Diptera)	Fruit flies, hessian fly, white flies,	150,000	Complete	Only larva
7	Ants (Order Hymenoptera)	Red ants	> 20000	-	Adult
8	Termites (Isoptera)	Marcoterms, microterms	2,000	-	only adult
9	Bugs (Order Hemiptera)	Stink bug, chich bug	25,000	incomplete	adult&nymph

Table 2.1 Summary of insect's orders

Some major insect pests of crops

	Name	Crops damaged	Type of damage
1	Black Cut worm	Many plants: maize, sorghum, onion, potato, etc	Cuts seedlings at the base
2	American Ball worm	Maize, tomato, cotton, pea, many others	Damage ear, fruit, ball, pod
3	American fall army worm	, most crops All cereals	Damage leaf
4	Aphids	Maize, pea, apple,	Absorb sap from leaf, stem

5	Sweet potato weevil	Sweet potato	Damage root of sweet potato
6	Desert Locust	All vegetation, mostly cereals	Damage leaf
7	Termites	Most crops	Damage root and stem, cover with soil
8	Fruit flies	Guava, orange, peach, mango	Damage fruit
9	Scale insect	Orange, lemon, Guava	Absorb sap from leaf stem, produce black fungi
10	Red ants	Vegetable roots	Damage root
11	Thrips	Most crops	Absorb sap from leaf

Table 2.2 some important insect pests

Some of common horticultural insects' pests

a) Army worm

Life Cycle

The adult moth lay eggs in masses on crowns of seedlings and on leaves of older plants. In 5-10 days tiny caterpillars hatch and feed for several weeks. They then pupate and emerge as adults 10 days later. Three and more generations are commonly produced each season — just as you're ridding worms from the leaves of your garden plants, another generation is preparing to leave the soil to replace them — but some species of army worms will lay up to six times. In places with milder winters such as the deep south, armyworms will overwinter as eggs and pupae beneath the soil. In warm climates, they may be active all year.

Fig tomato attacked by armyworm

b) Cutworms

Cutworms are the larvae (caterpillars) of several species of night-flying moths in the family Noctuidae. The larvae are called cutworms because they cut down young plants as they feed on stems at or below the soil surface.

Life cycle

The mother moth lays eggs on plant debris. The eggs hatch after several days and first instars larva starts on feeding plants or weeds. They usually damage seedling by cutting at the base. The larva damage seedlings during night. It spends day time inside the soil near the cut seedlings.

- The adults are night-flying moths and do not cause damage.
- There are also species of climbing cutworms that move up plants and feed on foliage, buds and shoots.
- Cutworms attack a variety of plants like asparagus, bean, cabbage and other crucifers, carrot, celery, corn, lettuce, pea, pepper, potato and tomato.

Fig cut worms

Female moths can lay hundreds of eggs, one at a time or in small clusters.

- They deposit eggs on low-growing plants and plant residue.
- Migrating moths lay eggs on the soil and the larvae hatch to feed on plants.
- Young larvae feed on leaves or small roots until they reach about 1/2 inch in length. Eggs and larvae may be seen on young weeds.

- Larvae start feeding on seedling stems, by cutting or burrowing through them.
- Cutworms may survive on weeds, through mild fall and winter seasons and attack vegetables in the spring.

c) Sweetpotato weevil

Sweetpotato weevil is the most serious pest of sweet potatoaround the world. It causes damage in the field, in storage, and is of quarantine significance. It is inherently of interest to entomologists due to its strikingly colorful appearance and extremely long rostrum (beak).

Symptoms of damage:

- Thickening and malformation of vines and often cracking of the tissue.
- Discoloration, cracking, or wilting of damaged wines
- An infested tuber is often riddled with cavities or tunnels
- Attacked tubers become spongy, brownish to blackish in appearance
- Start rotting form the top and develop an unpleasant smell and a bitter taste
- Unfit for human consumption.

Identification of pest:

- **Egg**: Oval, yellowish-white laid singly in small cavities on the sweet potato root or base of the vine. The cavity is then sealed with a plug of the mother's excrement
- **Larva**: Legless grub, white in colour. Head is comparatively large and brown or pale yellow
- **Pupa**: Pupa is whitish in colour and pupation takes place in the feeding tunnel
- **Adult**: Weevils are beetles with a long pointed snout, body is slender resembling ants

Fig Adult sweetpotato weevil and its larva

Fig weevil Damaged roots

Life Cycle and Description

A complete life cycle requires one to two months, with 35 to 40 days being common during the hot months. The number of generations occurring annually is estimated to be 5to 8.

Egg: Eggs are deposited in small cavities created by the female with her mouthparts in the sweet potato root or stem. The female deposits a single egg at a time, and seals the egg within the oviposition cavity with a plug of fecal material, making it difficult to observe the egg. Most eggs tend to be deposited near the juncture of the stem and root (tuber). Sometimes the adult will crawl down the cracks in the soil to access tubers for oviposition, in preference to depositing eggs in stem tissue. The egg is oval in shape and creamy white in color. Its size is reported to be about 0.7 mm in length and 0.5 mm in width. Duration of the egg stage varies from about five to six days during the summer

to about 11 to 12 days during colder weather. Females apparently produce two to four eggs per day, or 75 to 90 eggs during their life span of about 30 days.

Larva: When the egg hatches the larva usually burrows directly into the tuber or stem of the plant. Those hatching in the stem usually burrow down into the tuber. The larva is legless, white in color, and displays three instars. The larva creates winding tunnels packed with fecal material as it feeds and grows.

Pupa: The mature larva creates a small pupal chamber in the tuber or stem. The pupa is similar to the adult in appearance, although the head and elytra are bent ventrally. The pupa measures about 6.5 mm in length. Initially the pupa is white, but with time this stage becomes grayish in color with darker eyes and legs. Duration of the pupal stage averages 7 to 10 days, but in cool weather it may be extended to up to 28 days.

Adult: Normally the adult emerges from the pupation site by chewing a hole through the exterior of the plant tissue, but sometimes it remains for a considerable period and feeds within the tuber. The adult is striking in form and color. The body, legs, and head are long and thin, giving it an ant-like appearance. The head is black, the antennae, thorax and legs orange to reddish brown, and the abdomen and elytra are metallic blue. The snout is slightly curved. The beetle appears smooth and shiny, but close examination shows a layer of short hairs.

The adult measures 5.5 to 8.0 mm in length. Adults often feed on the lower surface of leaves, and are not readily noticed. The adult is quick to feign death if disturbed. Adults can fly, but seem to do so rarely and in short, low flights. They are active mostly at night. Females feed for a day or more before becoming sexually active, but commence oviposition shortly after mating; the average preoviposition period is seven days.

Host Plants

This weevil feeds on plants in the plant family Convolvulaceae. its primary hosts are in the genus *Ipomoea*. Alternate hosts are Railroad vine, *Ipomoea pes-caprae*, and morning glory, *Ipomoea panduratea*, are among the suitable wild hosts.

Damage

Sweet potato weevil is often considered to be the most serious pest of sweet potato, with reports of losses ranging from five to 97% in areas where the weevil occurs.

A symptom of heavy infestation by sweetpotato weevil is yellowing of the vines. Thus, incipient problems are easily overlooked, and damage not apparent until tubers are harvested. The principal form of damage to sweet potato is mining of the tubers by larvae. The infested tuber is often riddled with cavities, spongy in appearance, and dark in color. In addition to damage caused directly by tunneling, larvae cause damage indirectly by facilitating entry of soil-borne pathogens. Even low levels of feeding induce a chemical reaction that imparts a bitter taste and terpene odor to the tubers. Larvae also mine the vine of the plant, causing it to darken, crack, or collapse. The adult may feed on the tubers, creating numerous small holes that measure about the length of its head. The adult generally has limited access to the tubers, however, so damage by this stage is less severe than by larvae. Adult feeding on the foliage seldom is of consequence.

d). African bollworms (*Helicoverpa armigera* family: Noctuidae)

Host: Cotton, pigeon – pea, tomato, sorghum, groundnut, soybean, tobacco, potato, maize, forest trees and a range of vegetable crop.

<u>Damage</u>

- Affected plant parts: leave, fruit pod, inflorescence and growing parts
- Causing serious losses throughout its host ranges.
- On cotton: two to three larvae on a plant can destroy all the bolls within 15 days.

- Early instar larvae feed in leaves and shoots,
- Larger larvae bore into maturing green bolls.

On tomatoes: young fruits are invaded and fall; large larvae bore into older fruits; secondary infections by other organisms lead to rotting. In Ethiopia, 4.6% grain loss on beans and 17% loss in chilies have been reported

Life history

1. Female lays an average of 730 eggs.
2. Hairy surface are preferred for ovipositor, which is closely linked with the period of bud burst and flower production in most host plant.
3. Eggs hatch in 3 – 9 days at depending on different temperature, 3 days at 22. 5'C and 9 days at 17.0'C
4. The larval period lasts 18 – 50 days depending on different temperature (18 days at 22.5'C) and 50 days at 17.0'C). Rate of development is also affected by food availability.
5. Fully grown larvae leave the plant to pupate in the soil at a depth of 3 – 15 cm.
6. It passes 13 – 18 days in the pupal stage (at the pupal stge, high soil moisture cause death of pupae).
7. They pass through many generations per year.

Distribution

It is found all over the world. It is also largely found in Ethiopia and causes serious damage to crops.

Fig African bollworms on tomato

d) **African migratory locust** (*Locusta migratoria*, subfamily – Oedipoding)

Host: *L. migratoria* is primarily a grass feeder. During outbreaks; however, the gregarious individuals are less discriminating and feed on a wider range of plant material.

Economically important hosts include sorghum, millets, maize, rice, sugarcane, wheat bamboo and pasture grasses, cassava, sweet potatoes, beans and other legumes.

Damage

- Defoliation is the primary injury to plants, due to both foliage eaten and clipped from the plant and also may cause direct losses by feeding on ripening kernels of grains.

Life History

a) Including three stages – the eggs nymph (hopper), and adult.
b) Female oviposit their eggs in wet soil area (from 20-120)
c) After 2-4 weeks. The eggs hatch into wingless nymphs called hoppers, depending on temperature.
d) Hoppers shed their skins many times, each time growing in size (duration 4-8 weeks). Depending on temperature.
e) After final shedding, the nymph become adult locut, which are sexually matured:

f) There are three to five generations each year.

Distribution

Different subspecies in southern Europe, Africa south of the Sahara, Russia, China, Australia

Fig Migratory locust

1.1.1 Rodent pests

These are mammals with teeth which are well adapted to gnaw or grind hard substances. They include mice, squirrels, porcupines, rats and grass cutters. These animals may damage fruits and vegetables and are particularly very injurious to young seedlings of oil palm, rice, sugar cane, and the tubers of root crops such as cassava. The larger rodents such as squirrels and grass cutters can be trapped, and wire netting fences may be erected to protect crops from damage. Small rodents can be prevented from destroying young seedling of palm trees by placing collars of small-mesh wire netting around the base of the trunk.

Rodents belong to the most important pests of stored produce. In a number of countries they cause as much if not more damage than insect pests. Rodents have an exceptional ability to adapt themselves to different environmental conditions and an incredible potential for reproduction one pair of rats can theoretically have 350 million offspring within the space of three years. Estimates state that over 3.5 million rats are being born daily.

Characteristic features of rodents

Rodents are characterized by their teeth. They have a pair of incisor teeth in the upper and lower jaws, separated from the molars by a large gap (diastema). The incisors are curved inwards and have an extremely hard anterior coating. The softer inside layer is worn down much more rapidly than the hard, outer layer. This means that the teeth are continually kept sharp, enabling them to damage even materials such as masonry and electric cables.

a).Squirrel b). House mouse c). Porcupine

Fig Different types of rodents

Rodents as storage pests

Rats and mice (Muridae) are mainly causing damage to stored produce. Additionally some squirrels (Sciuridae) can also cause losses. The three most important rodent species are to be found all over the world:

- Black rat or House rat (Rattus rattus)
- Norway rat or Common rat (Rattus norvegicus)
- House mouse (Mus musculus)

Damage and losses

Rats and mice cause losses in a number of ways:

a) **Feeding on stored produce:** Rats eat an amount of food equivalent to 7% of their body weight daily, i.e. a rat with a body weight of 250 g will eat around 25 g daily, amounting to 6.5 kg of grain a year. Mice eat a daily amount equivalent to around 15% of their body weight, i.e. a mouse weighing 25 g will eat between 3 and 4 g a day, amounting to 1.4 kg of grain a year. It should, however, be borne in mind that the actual losses are much higher than the amount of produce eaten by the

animals, as they contaminate the stored produce with urine, feces, hair and pathogenic agents. As it is difficult or even impossible to remove filth produced by rodents from the stored produce, infested batches often has to be declared unfit for human consumption or written off as total losses.

b) **Transmission of disease:** There are around 50 diseases which can be transferred to man by rodents, including typhoid, paratyphoid, trichinosis, scabies, plague and haemorrhagic fevers like ebola. In addition, rodents may be vectors of a large number of diseases affecting domestic animals. The problems and costs resulting from these diseases are not normally taken into account when assessing infestation by rodents.

c) **Reducing nutritional value and germination percentage:** As rodents prefer food rich in proteins and vitamins and feed mainly on the embryo, they cause particular damage to the nutritional value and germination ability of seeds.

d) **Damage to material and equipment:** These often lead to subsequent damage:

- ✓ Produce leaking out of damaged bags or storage containers
- ✓ Bags stacks collapsing due to damage to the lower layers
- ✓ Short circuits leading to sparks or fire from cables being chewed
- ✓ Silos and warehouses may subside or even collapse as a result of being undermined
- ✓ Drainage canals around a store may be damaged.

Fig Rodent type mole rat and damaged root of sweet potato

Other pests may include

a) Birds damage by eating fruit and leaves of vegetable, fruits and other crops

House Sparrow **Everglade Kite** **Gouldian Finches**

Fig Bird types

b) Mollusks Garden snails and slugs may damage leaves of many kinds of vegetables.

Snails Slug

Fig Mollusks type

1.1.2 Plant diseases

In plants, then, disease can be defined as the malfunctioning of host cells and tissues that results from their continuous irritation by a pathogenic agent or environmental factor and leads to the development of symptoms. A memory aid similar to the disease triangle but including, in addition, the factor of time in the development of a disease

- A virulent pathogen should be present
- A plant should be susceptible
- The environment should be suitable

- Time

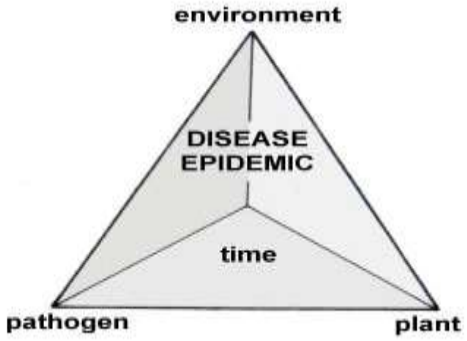

Fig 2.11. Disease pyramid

If one of the three appears late, or early or missing within given time, the disease will not occur. Therefore, any practice which disturbs any of the four conditions or break the pyramid will be considered as a disease management method.

Plant diseases are significant of humans because they cause damage to plants & products. The major effects of plant disease include:

- May limit crop choice
- Reduce the quantity & quality of products in the field & during storage.
- Increase the cost of production
- Cause economic loss to growth
- Increase prices of crop for consumers
- Destroy the beauty of nature

Classification of plant diseases

Plant disease can be classified in different ways:

- On the basis of their occurrence on the plant (Localized /systemic)
- On the basis of their mode of perpetuation (seed, soil or airborne)
- On the basis of the symptoms they caused (rust, light, wilt...)
- Type of plants affected (cereal, horticultural, coffee , forest diseases etc)
- Plant organs they affected (Root, stem, fruit or foliage diseases)
- Occurrence & spread (Endemic, Epidemic, sporadic, pandemic diseases)

- On the basis of major causal agent
    - Infections - Biotic (fungi, bacteria, virus, Nematode.)
    - Non- infectious - Abiotic (climatic factors, mineral toxicity air pollination, cultural practices...)

Causes of plant diseases

A. Infectious/biotic plant disease

Infectious diseases are plant diseases those caused by biotic organisms. They grow and multiply in host, and transmit from one plant to other plant. These include:

- ✓ Diseases caused by fungi
- ✓ Diseases caused by prokaryotes(bacteria and mycoplasmas)
- ✓ Diseases caused by parasitic higher plants
- ✓ Diseases caused by viruses and viroids
- ✓ Diseases caused by nematodes
- ✓ Diseases caused by parasitic higher plants

B. Non-infectious/abiotic diseases

Noninfectious diseases are diseases those are caused by non living, environmental factor. Non-infectious disease is sometimes termed as **disorders**. They are characterized by:

- Occurred in the absence of the pathogen (no sign of disease);
- Can't transmit from diseased plant to the healthy plant;
- Infect the plant in all stage (seed, seedling, and mature plant);
- Distribute evenly in the field (no diseases center, no disease developing factors.)

The following factors will cause noninfectious diseases:

- ✓ Too low or too high a temperature, e.g. scorching, freezing;
- ✓ Injury by air physical phenomena , e.g. wind, rain, thunder;
- ✓ Lack or excess of water or moisture in soil or air e.g. drought, water logging.

- ✓ Diseases caused by chemical factors:
- ✓ Lack or excess of nutrient element;
- ✓ Air pollution;
- ✓ Misuse of pesticides or chemical products;
- ✓ Improper cultural practices.

There are almost unlimited numbers of environmental factors that can cause disease in plants. Most of them affect plants by interfering with the normal physiological processes.

How? By

1. Causing an excess of a toxic substance in the soil or in the air, or
2. Lack of an essential substance such as water, oxygen , or mineral nutrients, or
3. Causing an extreme in the conditions supporting plant life, such as temperature, humidity, oxygen, carbon dioxide or light
4. Some of these effects are the result of normal conditions, e.g., low temperatures, occurring at the wrong time or of abnormal conditions brought about naturally, e.g., flooding, drought, or by the activities of people and their machines, e.g., pollutants, soil compaction, or weed killers.

Diagnosis of the specific environmental factor that causes or has caused a disease is sometimes made easy by the apparent change in the environment, e.g., flood or a late or an early frost. Some environmental factors cause specific symptoms on the plants that help diagnose the cause of the malady, but most of them cause non-specific symptoms that, unless the prehistory of the environmental conditions, applied treatments, etc., in the area are known, make it very difficult to arrive at an accurate diagnosis of the cause.

General characteristics of plant disease pathogens

I. Bacteria

Definition: Any of the unicellular, prokaryotic microorganisms of the class Schizomycetes, which are unable to make their own food, reproducing by fission. The majority of bacteria are strict saprophytic.

Shapes: Most plant pathogenic bacteria equipped with thread-like flagella

1. Rod-shaped
2. Spherical
3. Spiral § § §
4. Comma ,,,

Almost all plant-pathogenic are rod shaped. Most plant pathogenic bacteria equipped with thread like flagella (an organ for locomotion on bacteria). Based on the number and location of flagella bacteria can be classified as:

- Athrichous – without flagella, e.g. *Corynebacterium*
- Monotrichous – with one flagella at one end, e.g. *Xanthomonas*
- Lophotrichous – many flagella only at one end, e.g. *Pseudomonas*
- Amphitrichous – many flagella on both of the ends e.g. *Agrobacterium*
- Peritrichous – flagella on all sides of the wall of the body, e.g. *Erwinia*

Reproduction: by fission, every 20 minutes once, multiply very quickly and migrate throughout the plants very quickly.

Dissemination:

- ✓ By transporting diseased plant materials.
- ✓ By animals such as insects, birds.
- ✓ By splashing rains or wind-blown dust.

Penetration: entering crops though wounds and small natural openings (such as stomata and hydathodes)

Damage: secreting toxins, which kill host cells, causing cells grow abnormally or break down crop tissues.

Some of pathogenic genera of bacteria

	Shapes	Signs	Symptoms
Pseudomonas	Rod-shaped, one or more polar flagella	White or yellow colonies	Wilt, leaf spot
Xanthomonas	Rod-shaped, polar	Yellow colonies	Wilt, rot, leaf, leaf

	flagella		spot
Agrobacteria	Rod-shaped, peritrichous flagella	White, rarely yellow colonies	Gall
Erwinia	Rod-shaped, petitrichous flagella	White/cream or yellow colonies	Soft rot, die-back, leaf spot

Table 2.3 Summary of bacteria type

Identification of bacteria

- Cell shape.
- The number and arrangement of flagella.

II. Fungi

Any of numerous eukaryotic organisms of the kingdom Fungi, which lack chlorophyll and vascular tissue and range in form from a single cell to a body, mass of branched filamentous hyphae that often produce specialized fruiting bodies. Most of the species are strictly saprophytic, only a few species attack living plant when temperature and moisture conditions are favorable.

Reproduction: fungi reproduce chiefly by means of spores

- Unicellular or multi-cellular
- Formed by sexual or asexual

1. *Sexual*: two gametes are fused together.
2. *Asexual*: the tip of mycelium breaks down to form spores.

Penetration:

- Through wounds and natural openings.
- By forcing their way directly though the plant's protective epidermis.

Dissemination:

- ✓By air currents, splashing rains to transport spores.
- ✓By animals such as birds, insects or mites.
- ✓By diseased plant materials.
- ✓By farmer's hands, clothing and equipments.

Identification of fungi:

- ✓ Spores: shape, size, manner and arrangement of spore on the sporophore.

- ✓ Fruitification or spore-bearing structure.

Common diseases caused by fungi: Leaf rust, wilt, galls, stem blight, scabs and others.

III. Viruses

Any of various simple submicroscopic parasites of plants, animals, and bacteria that often cause disease and that consist essentially of a core of RNA or DNA surrounded by a protein coat. Unable to replicate without a host cell, viruses are typically not considered living organisms.

Basic structures: viruses consist of nucleic acid (5-40%) and protein coat (capsid, 60-95%)

- Nucleic acid consists of RNA or DNA, but not both.
  1. Most plant pathogen viruses consist nucleic acid with RNA.
  2. Nucleic acids are the main element for infection.
- Coat proteins are proteins surrounded the nucleic acid, protecting the nucleic acid from external damage.

Reproduction: Viruses can't reproduce by their own, but reproduce by incorporating their nucleic acid into the nucleic acid of a plant cell---interfering with normal cell division and growth of the host plants.

Symptoms:

- ✓ Yellow to light-or dark-green mottling.
- ✓ Stunting or excessive growth.
- ✓ Early leaf-fall or loss of vigor.

Penetration: Plant viruses enter cells only though

- ✓ Wound made mechanically.
- ✓ By vectors especially aphids and leaf hoppers.

Dissemination: Viruses are transmitted from plant to plant by:

- ✓ Vegetative propagation, e.g. by budding, grafting.
- ✓ Mechanically though sap.
- ✓ Seeds, pollens, insects, nematodes and other animals.

As for insect vectors, there are two kinds of transmission.

1. Non-persistent transmission (e.g. pepper mottling virus)
   - ✓ The acquisition period is short.
   - ✓ The inoculation period also short.
   - ✓ No incubation period in the insect.
2. Persistent transmission (e.g. potato leaf rot virus)
   - ✓ Acquisition period is long.
   - ✓ Inoculation period is long.
   - ✓ There is an incubation period.

IV. Nematodes

It is any of several worms of the phylum Nematoda, having elongated, cylindrical, non-segmented bodies, commonly microscopic, often narrowing at each end.

Reproduction: Nematodes reproduce through laying eggs.

Sexual

- ✓ Sex separate nematodes.
- ✓ Hermaphroditic (both sexes in one nematode)

Asexual: parthenogenetic (eggs produced without fertilization).

Harmful and beneficial roles of nematodes

Harmful roles

- ✓ Feeding on root or underground stems of plants.
- ✓ High populations affect the water and nutrients absorption by infecting the roots.
- ✓ The wounds caused by nematodes often act as ‘open doors’ to root-rotting and wilt-inducing fungi and bacteria and some viruses.

Beneficial role: feeding on parasitic fungi, bacteria, and other organisms.

Penetration:

- ✓ Through wounds;
- ✓ Directly penetration by their stylets, by repeated back and forth movement of

their stylets creating a small opening in the cell wall.

Dissemination:

- ✓ Spreading by them-selves in the soil.
- ✓ Spreading by anything that carries soil particles.
    1. Farm equipments.
    2. Irrigation
    3. Animal feet and others.

Symptoms:

Plant with large population of parasitic nematodes is often express symptoms of drought, nutrient deficiencies such as yellowing of the foliage.

Fig 2.12 Nematode damaged sweet potato

Diagnosis of plant Disease

A cause is associated to disuse. In strict sense, cause (in pathogen that incites infectious disease and any agent that injures plant) means anything inflict the plant to suffer. Therefore, causal agents are not only those animate in nature but also are inanimate. The animate causes are fungi, viruses, bacteria, nematodes, parasitic higher plants, mycoplasmas and protozoa. The inanimate causes are genetic or physiologic disturbance, soil factors, nutrition deficiencies, climatic condition, chemical factors, etc.

For a person who is to diagnose plant disease, it is prudent to first determine whether the disease is incited by a pathogen or an environmental factor. When typical symptoms of a disease are present for some cases, it is fairly easy for a somewhat experienced

person to determine whether the disease is caused by a pathogen or an environmental factor. In most cases, however, a detailed examination of the symptoms and an inquiry into characteristics beyond the previous symptoms is necessary for a correct diagnosis.

General Symptoms and signs of plant Diseases

Disease symptoms are divided in to three general categories:

1. **Necrotic symptoms –** these are those symptoms that result from cessation of function of living tissues, leading to death. Necrotic tissue is dead tissue.
2. **Atrophic or hypoplastic symptoms:-** are those symptoms result from underdevelopment or retardation of function.
3. **Hypertrophic or hyperplastic symptoms:-**
   these are symptoms result from over development or acceleration of function.

A. Necrotic symptoms

a. **Blight:** a disease characterized by general and rapid killing of leaves, flowers, shoots and/or stems. (E.g. *ascochyta* blight of field pea caused by my *Cosphaerella pinodes).*

Fig 2.12 tomato and carrot blight

b. **Rot:** the discoloration and disintegration of succulent plant tissues as a result of fungal or bacterial infection (E.g. black root on faba bean caused by *Fusarium solani*).

Healthy and damaged plant (root rot)

Fig 2.13 Rotting of root for tomato plant and other plant

Wilt: loss of rigidity and drooping of plant parts due to insufficient water in the plant (E.g. foot rot on faba bean caused by *Fusarium avenaceum* and wilt of grass pea caused by *Fusarium oxysporium (*Fungus*)*). In wilting, if plants wilt and it is not due to a lack of water, it may be an indication of disease. Wilting may be occurring because nutrients and water cannot move to the different plant parts, because the transportation system of the plant (*the xylem and phloem*) may be affected. This may be due to the transportation vessels being blocked by the disease-causing organism or to scarring or cancer formation inside the transportation vessels in response to the disease organism. It can also be due to the disintegration of specific plant parts, such as the roots. Examples of diseases that may cause wilting are root rot caused by *Phytophthora or Pythium spp*., collar rot, caused by *Phytopthora spp*., and seedling damping-off in nurseries, caused by *Fusarium oxysporum*.


Fig 2.14 wilting of banana and cabbage

c. **Blotch:** a disease characterized by large, and irregular in shape, spots or blots on leaves, shoots and stems.


Fig Tomato bloch

d. **Canker:** a necrotic, often sunken lesion on a stem, branch, or twig of a plant.


Fig Characterized (in woody plants) by the death of cambium tissue and loss and/or malformation of bark.

e. **Dieback:** progressive death of shoots, branches, and roots generally starting at the tip.

Fig Die back of avocado and lemon

f. **Scorch:** burning of leaf margins as a result of infections or unfavorable environmental condition.

Fig Leaf and fruit scorch of tomato

g. **Shoot hole:** a symptom in which small diseased fragments of leaves fall off and leave small holes in their place

h. **Spot**: a self limiting lesion on a leaf

 Fig leaf spot

i. **Yellows:** a plant disease characterized by yellowing of the foliage


Fig leaf yellowing

j. **Damping – off:** a condition in which the seedling stem is attacked near the soil surface, become constricted, weak, and results in toppling (E.g. Collar rot on faba bean caused by *sclerotium rolfsii*).


Fig damping of seedlings

B. The common atrophic symptoms

Chlorosis: yellowing of normally green tissue due to chlorophyll destruction or failure of chlorophyll formation.

i. Dwarfing: stunting of the plant

ii. Etiolating: yellowing of tissue and elongating of stems caused by reduced light or darkness

iii. Resetting: short, bunchy plant growth due to infection by a disease

Etiolating Dwarfing (stunting)


Fig Chlorosis

C. The common hypertrophic symptoms

A. **Callus:** a mass of thin-walled cells usually developed as the result of wounding or infection

a. Club root – enlarged roots appearing like spindles or clubs.


Fig 1.3.3. Club root of cauliflower

b. Gall – enlarged portions of plants usually filled with fungus mycelium.


Fig 1.3.4 Crown galls on pear seedlings

c. Leaf curls – distortion, thickening and curling of leaves.

B. **Curl:** inward folding of leaves, or rolling.

Leaf curl of tomato leaf distortion of sweet potato

Fig leaf curl

Fig. 4. Symptoms of tomato yellow leaf curl virus (TYLCV)

Survival of pathogens

As far as the host plant is in the field, the pathogens survive on this host. Otherwise, they survive on perennial plant, volunteer plant, in seeds, in the soil and crop residues. They also survive on alternates. They mostly survive as a sephyte or in the form of resting spores or dormant stages. Some of them also survive as stage or stage-structure of completing their suitable lifecycle for that part of the season. When the next cropping season comes those pathogens start infecting their normal host where by their

usual disease cycle start. Disease cycle is a sequence of events that occur between the time of infection and final expression of diseases.

Transmission of pathogens

Transmission mechanism of pathogens is also an important aspect to device or implements effective control measure against diseases. Therefore, major transmission mechanisms are briefly mentioned here. These include, spreading through planting material on/ in seeds, by wind, rain drops, irrigation water and flood, farm implement and vectors. According to the transmission mechanisms of each pathogen, the disease cycle is interrupted from its normal pathway or speed so that disease in crops are reduced or managed below economic threshold level.

Table 2.4: Summary of diseases with causing agent, host and transmission methods

	Name of disease	**Causal organism**	**Crops affected**	**Mode of transmission**
1	Late blight of potato	Fungi	Potato, tomato	Wind borne, soil borne, seed borne
2	rust (Leaf rust, stem rust, stripe rust)	Fungi	Wheat, Maize, avocado (different types of rusts)	Wind borne, soil borne
3	Damping off	Fungi	All seedlings (nursery)	soil borne
4	Common bacterial Blight of bean (CBB)	bacteria	Haricot bean	Wind borne, soil borne
5	Black rot of cabbage	bacteria	Cabbage	Wind borne, soil borne, seed borne
6	Coffee berry disease (CBD)	Fungi	Coffee	Wind borne, soil borne
7	Smuts (loose smut, head smut ...)	Fungi	Sorghum, barley, wheat (Different types of smuts)	Wind borne, soil borne, seed borne
8	Septoria leaf spot	Fungi	Tomato, pepper	Wind borne, soil borne
9	Verticillium wilt	Fungi	Potato, tomato	Soil borne
10	Root rot	Fungi	Lentil, chick pea	Soil borne
11	Sorghum anthracnose	Fungi	Sorghum	Wind borne
12	Banana anthracnose	Fungi	Banana	Wind borne
13	Mango anthracnose	Fungi	Mango,	Wind borne, soil borne
14	Powdery mildews	fungi	Mango, carrot, lettuce,	Wind borne, soil

			celery, pumpkin	borne
15	Enset wilt	Bacteria	Enset	Soil borne (also by farm tools)
16	Fire blight	bacteria	Apple	Wind borne, soil borne
17	Maize blight	fungi	Maize	Wind & soil borne
18	Early blight	fungi	Potato and tomato	Wind & soil borne

1.3.4. Identifying Plant Disorders

Physiological or abiotic disorders are distinguished from other disorders in that they are not caused by living organisms (viruses, bacteria, fungi insects etc), but are caused by non-living, abiotic situations. They are physical or chemical changes in a plant from what is normal and generally caused by an external factor. Some non-infectious disorders are easy to identify, but others are difficult or even impossible. Most of them are not reversible once they have occurred. To help in identifying physiological disorders it important to know that:

- Physiological disorders are often caused by the lack or excess of **growth factors** that supports life
- Physiological disorders can affect plants in **all stages of their lives**.
- They **cannot be transmitted**.
- Physiological disorders often serve as the ‘open door’ for pathogens to enter.

Some of the physiological changes that can occur are:

a) **Nutrient Deficiencies**

Nutrient deficiencies often result from a lack of plant nutrients in the soil. Deficiency symptoms include **chlorosis** or **necrosis on leaf margins** or tips, and other symptoms can occur. The easiest ways to recognize nutrient deficiencies is the relatively uniform distribution pattern of symptoms in the field as compared to many diseases caused by plant pathogens**.**

b) Nutrient Toxicities/Excesses

Damage from excessive macronutrient levels can occur as the result of over-application of fertilizers or manures. Nitrogen toxicity is most typical under hot, dry conditions and plants turn an overly-deep shade of green. these can be confused with canker diseases. Similarly, **twisting** and **distorting** of mature tomato plants that experience ammonium toxicity may appear similar to symptoms caused by viruses. Symptoms often include **chlorosis** or **necrosis on leaf margins** or tips, but leaf spotting, flecking, and other symptoms can occur.

c) Moisture extremes

Both water deficiency and excess can cause injury to plants.

- **Deficiencies in Available Water**

A short-term deficit of water might result in only minor effects on the plant such as wilted leaves or shoots. These symptoms may be temporary and occur during the warmest part of the day when transpiration rates are highest. when the air temperature declines, or supplemental irrigation is applied, or a rain event occurs, etc. the symptoms of low water status may disappear. During chronic periods of water deficit, plants may **grow more slowly** or not at all, young leaves may **not fully expand**, or foliage may not appear as colorful relative to foliage when the plant is not under low water stress. In severe cases "**scorching**" or **marginal leaf** necrosis can occur

- **Excessive Quantities of Water**

Excessive soil moisture can result in reduced oxygen availability to roots. Oxygen is a principal component for the physiological uptake of water into the roots. Therefore, similar to drought, a primary symptom of flooding is **wilting of** plant. Also similar to low water status, excess soil moisture can manifest as acute or chronic. During acute water excess (flooding), roots are subjected to low oxygen status and cell weakening and/or death occurs. Symptoms include discolored and/or water-soaked and mushy roots. Under these conditions roots can become weakened and **predisposed to disease** by

pathogens such as *Phytophthora spp.* In the case of chronic excess of water, plants appear **stunted** and have **underdeveloped shoots**. Adventitious roots may form at the root crown. Bark can **split**. If soil appears to be excessively wet, is discolored, or smells strongly of rotten eggs, water drainage in the area should be addressed.

d) **Temperature extremes**

Excessively high or low temperatures can be detrimental to plants.

High Temperature Damage

Some plant species can be very sensitive to high temperatures. For example, shoots and/or roots may stop growing if high temperatures prevail for an extended period of time. Roots may die. If high temperatures are coupled with low soil moisture, plants may exhibit **scorching on the margins** of the leaves, **premature leaf drop**, and in severe cases entire plant **death**. Sometimes physiological changes result in **abnormal color** or **growth** habits. Many food crops species are highly subject to **poor pollination** during periods of high temperatures.

- **Low Temperature Damage**

Damage from low temperatures generally develops because ice crystals form in plant cells resulting in death of cells. **Dehydration** or low water status can also occur as a result of low temperatures. Many plants native to tropical regions can be injured by chilling injury (e.g., damage occurs above 32°F; 0°C) and killed if sub-freezing temperatures occur for long periods of time.

Chilling temperatures (above 32°F; 0°C) can damage newly expanding plant parts, resulting in a **purplish coloration** of foliage and possible necrosis. Woody parts of plants can also be injured by sub-freezing temperatures. Bark can **crack**, thereby exposing underlying wood to attack by pathogens or insects.

e) Chemical Injuries (Phytotoxicity)

Inappropriate products, overly high rates, or certain product mixtures agricultural chemicals (herbicides, insecticides, fungicides, and plant-growth regulators) can damage crops. When using a material or a mixture for the first time it is best to test on a small scale first.

f) Mechanical Injury

Mechanical damage comes in many forms such as storms, misuse of equipment, or animal activity. Symptoms of broken limbs, flattened tree tops or torn bark on tree trunks are easy indicators of mechanical damage.

Fig 2.4.1 Problems of N defficiency (yellowing of leaves in vine) and witing (high temperature) in tomato.

Fig 2.4.2 Problems of K defficiency in tomato and cabbage plant (marginal drying)

Fig Problems calcium defficiency in tomato fruit and lemon plants

Fig Problems of excess water in onion and tomato plants (poor drainage)

Fig 2.4.5 Effect of low temperature on apple and sun scorch on tomato fruit

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1 Define weeds, insects, diseases, rodents, disorders and beneficial organisms (10 points).

2. What do mean by infectious and non infectious diseases? (10points).

3. Explain different type of weed classifications (10 points).

4. List at least 10 types of insects with their orders (10 points).

5. Explain the direct and indirect harmfulness of weeds on crop plants (10 point).

6. What are beneficial organisms for weeds, insects, and diseases (10 point?)

Note: Satisfactory rating - 60 points and above Unsatisfactory - below 60 points

You can ask your teacher for the copy of the correct answers.

Information Sheet-3	Identifying Levels of Weed Infestations, Plant Pests, Diseases and Disorders Tolerated by the Client or Market

3.1 **Tolerated by the client or market**

'Pest Control' or now more usually 'Pest Management', does not mean that it is necessary to kill every organism in the crop or on the harvested produce. Some presence of some pests or crop damage will be tolerated. What and how much presence or damage will be accepted depends on the client and the market. Details of client and market tolerance may be documented in market contracts or specified in phyto sanitary regulations and country quality standards or where these legal guidelines are not available, a farmer or manager will have a clear understanding about the relationship between produce quality and price.

Tolerance levels will be taken into consideration when thresholds for treatment of pests are established. Thresholds for treatment will be documented in the Integrated Pest Management, (IPM) Strategy where this exists.

Some examples of tolerance levels are given below:

- **Produce for the local market in Ethiopia**: Local buyers are very tolerant but there is a clear relationship between price and quality (poor quality; small size, yellowing presence of caterpillars, etc. means less potential customers and lower price).
- **Produce for sale to primary and secondary whole sellers (Middle men)** for transport to Addis or Countries in the Region. Here there is a lower tolerance for pests and diseases, particularly those pests and diseases that are likely to cause produce to deteriorate during transport. Therefore whilst there is no direct legislation or contract for this type of sale, in practice infected products will not be purchased by the Middleman.
- **Produce exported to Europe, America, the Far East and Australia**, is subject to much more stringent regulation and tolerance levels for pest are very low and in some cases Zero. Produce will be subject to **Phyto sanitary inspection** by the Ministry of Agriculture **and will need a Phyto sanitary Certificate** before export is allowed. **Quarantine pests listed in the receiving country are not allowed** so if

these are found during the inspection, a phyto sanitary Certificate will not be issued. In addition to this the receiving country or the client may set levels of pest and pest damage for non-quarantine pests that must not be exceeded. Produce that is found to be infected with quarantine pests or exceeds the levels of non-quarantine pests/pest damage acceptable in the receiving country or by the client on arrival will be destroyed or returned at the expense of the Farmer or Exporter concerned.

3.2 Identify infestation levels that compromise growth, yield and profitability

Crop plants are able to tolerate an amount of pest or disease infestation or damage without significant loss of yield. The difficult question is however 'how much is too much'? In the field two levels of infestation / infection or crop damage may be used in practice:

Damage Threshold: This is the level of infestation, infection or crop damage where crop growth and yield is reduced and

Economic threshold: which is the level of infestation, infection or crop damage where the value of crop loss is equal to the cost of treating the infestation or infection.

Applying these concepts in the practical circumstances in the field is however more difficult:

- Technically damage and economic thresholds can only be determined experimentally.
- Describing and quantifying the amount of pest presence and crop damage being caused is time consuming and difficult in commercial crop circumstances.
- Technically damage and economic thresholds will vary with variety, crop age, presence of other pests and diseases in the crop, agronomic practices implemented and weather/climate prevailing at the time.

Guideline thresholds have been produced and published for some major crop pest combinations and for Biological Agent introduction in high value Greenhouse crops but for most crops farms will base their decisions to spray on experience and local risk assessment.

For example in a tomato crop:

- Preventative sprays for some diseases, e.g. Early and late blight in tomatoes will be applied during the rainy season
- Spider mite will be treated starting at low levels of infestation in hot dry weather but may not need treatment at low levels of infestation in the cold or rainy season. In the latter cases where conditions do not favor multiplication of the pest, the size of the infestation will be monitored by crop scouting and treatment will only be applied when the population of spiders shows signs of significant increase.
- To the absolute pest, a pest which has the capacity to completely destroy a crop, treatment will start as soon as the pest is detected in the crop or in the pheromone traps.

You need to build up a portfolio of experience to be able to make decisions about when treatment is justified. When you are on the College farm or on cooperative training observe the level of pest management in the field and ask how decisions to apply treatment are being made. Also evaluate the performance of the crops in your student plots.

For ornamental crops grown e.g. cut flowers for crops grown for export, the thresholds for pests in crops may be much lower; aesthetic threshold or even zero tolerance.

The Aesthetic threshold will be used where the appearance of the crop or produce is important.

Zero tolerance i.e. not pest presence will be needed for phytosanitary pests in the receiving country and may be required for all pest for produce going into some countries; USA, Japan and Australasia have particularly strict rules.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Explain some examples of tolerance levels (5 points)
2. Define damage threshold and economic threshold (5 points)
3. How you can determine economic threshold for pests (5 points)

Note: Satisfactory rating - 15 points and above Unsatisfactory - below 15 points

You can ask your teacher for the copy of the correct answers.

Information Sheet-4	Identifying Infestation or Infection Levels

3.1 Identifying infestation levels

The first weed survey should occur shortly after crop emergence and continue at weekly intervals until control options are no longer available. Scouts should record the relative weed abundance and growth stages at ten randomly selected plots. When moving between sites always look for pockets of problem weed infestations.

1. Identifying **levels of weed Infestations** can be done in two ways

i) By counting weeds by taking sample plots using quadrate

Materials required: quadrate, measuring tape, note book, pen

Preparing quadrate

- Prepare four pieces of wood with 1 m length
- Fix the four edges with a nail as indicated in the picture
- Make four or five sections vertically and horizontally with a string at equal spacing
- Take 3 to 10 sample plots using quadrate depending on weed density and the size of the farm
- Count the number of each weed species present and record

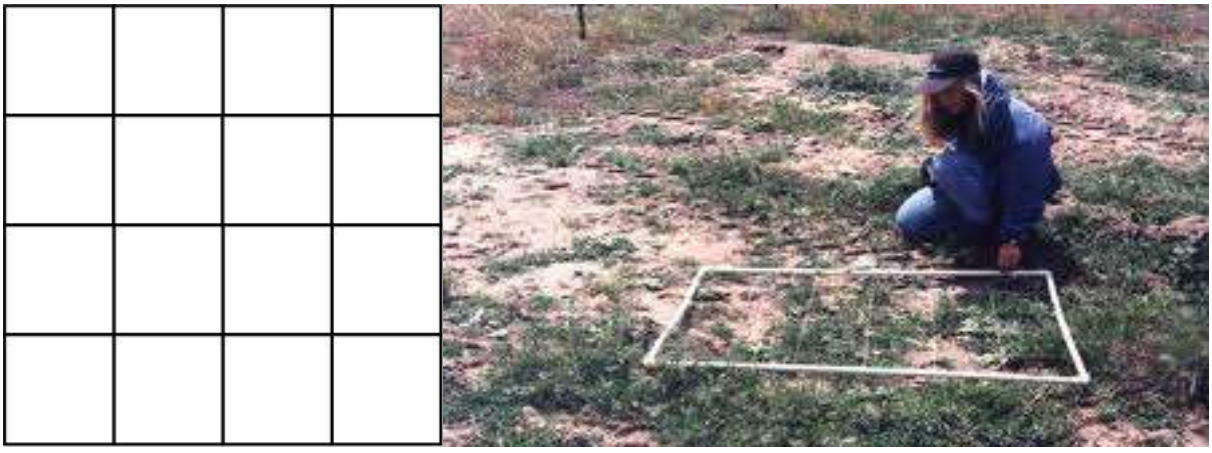

Fig Assessing level of weeds by using quadrate methods

a) Calculate the total density of weeds and the density (**D**) of each weed species

add all the weed species to obtain the total number of weeds in the quadrate

$$\mathbf{D} = \frac{no.\ of\ \ weed\ \ plants}{area\ of\ \ sample}$$

b) Calculating percent abundance of each weed type and species **(**broad leaved weeds, grassy weeds, annual weeds and perennial weeds)

$$\%\ \text{Abundance of each weed} = \frac{no.\ of\ \ types\ of\ \ weed\ \ in\ \ a\ \ sample}{total\ no.\ weeds\ in\ \ a\ \ sample} \text{x}100$$

ii) Estimating percent ground cover (area covered by weed) by visual observation

Percent ground cover is estimated by visual assessment of weed density. Visual assessment is the simplest way to determine weed density. It is quick and easy and useful for smaller sites and most species, but can be subjective. To improve the accuracy of visual assessments please refer to Figure 3, which gives you an idea of how different weed densities, as a percentage of ground cover, may look.

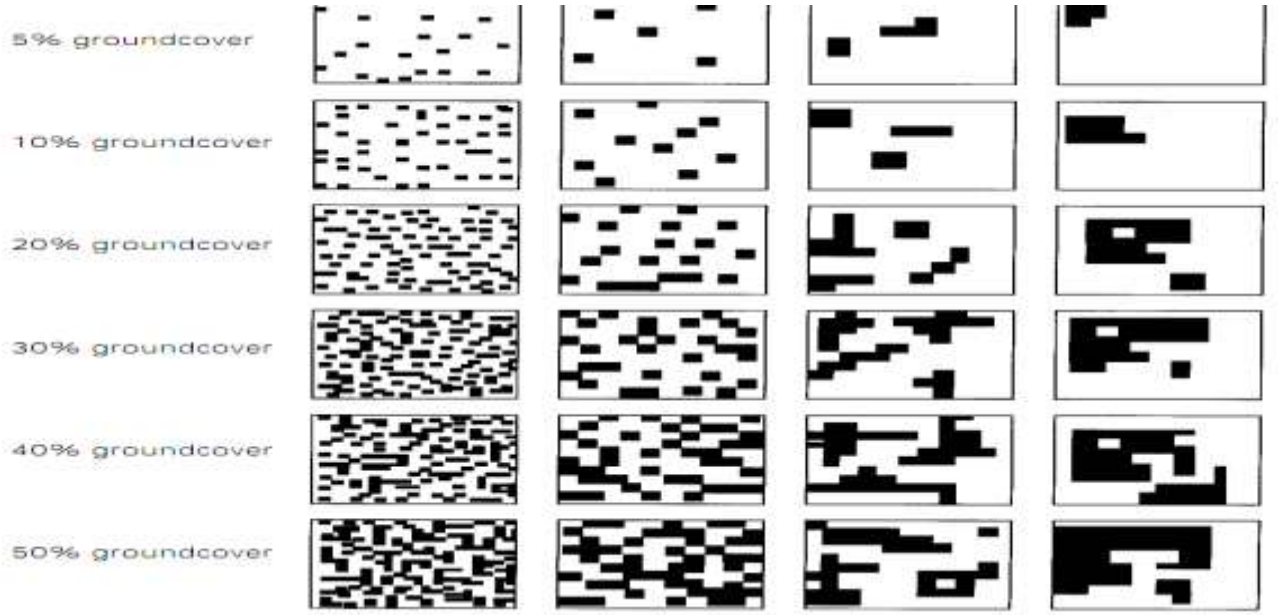

Fig: A guide for the visual assessment of weed infestation as a percentage of ground cover.

Compare the view of the field with the picture and estimate the weed cover.

Group weeds populations into the following four categories and estimate the level of damage

% ground cover	Weed density	Degree of damage
Greater than 25%	Fairly dense, or more than 1 plant per foot of row for broadleaf weeds and 3 plants per foot of row for grasses, or large areas of heavy infestations	H = Sever/ **High**
15-25%	Fairly uniform concentration of weeds across the field. Average concentrations of no more than 1 plant per foot of row or scattered spots of severe infestations. Economic loss likely unless control measures taken	SS=Slightly sever
5 - 15%	Weeds scattered throughout the field, an average of no more than 1 plant per 3 feet of row, or scattered spots of moderate infestations. Economic loss unlikely but possible in certain areas	M =Moderate
1 - 5%	Occasional plants	L = Slight/**Low**
less than 1%	very few weeds within the field. Enough plants to produce seed but not likely to cause economic loss in the current year	**Trace** (rare)

2. Identifying levels of insect infestations can be done in two ways

A) In terms of number of insects present per m^2 of area or per plant

For narrow spaced crops, the number of insects present can be expressed per m^2 of area. In wider spaced crops, the number of insects present can be expressed per plant.

i) General procedure for small crops/narrow spaced crops

- take eight blocks of $1m^2$ each for 1 hectare field
- take 10 plants or tillers from each block and look for damage
- count the number of insects present in each plant

Field location_____Field name/Code_____area of Field_____

Scout round	Schedule /date	Type of Insects recorded	Number of insects present in m^2 or per plant	Type of Disease recorded	Severity of Disease damage recorded
1st					
2nd					
3rd					

Number of tillers affected	Grade

0	0
0-5	1
5-10	2
>10	3

Fig Field scouting schedule for pest infestation

ii) **In wider spaced crops**

Take some 10 to 50 plants from a row of the crop at about five different places depending on the type of the insect

Aphids rating

Count/ density	Grade /rating	
< 50 aphids per plant	None (few)	
>50 aphids per plant	Moderate - high	
Tassel covered	Very high	

b) In terms of leaf area damaged

This method is used to identify the amount of damaged leaf area in percentage both for insect or disease damage by visual observation. This is usually done by using standard pictures

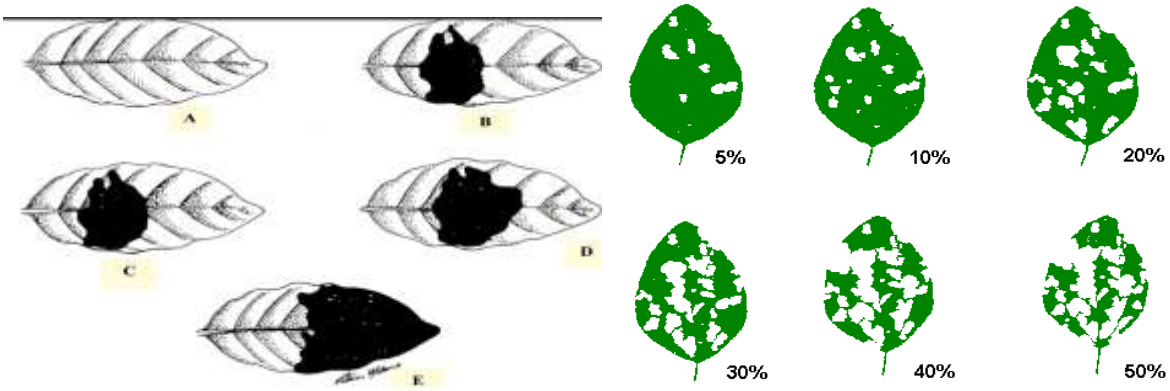

Fig Percent of damaged leaf area for insects and diseases

3. Identifying levels of diseases and disorder infestations

Method of assessing disease damage is similar to that of insect damage infestation. It is determined in two ways:

a) As percent number of plants infected by looking at 10 to 20 plants randomly selected from 5 randomly selected plots within a field.

b) Percent of foliage (leaf area) infected: this method is used for leaf diseases. The same pictures above are used for visual comparison of affected leaf area.

3.2. Determining economic injury level

Economic damage/ loss: is the amount of damage done to a crop which is financially justified by the cost of taking artificial control measures which varies from crop to crop. Knowing whether or not it is necessary to take action against a pest, especially when pesticides are involved, enables the producer to make financially and ecologically sound decisions.

According to the level of pests' damages to crops, pests can be divided into two types.

1. ***Economic pests***: pests cause a crop loss of 5% or more in a definite field.
2. ***Non-economic pests*** mean pests cause a crop loss of less than 5% in a definite field.

Keeping insect infestations below significant levels through preventative measures is at the core of long term integrated pest management. Immediate pest control is reactive and is warranted only when the insects begin to affect the producer economically. A common problem for most producers is deciding whether or not to apply a control method for a specific pest. The initial response may be to spray as soon as insects are found in the crop. But implementing control measures is **costly**. Many insecticides have broad spectrum activity **affecting non-target organisms** and therefore, **unnecessary applications can have undesirable environmental effects**. So it is important to ask when an infestation becomes economically viable to control. We must ask the following questions before applying pest control method.

- When should we apply pest control measure?
- How many insects are there in the field?
- Does the pest cause significant yield loss?
- Which of these pests are large enough to cause economic injury?

To resolve this problem and make good decision as to **whether insect control has an economic benefit or not** one must consider the economic thresholds of the pests.

a. **Economic Thresholds/ET (Action Thresholds/AT): is** the **pest density** at which some control should be exerted **to prevent** a pest population from **increasing**

further& causing **economic damage/loss**. **ET** is the level a pest population must reach before treatment to control the pest can begin. The action threshold for pest management must be lower than the economic threshold.

Economic threshold for disease is called **Damage Threshold (DT):** It is the maximum damage a crop can sustain **without yield loss** by a disease. It is generally used for **plant diseases**. Since disease pathogens are too small to be easily seen, counting their numbers is impractical, so an estimate is made of the amount of damage caused by them.

b. **Economic Injury level (EIL):** is pest population density at which economic damage occurs. It is where the **cost of the control** measure **is equal to** the **loss** likely to be inflicted by the pest. If the pest population reaches this boundary, economic damage will occur. EIL is above the economic threshold,

Economic thresholds can be expressed by:

- number of insects per plant or
- number of insects per square meter of field
- the amount of leaf surface damaged
- area of land covered by weeds

Knowledge of economic thresholds can reduce crop losses, production costs and potential impacts on non-target organisms and the general environment. Unfortunately, not all combinations of pests and crops have been studied, and some reported thresholds are merely educated estimates.

Currently Recommended Economic Thresholds for Insect Pests

- Cutworms in (Cereals) 3 - 4 larvae/m^2
- Grasshoppers (Cereals): 8 - 12 grasshoppers /m^2; Flax, Lentil 2 grasshoppers /m^2
- Coffee bug: 2-3/plant
- Corn leaf aphid (on Cereals): 12 - 15 aphids / stem prior to soft dough
- Green bug (on Cereals): 12 - 15 aphids / stem prior to soft dough
- Pea aphid (on Peas) 2 - 3 aphids on top 20 cm of plant tip

- Thrips (Barley, oats): 7 - 8 thrips / stem prior to head emergence; On Red Clover 50 – 80 thrips per flower head
- Painted lady butterfly (on Sunflowers) 25% defoliation
- Red sunflower seed weevil (Sunflower Oil crop): 12 - 14 weevils/head at 85 - 100% bloom; Confectionery: 1 - 2 weevils/head at 85 - 100% bloom
- African bollworm in cotton: 10 larva/egg
- Jassid in cotton:50 nymphs
- Whitefly in cotton: 200 adults
- Aphids in cotton: 20% of farm area

Economic thresholds can fluctuate depending on a combination of factors including:

- the type of pest,
- type of crop,
- stage of the crop,
- cost of control and
- growing conditions
- the final market prospects for the product.

When conditions are ideal, a vigorously growing crop may be able to withstand a higher pest population with little yield loss, depending on the stage of the plant. Conversely, relatively fewer insects may significantly damage a stressed crop. On the other hand, with some sucking insects, such as aphids on flax, a higher yielding crop will suffer a greater percentage yield loss than will a crop already under stress. Economic thresholds serve merely as a guideline to the producer, and to be effective, the plant's growth stage and growing conditions must be considered along with these other factors.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Explain methods of weed infestation identification. (5 points).

2. Levels of insects can be identified by (5 points).

3. Explain diseases and disorder identification (5 points)

4. How you can determine economic injury levels for weeds, diseases, insects and disorders. (10 points).

Note: Satisfactory rating - 25 points and above Unsatisfactory - below 25 points

You can ask your teacher for the copy of the correct answers.

Information Sheet-5	Obtaining Professional Advice

It is not expected that you will always recognize the pest, disease or disorder that you have found; so sometimes you will need professional advice.

There are a number of sources of professional advice available to farmers

- The local Government District Agent and Plant Clinic will be able to help with identification and selection of appropriate treatment.
- Technical advice may be provided by input suppliers and service providers. In this case identification will be ok but the advice about appropriate treatment may be influenced by what products they wish to sell.
- Commercial farms may employ the services of a specialist crop Protection Consultant

Please consult with your Employer and follow the enterprise guidelines and procedures if you need to access professional advice.

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. When you can get advice? (10 points).

2. When you can get advice (5 points).

Note: Satisfactory rating - 15 points and above Unsatisfactory - below 15 points

You can ask your teacher for the copy of the correct answers.

Operation Sheet-1	Identification and reporting of the weeds, insects, diseases and disorders for horticultural crops

Objectives:

- To explain how to identify weeds, insects, diseases and disorders.
- To classify each type of weeds, insects, diseases and disorders.
- To identify life cycle of insects and in which stage it may founds.
- To identify parasitic weeds and other introduce weeds.

Materials: - magnifiers (hand lens), microscope, forceps, net, sspecimens, grass shears, buckets, sacks, pots or jars, notebooks and pencils, flip chart; marker pens and tape.

Procedure

1. Identify different horticultural crops and diagnose any insect damage and diseases symptoms.
2. Catch insect pests by using net.
3. Take the sample of diseased plant parts (for disease identification)
4. Observe the main characteristic of the main order insects that damage the crop with magnifiers and microscope.
5. Identify the insect life stage and which stages are more dangerous.
6. Identify each weed species within the farm by name and classify.
7. Observe for disorders like water logging, nutrient deficiency, and climate related factors.
   Note: Mostly disease symptoms are patchy and disorders but not.
8. Record your observations in the following tables and report

A. Weeds

No	Common name of the weeds	Host plants (parasitic or not)	Morphological explanation (Narrow, broad or sedges)	Similarly classify
1				
2				
3				
etc				

B. Diseases

S.No	Common name of the disease	Host plants	Main symptom	Causing agent (pathogens)
1				
2				
3				
etc				

C. Insects

No	Common name of the insect	Host plants	Characteristics of the insect	Growth stage	Damaging stage
1					
2					
3					
etc					

D. Disorders

No	Type of disorder	Crop type	Characteristics of the disorder	Classify
1				
2				
3				
etc				

Other pests like rodents, birds.

LAP Test	Practical demonstration

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: You are required to perform the following as directed

Task1. Identification and reporting of the weeds, insects, diseases and disorders for horticultural crops

HORTICULTURAL CROPS PRODUCTION

Level-III

Learning Guide-65

Unit of Competence: Control Weeds, Plant Insects, Diseases and Disorders

Module Title: Controlling Weeds, Plant Insects, Diseases and Disorders

LG Code: AGR HCP3 M15 LO1-LG-64

TTLM Code: AGR HCP3 TTLM 0120v1

LO2. Plan the implementation of control measures

Instruction Sheet	Learning Guide 65

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Selecting control measures suitable for the infestation
- Selecting tools, equipment and machinery
- Identifying occupational Health and Safety hazards
- Selecting suitable safety equipment and personal protective equipment (PPE)
- Selecting control measures in full consideration of OHS

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Select control measures suitable for the infestation
- Select tools, equipment and machinery
- Identify occupational Health and Safety hazards
- Select suitable safety equipment and personal protective equipment (PPE)
- Select control measures in full consideration of OHS

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, 2, 3, 4 and 5”.
4. Accomplish the “Self-check 1, 2, 3, 4 and 5”.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, 2 and 3.
6. Do the “LAP test” for each operation sheet.

Information Sheet-1	Selecting Control Measures Suitable for the Infestation

1.1. Weed Control Methods

A. Cultural Control methods

Cultural control refers to the application of thorough cultural practices, to make the environment less favorable for weeds to develop. These include:

a) **Tillage** /Land preparation/ Hoeing

b) **Crop Rotation :** Planting different types of crops with varied characteristics reduces the likelihood that specific weed species will become adapted to the system and become problematic

c) **sowing "clean" seeds.** crop seed may be contaminated with weed seeds**.** Weed seeds may get the chance of spreading in to the field together with crop seed while sowing. This is common specially for small cereal crops such as teff, wheat, barley. This can easily be avoided by sowing clean/pure seed. this can be checked by seed purity test.

d) **Adjusting plant population.** Weeds can be shaded by planting crops so closely together that they keep the sunlight from reaching the emerging weeds.

e) **Time of planting:** Sometimes the planting date of crops can be delayed until after weeds have emerged and have been removed by cultivation or by herbicides.

f) **Growing resistant varieties**: effective method for controlling parasitic weeds such as striga.

B. Physical Control

In general, physical controlling methods include:

a) **Manual control /Hand pulling /uprooting: -**hand pulling is most effective for annual and biennial weeds. Pulling of annual weeds prevents seed production.

b) **Mulching and shading:** By serving as a physical barrier and by keeping light from reaching weed seeds . less laborious but does not kill perennial weeds.

c) **Mowing/slashing/chopping** the weeds.

d) **Cleaning farm tools** equipment thoroughly before moving it from weed-infested to new area.

e) **Grazing by animals**: - Grazing serves the same purpose as mowing in weed control. To be effective, grazing must also prevent seed production. Therefore, the age of the target weed is an important consideration in a grazing program.

f) **Limiting the movement of domestic animals** from infested to a new field.

C. Biological control methods

Biological control measures refer to the use of beneficial living organisms (parasites, insects, diseases) to regulate or suppress weeds. Natural enemies that are used for biological control are called bio-control agents.

Some of suitable bio-control agents are:

- releasing insects such as **b**eetles to feed on weeds
- releasing grazing animals ,
- spraying disease causing organisms (fungi)

D. Chemical control

The chemicals used to control weeds are known as "*Herbicides". Herbicides* can be classified based on the following

- Time of application
- Selectivity

Fig 1.1 Chemical controlling methods

Application of Herbicides based on time

a) **Pre-plant incorporation** herbicides: these are soil applied herbicides sprayed on the soil before sowing the crop. eg. Atrazine and simazine used.
b) **Pre-emergence herbicides**: these are also soil applied herbicides sprayed on the soil after sowing the crop but before emergence. eg. Atrazine and simazine are used as both pre-plant and pre-emergence herbicides
c) **Post emergence herbicides**: these group of herbicides are sprayed on the leaf of the weed after emergence. eg 2,4-D

Based on Selectivity herbicides are grouped into two

a) Selective Herbicide: Kill only some species of weeds selectively. They have greater degree of activity on one group of plants while not injuring others. for example 2,4-Dis a **selective systemic herbicide that** kills only broad leaved weeds but not grasses at the recommended rate. **Others examples** atrazine, diuron, and alachlor.

b) **Non- Selective Herbicide**. this herbicides kill all weed species indiscriminately. They are usually used to clean roads. Example, **Glyphosate** (Roundup) is a **nonselective systemic herbicide** that kills most species of plants.

- **Soil sterilants:** Soil sterilants are chemicals that **render** the **soil toxic** to higher **plant** life.

The **difference** between a soil **sterilant** and a **nonselective** herbicide is that the soil sterilants remain in the soil and **kill seeds** that germinate **for extended periods of time**, thereby preventing regrowth of plants.

The length of **time** soil remains void of plants **depends** on the **material used, rate of application, and the environmental conditions**, such as light, temperature, moisture, and soil properties, which affect the rate of decomposition of the herbicide.

Fig 1.2 Mulching (grass mulch) Fig1.3 Pre-emergence herbicide application

Controlling parasitic weeds

I. Preventing the dispersal of parasitic weeds' seeds
- By preventing its introduction into a field by the use of weed free seeds.
- By cleaning equipment thoroughly before moving it from weed-infested to new area.
- By limiting the movement of domestic animals from infested to a new field.

II. Cultural control

a) Use of trap crop: trap crops are those crops which can promote parasitic weed seeds germination but do not support parasitism.
- They induce the germination but are not parasitized.
  - Trap crops for *Orobanche crenata*: pea, groundnut, pigeon pea, French bean.
  - Trap crops for *Striga asiatica*: cotton, groundnut, pea, soya bean.

b) Use of catch crops: catch crops mean those crops which can promote parasitic weed seeds germination and support parasitism but are destroyed prior to parasitic flowering (by plowing under or the use of herbicides such as 2,4-D)
- They are the hosts of parasitic weeds planted before main crop growing season.
- The land under catch crop plowed within 6-8 weeks or applied herbicides.
- High density of catch crop induces high germination of parasitic weed seeds.

c) Addition of mineral fertilizer: for instance, *Striga spp* are often seriously associated with low soil fertility. addition of N (nitrogen) can reduce infestation.

d) Use of resistant varieties: growing varieties that are not affected by the weeds.

III. ***Chemical control***

- Soil-applied herbicides such as paraquat can be used before planting to control parasitic weeds.
- Foliage-applied selective herbicides, such as 2-4 D can be used after emergence.
- Use of synthetic stimulants: e.g. injection of ethylene gas into fallow soils, which stimulates germination of witchweeds resulting in subsequent death since no host, is present in the field.

Principles of weed control

a) Critical period of weed competition

Critical period of weed competition is the early growth period of the crop when the crop is highly sensitive to weed competition and yield is significantly reduced. The crops need to be free from any weed during this period in order to get the attainable yield. Generally the critical period of weed competition for crops lie within the first several weeks after emergence.

Crop	**Critical period of weed competition**
Potato	the first 6 weeks
Maize	the first 5-8 weeks (two months)
Sorghum	the first 6 weeks
Wheat	the first 6 weeks

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b) Always kill weeds before flowering or seed setting

Never try to perform manual methods of weed eradication on weeds or alien species that have gone to seed or are in flower, as the method is likely to spread the seeds and cause a bigger problem in the future. Always try to eradicate weeds before they form seeds. If the weeds have already formed seeds, herbicides might be a preferable method of control.

c) Weed seed bank depletion

One approach to reducing weed pressure over the years involves reducing the number of weed seeds in the soil. This practice only works with weed species that are said to be seed-limited. These species typically produce seeds that do not remain viable in the soil for extended periods of time. weed seeds may persist in the seed bank for many years or even decades, making it impossible to manipulate the seed bank with agronomic practices.

Weed seed bank depletion is generally accomplished by integrating two methods. The first is stimulating weed germination and emergence and then destroying weeds that have emerged. The second is preventing the addition of new weed seeds into the seed bank.

i) **Stimulating weed germination**

- Stimulate weed germination with light tillage when the soil is moist. This can be done in off season where there are no crops but it is also possible to apply in the cropping season.

- allow the weeds to grow for a short time, wait for some days till the weeds emerge
- Destroy the emerged weed seedlings by plowing at young stage or when the density of the seedlings is at its maximum
- Allow the growth of second flush of weeds and repeat the procedure several times till the crop season

ii) **destroying weeds before flowering or seed setting**

to deplete weed seed bank weeds must be prevented from producing new seeds to prevent the addition of new weed seeds into the seed bank. This is done by killing weeds before flowering or seed setting. Collect all seeds from weeds that have already set seeds in the field and bury them in a pit. This prevents build up of seed bank..

For effective control of weeds, certain guiding rules must be followed. These are

- For Annual weeds: When small, most annual weeds are easy to control. The prime concern is to prevent these weeds from going to seed
- For Biennial weeds Control is more effective when the plants are in the rosette stage of their first season of growth.
- Perennial weeds not only reproduce by seeds but many also spread by asexual means, making control more difficult. Hence their underground propagation parts must be considered during control.

1.2. Insect Control methods

1) Cultural Methods of Insect Control

a) **Field sanitation**: it includes destruction of weeds (alternate hosts) and crop residue

i) Destruction of weeds: some weeds act as host to insect pest, timely control of weeds would deprive them of their host.

ii) **Crop residue management**. Cleaning crop fields after harvest and destroying crop residues helps in destroying over wintering pest populations.

b) **Crop rotation:** since insects are generally selective in the choice of crops they attack, a rotation of crops can result in a reduction of insect numbers when new crops are planted.

c) Intercropping /cropping patterns: for example intercropping checks the spread of pest and is less frequent than in monoculture.

d) **Dry tillage practices:** ploughing and harrowing normally reduce the population of soil pests by exposing them to sunlight, predators and parasites.

e) **Adjusting time of planting:** it is used to avoid period when insect's population is at its peak. For example sorghum midges can be effectively controlled by planting early so that flowering is complete before the adult midge population reaches damaging levels.

f) **Timely harvesting:** prompt harvesting is known to help protect maize and beans from damage by maize weevil and bean bruchid.

g) **Trap cropping:** A trap crop is used to divert the pest from the main crop. The pest usually prefers it to the main crop for feeding or egg lying. The trap crops are grown in strips at appropriate intervals within the field. The pest population concentrates on the trap crop, while the main crop suffers little damage. Example: growing napier grass around maize traps maize stalk borer.

h) **Home-made sprays**: insects can be repelled from the field by spraying home-made extracts of garlic, neem tree seed extract, hot pepper, ginger either separately or in mixture. these extracts can be sprayed on the crops before or after the appearance of the insects

i) Apply **detergent soap** on the leaves of plants (to control aphids, scale insects)

j) **Growing resistant varieties:** pest may also be controlled by planting pests resistant varieties.

k) **Fire**: - Fire may kill larva and pupa of pests that overwinter beneath the soil but may also kill beneficial insects.

Fig 1.5 intercropping

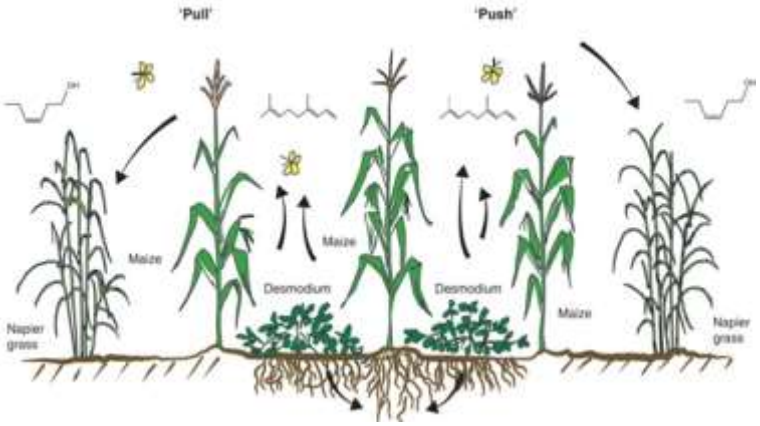

Fig 1.6 pulls and push principle for stalk borer

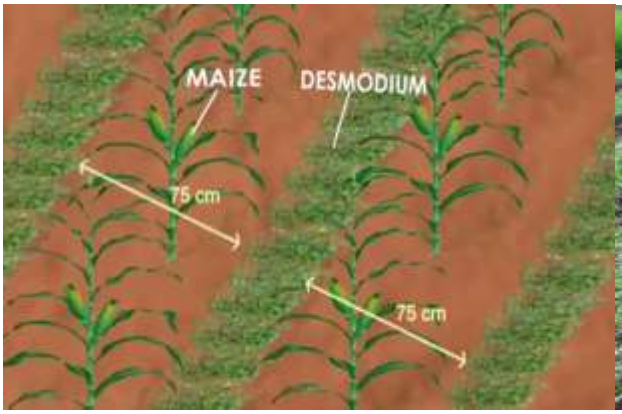

Fig 1.8 Intercropping with Desmodium

Fig1.9 pull and push principle for stalk borer control

Fig1.10 wire worm damage of potato due to late harvesting

2) Physical control of insects

a) **Hand picking:** for example, fully grown adult grasshoppers and caterpillars of some insects may be manually collected and removed from the crops

b) **insect traps**: moths can be trapped using light traps and pheremone traps. This is generally used for monitoring army worm

c) **Using sticky color board traps**: insects are generally attracted by different types of colors. hence this can be used as a trap by painting a sticky material (petrolium jel/vaseline) on the colored boards and placing them in the field

d) **Using repellants**: insects can be repelled or kicked off the field by spreading some undesirable materials in the soil. for example grounded egg shell, coffee residue etc can be spreaded on the soil around seedling to control cut worms.

e) **Physical barriers/nets/green houses**. Growing crops inside a controlled room like glass house/ green house, lat house etc prevents the entrance of insects into the room.

f) **Washing/brushing**: small insects such as aphids and scale insects can be removed by washing with water or rubbing with brush. they can also be rubbed off using running water jet

g) **Soil solarization**: this is the practice of covering the field (soil) with a plastic sheet/mulch during dry season for more than three weeks. The plastic absorbs sunlight and increases the temperature of the soil killing the insects in the soil.

Fig1.11 Sticky color board trap

Fig 1.12 spreading egg shell for cut worm control

Fig 1.14 physical barrier (covering with net) Fig 1.15 covering fruits with net/plastic

Fig 1.16 plastic sheet mulch Fig 1.17 Soil solarization with plastic mulch

3) Biological control of insects

Biological control refers to the use of living organisms for the control of pests. It is the use of predators, which feed on harmful insects and reduce their numbers to a minimum. Biological control includes the following:

i. Using parasites and predators.

   *Example r*eleasing lady beetle to feed on aphids,

   Parasitic insects, wasps, frogs, birds, chicken and some kinds of bugsfeed onAfrican bollworm, army worms, cut worms

ii. The use of disease causing pathogens (bacteria, fungi, viruses, and nematodes) on insects

Birds feeding caterpillar

Mantis feeding on locust

Plant bug feeding on trips

Lady beetle feeding on aphids' wasp feeding on caterpillar Ants feeding on caterpillar

Fig. 1.18 Predator insects

4) Chemical Method of Insect Pest Control

Chemicals used to kill insects are called insecticides**.** The most effective method of controlling insect pest is by spraying or dusting crops with insecticides. The choice of insecticide will depend on the feeding habits of any particular insects.

i. **Contact poisons**: This would kill insects as a result of direct application and are most effective when they are sprayed onto the body in a form of a fine mist which completely covers the insect. They are particularly useful in controlling sucking insects. Examples of contact poison include: Didimac 25, etc.

ii. **Systemic poisons:** These chemicals are absorbed either by the leaves, stems or roots of crops without harming them but the chemical will poison any insect which feeds on the treated crop. Systemic insecticides are particularly useful in controlling **sucking insects** such as mealy bugs and aphids. Eg. Chloropyrifos.

iii. **Stomach poisons:** Biting and chewing insects are usually controlled by the use of **stomach poisons**. Examples: **lead arsenate**.

iv. **Fumigants:** Insect pest of stored products are generally controlled by fumigants that is insecticides which kill by poisonous vapors or fumes. Examples are carbon disulphide, hydrogen cyanide (gas) sulphur and methyl bromide.

5) Regulatory method of pest control

Regulatory methodis the use of legislation to enforce the quarantine of plant material. The legislation requires that propagating material (seeds, cuttings, whole plant) imported from abroad be accompanied by a phytosanitary certificate stating that they are free from pests and diseases. Materials are inspected by a trained quarantine officer at the port of entry and if dangerous organisms are found the whole consignment may be destroyed.

1.3. Disease control methods

A. Cultural control methods

The most common cultural controlling methods includes:-

a) **Field sanitation**: field sanitation is destroying weeds and infected crop residue. this is the most important method to control most crop diseases.

b) **Crop rotation**: - Rotating fields to different crops each year can be overemphasized as one of the most important and easily implemented disease control strategies. This practice avoids the buildup of certain plant pathogens in the soil.

c) **Growing disease-resistant Varieties**: - The use of disease-resistant varieties is among the most economical and reliable methods of disease control.

d) **Sow healthy seed and transplant only healthy seedlings**: - A basic rule for controlling plant diseases is to begin each growing season with healthy seed and transplants. A crop established with infected or infested plant material may contaminate an entire field and remove it from production for many years.

e) **Dry tillage:** ploughing and harrowing normally reduce the population of soil borne diseases by exposing them to sunlight.

f) Sowing healthy seed: seed born diseases are effectively controlled by sowing healthy seed**.**

g) **Water management**: irrigation water can carry soil born diseases from field to field. In addition, overwatering a nursery bed increases the risk of damping off disease for seedlings.

h) Avoid handling many seedlings together during transplanting (eg cabbage, tomato)

i) Other Cultural Practices :- include planting after soils have warmed, selecting well-drained areas, using raised beds, reducing plant densities, avoiding entering into the field while the leaves are wet, scheduling overhead irrigation when foliage will dry soon afterwards, and avoiding root pruning and stem injury by cultivating too deep or too close to plant stems.



healthy seed tuber diseased seed tuber diseased seedling

Fig1.16 Planting materials

B. Physical Control methods

a). Hot water treatment of seeds

- Hot water treatment is widely used for the control of seed-borne pathogens, especially bacteria and viruses.
- it is effective for the control of seed born fungal diseases like loose smut of wheat and bacterial diseases. For example: Black rot of cabbage can be controlled by hot water treatment of the seed at 50^0C for 20 or 30min and loose smut of wheat/barley/sorghum at 52oC for 30 minutes

b). Soil solarization

the solar energy is preserved by mulching the soil with transparent polyethylene sheet for 3-5 weeks is effective to increase soil temperature (10-15 0C above normal temperature) enough

to kill the most of the soil-borne pathogens and weeds. Fungal diseases such as damping-off, root rots, stem rots, fruit rots, wilts and blights caused by fungi such as Verticillium spp. and nematodes have been successfully managed by soil solarization.

Steam or Hot Air Sterilization of soil: Steam or hot air is passed through perforated pipes at a depth of 15 cm to sterilize the upper layers of soil. It is mostly practiced under green house conditions.

Hot Water Treatment of soil: It is mainly done in pot culture studies to kill the fungi and nematodes. The pots containing soil are immersed in boiling water at 98^0C for 5 minutes or drenching boiling water at 20 liters/m^2

c). Dis-infecting farm tools with fire and chemicals. Cutting tools during grafting and pruning must be disinfected with 10% solution of chlorex (berekina). Digging tools can be sterilized with fire to kill pathogens found on the surface after every plowing or digging.

3. Biological control methods

Plant diseases can also be controlled by using Bio-control organisms (bio-agents) which can be fungi, bacteria, or nematodes. Bio-agents are multiplied in the laboratory and sprayed on crops. They antagonize disease causing pathogens.

4. Chemical control methods

Since most plant diseases are caused by fungi, the majority of the chemicals listed her are fungicides. Fortunately, most of the fungicides and bactericides have low mammalian toxicity and do not present serious health hazards.

1. **Fungicides: - Fungicides** can be classified as protectants, eradicants and systemic Fungicides.
   - **Protectant fungicides**"protectants" and must be applied before infection to protect the plant from invasion by a pathogen. They act as a chemical barrier to infection by plant pathogenic fungi. Fungicide which is effective only if applied prior to fungal infection is called Protectant. Example Mancozeb, Zineb. Eradicant fungicides have been developed for the control of a limited number of fungi.

- **Systemic Fungicides**- Systemic fungicides are the compounds, which are transported over a considerable distance in plant system after-penetration. They kill fungi, which are found remote from the point of application. They are absorbed by the foliage or roots and move within the plant to the site of infection. Systemic chemicals may be protectants, eradicants, or both.

  Examples: Carbendazim, Benomyl, Thiobendazole, Metalaxyl, Tride morph, Pyroquilo n, Probenazole.

2.4 Rodent control methods

Before conducting control measures, it is important to identify the rodent pest species, asses the size of the infestation and the outbreak area. Vigilance and cleanliness are most important of all control measures. Control measures can be environmental, mechanical and chemical.

A. Environmental control: this involves structural changes in the environment such as making the area unfavorable for rodents to live, removing all sources of food, conditions necessary for nesting etc. these include

a. Land management: weed control with in and around the field, clearance of bush and harbor ridge and food source.
b. Rodent exclusions.
   - ♦ Use of barriers physical, mechanical or chemical.
   - ♦ Construction of rat baffle on storage stand
   - ♦ Closing holes leading to the storage by writ mesh.

B. Mechanical control

- Caught by traps
- Killed by sticks

C. Chemical control

It is an effective control measure.

a.) Acute toxicant (quick action, the animal dying soon after ingesting the poison)

- ♦ The onset of symptom is rapid;
- ♦ The acute poisons are mixed with cereals, which milled, broken or whole grains

  E.g. zinc phosphate – to adding water to adhere the bait.

Disadvantage

- The rodents have a limited period of consuming a lethal dose before symptoms arise and feeding ceases.
- Rodents that ingest sub – lethal quantities of the bait usually avoid the bait poison, this is known as ‘‘bait shyness” or shyness.
- Acute poisons are largely concerned with inducing rodents to feed rapidly on the poising bait this is done by pre – baiting techniques.

b.) Chronic toxicant (slow action)

- These are anti coagulants that reduce the ability of blood to clot and cause the rodent of hemorrhage.
- Onset of the symptom is slow.
- No need pre baiting for there is no “Bait shy”.

  E.g. Watering and Racumin

C. Fumigants

- Hydrogen cyanide
- phosphate gas

D. Biological control

It is a kind of control method, which involves the use of natural enemies (e.g. yellow weald cat, trained dogs, eagles, and fox).

1.5. Birds controlling methods

A. Non-lethal techniques

- Cultural methods (scarecrows, noise making devices, drum or creaking whip)
- Physical barriers (nylon nets for costly crops)
- Chemical repellents: methicasbon 75% WP.

B. Lethal control techniques: it’s the most successful controlling. Fenetrothion 60% EC the chemical is applied in breeding colonies and roosts when the birds rest from feeding (11:30-12:00) by airplane

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Explain controlling methods for weeds? (10 points).
2. Explain controlling methods for insects (5 points).
3. Explain controlling methods for diseases and disorders (10 points).
4. Rodents can be controlled by (5 points)

Note: Satisfactory rating – 30 points and above Unsatisfactory - below 30 points

You can ask your teacher for the copy of the correct answers.

Information Sheet-2	Selecting Tools, Equipment and Machinery

What tools, machinery and equipment are needed for crop protection activities will depend on the nature of the activity to be undertaken.

The general principles are:

- Consider what task, how many people and what tools you will actually need.
- Make a list
- Tools for monitoring may include: sticky trap, light traps, pheromone traps, pen note book, loop lens and pest identification guide
- Tools for removal of infected material may include: Sharp pruning tools, disinfectant for pruning tools, bag for infected material
- Tools for applying pesticide may include: measuring drum, stirring stick, measuring jug and scales or graduated scoop, application equipment, appropriate PPE, eye wash and first aid. All tools and equipment should be clean and well maintained. Check that the tools are in good working order before you leave the stores.
- Clean and check the tools, (condition and number), before they are returned to the stores
- Repair tools as necessary or prepare a written memo for the Manager detailing the problem and action required.

2.1. Selecting equipment

1. **Sprayer**: (manual knap sack sprayer, motorized sprayers, etc.) to spray pesticides as well as liquid foliar fertilizer application.

- **Knapsack** sprayers consist of :
  - ✓ a tank,
  - ✓ a pump, and
  - ✓ a spray wand with one or more nozzles.

- Some sprayers have a pressure-regulating valve or a pressure gauge to help the user maintain desired pressure.
- Small size, portability, and ease of use make the backpack sprayer a valuable tool for many users.

- Backpack sprayers are best suited for:

- small acreage,
- spot spraying,
- hard-to-reach areas, and
- other areas where a larger sprayer is impractical.

- Most knapsack sprayers use hand pumps.
- Hand-operated sprayers should have a comfortably located, reversible handle (to allow for left- or right-hand use.
- The sprayer should also have removable screens to protect the pump and nozzles.
- Sprayer should be cleaned regularly.
- Finally, the sprayer should have a stable base to hold it upright for filling and mixing.

Fig 4.1 Knapsack sprayers

1. Wick Applicators

- It is convenient method to apply contact herbicide
- Herbicide is applied to the plant by brushing against the plant.
- The application rate is controlled by adjusting the chemical solution,
- It reduced chemical usage compared to broadcast spraying is possible.

2. Buckets for carrying infested crops;
3. Sacks; for carrying infested crops part (leaf or whole plants)
4. Transparent collecting pots or jars with lids with a few small holes in them;
5. Magnifying lenses;


Fig 4.2 maginifying lens

6. Notebooks and pencils; flip chart and stand; marker pens; tape.
7. Insect net: for collection insects.


Fig 4.3. Insect net

8. Broadcast spreaders

- They are widely used to apply fertilizer, lime, or amendments on lawns, gardens, or fields.
- These machines may be small handheld or cart-mounted units for home or garden use,
- They may be three-point hitch, trailer-mounted, or truck-mounted units for field use.
- Spreaders for home or garden use can be simple drop spreaders with a series of holes along the underside of the hopper to meter and spread the material
- Larger field spreaders can be single spinner, twin spinner, or air boom designs.
- A large spinner spreader typically consists of a hopper, a drag chain or belt, a discharge gate, a chute, and one or two spinners.

9. Grass shears: for cutting grass in lawns & soft & succulent twigs.
10. Sickle: for clearing the land and harvesting.
11. Machete: similar purpose to bill hook & also for clearing purpose.
12. Wheelbarrow: to transport materials like farm yard manure, compost, seed, etc. from one area to another area in the farm.
13. forceps

Fig 4.4 Wheelbarrow

14. Basket :container of products during harvesting

15. **Boxes** (wooden, plastic): for packing and safe transporting of products.

16. **Ladder:** used for climbing of tall trees during harvesting

17. **Hose:** a plastic tube used for conveyance of water from water source to the required area i.e. farm area or temporary reservoir

18. **Axe:** clearing the lands and sharpening of the wooden tools for handle and other purpose

19. **Machinery:** are required for tillage purpose to avoid weeds and other pests for exposing to sun. It also needed for chemicals application and said to be sprayers.

4.2. Preparing Equipment

- After selecting materials checking functionality and numbers are very essential to complete activities at allocated time.
- if materials are damaged, it should be maintained or repaired
- Smooth delivery of material is important.
- Check the discharge material to check the air chamber and tubes for blockages and leaks.
- Refer to your operator's manual for correct settings and adjustments on all machines so as to operate properly.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Wick applicators are convenient to apply contact herbicides. Why? (5 points)
2. Differentiate between bbroadcast spreaders versus wick applicators (4 points)
3. List and explain equipments required for pest treatments (4 points)
4. What are advantages of machinery in case of weeds, plant pests, diseases and disorder protections (10 points?)

Note: Satisfactory rating - 23 points and above Unsatisfactory - below 23 points

You can ask your teacher for the copy of the correct answers.

Information Sheet-3	Identifying Occupational Health and Safety Hazards

All personnel have a responsibility in the work place to work with due regard for their own safety and that of their colleagues and to report to their Line Manager, practices and machinery or equipment which is considered dangerous.

Persons responsible for the Pest Management activities must:

- Check the work area , tools, machinery and equipment before you start work
- Ensure that the work area is safe and that the machinery, tools and equipment are clean and in safe working order
- Identify hazards; manual handling, tripping, poisonous products, sharp knives, noise, dust, high temperature and solar radiation, overhead power lines, etc.
- Consider what precautions are needed to minimize the risks identified and ensure that these precautions are implemented, see table below for guidelines.
- Ensure that your team members are fully informed and adequately trained to do the tasks to be undertaken
- Report concerns about unacceptable risk, in writing to your line Manager or the Farm Health and Safety Officer and make follow up to ensure that action is taken

Risk mitigation actions relating to the various tasks involved in implementation of IPM include:

Table 3.1 Hazards type and needed actions

Hazard type	Action needed
Manual handling leading to physical injury	• Ensure that the work place is clean and tidy and that trip hazards are removed • Use mechanical aids or find a friend when objects to be moved are large and or heavy
Sharp Knives cause cut fingers	• Use correctly and have First Aid available
Noise repeated exposure can cause hearing loss	• Use ear defenders for regular use of noisy equipment, e.g. tractors and motorized knapsack
Dust and possible inhalation of poisonous product	• Handle products carefully to avoid making dust and stand up-wind. Wear a dust mask when advised to do so on the product Label or if it is just ‘very dusty’.
Solar radiation and high temperature leading to heat	• Try to schedule hard physical labor for the cooler parts of the day and provide drinking water and rest breaks.

stress and dehydration	This is a particular problem for spray men wearing PPE
Overhead Power Lines will cause electric shock if contacted with metal tools and equipment	• Check the location before starting work and avoid damage cutting tools or falling branches or contact with the spray boom of the tractor
Working with poisonous products failure to implement safe working practices could result in poisoning of the operator, other people and consumers	• Read the label and follow the guidelines for PPE to wear and procedures to follow. Full details of OHS for activities involving pesticides are found in the TTLM for Transport, handle, store and apply pesticide. Note: Bio pesticides and botanicals, including 'home made preparations' require the same OHS precautions and conventional chemical pesticides.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. What are types of hazards occur in pests treatment area?(5pts)
2. How you can control hazards occur in pests treatment area?(5pts)

Note: Satisfactory rating - 10 points and above Unsatisfactory - below 10 points

You can ask your teacher for the copy of the correct answers

Operation Sheet-5	Identification of OHS Hazard

Objective

- To identify OHS Hazard
- How to control this OHS Hazard

Procedures

1. Identify OHS Hazard that will occur in treatment area.
2. Classify OHS Hazard
3. Discuss and set controlling mechanisms of each OHS Hazard
4. Finally report to your supervisors about type and controlling methods of OHS Hazard.

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions Follow above procedures

Task 1 Identify OHS hazards

Instruction Sheet 4	Selecting Suitable Safety Equipment and Personal Protective Equipment (PPE)

4. 1. Selecting and checking personal protective equipment (PPE)

Availability and the normal functioning of personal protective equipment are very crucial to run the working conditions. this is because, workers doing their own work with cut PPE are facing injury like physical, chemical, biological and radiation hazards. This is the case that up to 20% of agricultural laborer even the developed countries exposed on agricultural operation hazards due to misuse of operations. As a result of these, depending on the working criteria, personal protective equipment's are prepared for safe operation in the field as well as in the laboratories. These are Goggles, gloves, face mask, respiratory device, helmet, sun hat, and sunlight lotion, apron (overall), safety shoe, which should be clearly prepared and ready to use.

Personal protective equipment may include

a) **Head protective** equipment

Hard hat, helmet, sun hat, and sunlight lotion

b) **Respiratory protective equipment**

Respiratory device/face mask

c) **Footwear**

Boots or shoes

d) **Working clothes**

Overall/aprons

e) Gloves

f) Sunscreen lotion

g) Goggles

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. What is the importance of using proper personal protective equipment?(5pts)
2. Describe different types of PPE?(5Pts)
3. What are advantages of checking personal protective equipment? (5 points)

Note: Satisfactory rating - 15 points and above Unsatisfactory - below 15 points

You can ask your teacher for the copy of the correct answers

Operation Sheet-1	Identification of Personal protective equipments

Objective

- To identify personal protective equipments
- To check functionality and sufficiency of personal protective equipments

Procedures

1. Identify all the personal protective equipments physically one by one
2. Describe the use or purpose of personal protective equipments.
3. Check whether personal protective equipments are functional/non- functional.
4. Count the number of faulty and functional personal protective equipments.
6. Finally report to your supervisors about personal protective equipments.

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Follow above procedures

Task 1 Identify Personal protective equipments

Information Sheet-5	Selecting Control Measures in Full Consideration of OHS

Remember:

- Use selective pesticides where possible
- Use only registered pesticides and bio-pesticides and permitted biological agents
- Minimize drift and run off during application, particularly when spraying near to water
- Minimize Wastes and dispose of wastes responsibly not near to or into water sources

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. During selection of controlling methods what are essential points should be understood ? (10 points)

Note: Satisfactory rating - 10 points and above Unsatisfactory - below 10 points

You can ask your teacher for the copy of the correct answers

References

Environmental Protection Agency, (2012). Pesticides and food: why children may be especially sensitive to pesticides. http://www.epa.gov/pesticides/food/pest.htm

Schafer, K.S., Marquez, E.C., (2012). A generation in jeopardy: how pesticides are undermining our children's health and intelligence. Pesticide Action Network North America. 44pp.

Trotel-Aziz, M. Coudechet, S. Biagianti, and A. Aziz, 2008. Characterization of new bacterial biocontrol agent Acinetobater, Bacillus, Pantoeaand Pseudomonasspp. mediating grape vine resistance against Botrytis cinerea. Environmental and Experimental Botany, 64 (1): 21-32.

University of Sydney, 2003. Disease management using biological control. http:// bugs.bio.usyd.edu,au/PlantPathology/disease_mgmt/biological_ctrl.l (Date accessed October 5, 2007].

HORTICULTURAL CROPS PRODUCTION

Level-III

Learning Guide-66

Unit of Competence: Control Weeds, Plant Insects, Diseases and Disorders

Module Title: Controlling Weeds, Plant Insects, Diseases and Disorders

LG Code: AGR HCP3 M15 LO1-LG-65

TTLM Code: AGR HCP3 TTLM 0120v1

LO3. Implement control measures

Instruction Sheet	Learning Guide 66

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Coordinating enterprise work team and Integrated Pest management product suppliers
- Implementing control measures
- Undertaking implementation of Integrated Pest Management activities
- Maintaining a clean and safe work area
- Maintaining records

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, **upon completion of this Learning Guide, you will be able to**:

- Coordinate enterprise work team and Integrated Pest management product suppliers
- Implement control measures
- Undertake implementation of Integrated Pest Management activities
- Maintain a clean and safe work area
- Maintain records

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, 2, 3, 4 and 5”.
4. Accomplish the “Self-check 1, 2, 3, 4 and 5”.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, 2 and 3.
6. Do the “LAP test” for each operation sheet.

Information Sheet 1	Coordinating Enterprise Work Team and Integrated Pest Management Product Suppliers

Efficient organization of activities involving and affecting many operators in different departments and organizations requires:

- A clear understanding of roles and responsibilities
- Clear procedures that are known and understood by all concerned personnel
- Clear and timely communication
- Follow up

Tasks to be carried out are:

- Preparation of a Crop Protection Plan
- Checking stocks and securing additional inputs needed for the plan
- Routine Crop inspection, report and decisions about action needed
- Organization of manpower and materials for treatment needed
- Communication with other workers and team supervisors affected
- Instructions for action prepared and issued
- Treatment organized, applied and recorded
- Follow up to check effectiveness of treatment applied

How this works in practice varies according to the type of farm situation.

Two typical scenarios are described below

For a small Farmer using a Spray Service Provider

Key actors are: The Farmer, the Development Agent (DA), the Keble Pesticide Agent (KPA) and the Spray Service Provider (SSP)

Sequence of activities:

- **After planting**
  - ✓ Weekly Crop Inspection will be carried out by the Farmer
  - ✓ Problems found will be identified by the Farmer of the Farmer assisted by the DA or KPA
  - ✓ DA may visit the farm to establish the severity of infestation and need for treatment
  - ✓ Farmer Arranges for pesticide application to be completed by the SSP

- ✓ Farmer supervises application
- ✓ SSP records the application and issues invoice
- ✓ Farmer pays for the service and the cost of pesticide used.

In a Commercial Farm involved in Field crop and vegetable production:

Key actors are: The production manager, the Crop Protection Supervisor and the Store Keeper

Sequence of activities:

- **Before planting or at the start of the season**

  The Production Manager will:

  - ✓ Prepare a Crop Protection IPM Plan and ensure that essential supplies of products needed for crop protection are ordered and in place at the start of the season.
  - ✓ Additional purchases may be made during the season when the Store Keeper reports that stocks are nearing the threshold set for re-ordering

- **After planting**

  - ✓ Weekly Crop Inspection will be carried out by the Crop Protection Team
  - ✓ Crops Scout Reports will be prepared by the Crop Protection Team Leader
  - ✓ Findings will be discussed with the Production Manager and treatment requirements agreed
  - ✓ The Production Manager or the Crop Protection team Leader will prepare Spray Instructions
  - ✓ Spray Instructions are taken to the store Keeper who will release the products requested and update the stock records/inventory
  - ✓ Pesticide will be applied as necessary this task will be organized and application supervised by the Crop Protection Team Leader
  - ✓ Notices will be posted warning people of the Re-entry Time (REI) and the Pre Harvest Interval (PHI)
  - ✓ Spray records will be completed by the Crop Protection Team Leader. Completi on of spraying; Date, Field, crop, Pesticide Product Used and PHI will also be communicated to the pack house Manager by either the Production Manager or the Crop Protection Team Leader according to farm policy.

- **OHS**

  The crop Protection supervisor is responsible for:

  - Use of PPE and Safe working practices by the Team
  - First response in the event of an accident or spillage
  - Reports of machinery malfunction and OHS issues to Management.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. In a commercial farm involved in vegetable production, what are key actors? (10 points)
2. As a crop manager what will do before and after planting?(10 points)

Note: Satisfactory rating - 20 points and above Unsatisfactory - below 20 points

You can ask your teacher for the copy of the correct answers

Information Sheet 2	Implementing Control Measures

Select 1 hectare of field from the any infested farm and implement the following pest control methods in an integrated manner

i. implement field sanitation by doing the following activities
   - destroy alternate hosts (weeds)
   - destroy infected crop residue

ii. collect all insects found in the field on weeds by hand/hand picking and try identify each of them. Collect larva and pupa of moths, beetles, flies into a perforated container (use plastic water bottle); place some green leaves of host crops of weed leaves into the bottle so that the larva feed on it and complete its life cycle.

iii. rogue diseased plants plant parts (crop or weeds)and destroy them or burry them

iv. remove sucking insects (aphids and scale insects)by brushing and washing

v. clean and disinfect farm tools with fire to kill disease pathogens

vi. place insect traps /light traps in the field

vii. prepare and place sticky color board traps in the field

viii. apply plastic mulch and transplant vegetables seedlings

ix. prepare apply home-made sprays /extracts(extracts of neem, ginger, hot pepper, garlic) on insects

x. spread coffee residue, egg shell around plants

xi. collect some predators and release them on insects
   - collect ants and release them on caterpillars
   - release chicken to feed on caterpillars

xii. apply insecticide on the insects

Follow the following Principles while implementing control methods

2.3.1 Insect pests and Diseases for horticultural crops

Insect pests

1. Tomato Leaf Miner (Tuta absoluta)

- Damage symptoms

✓ Tomato plants can be attacked from seedlings to mature plants

✓ Infestation can be on apical buds, leaves, and stems, flowers and fruits

- ✓ Common signs include irregular mine, puncture marks, abnormal shape, exit holes, rot due to secondary infective agents, and black frass.
- ✓ It can reduce yield and quality significantly
- ✓ 50–100%losseshavebeenreportedontomato

- **Biology**

- ✓ Around 250 eggs per female
- ✓ 4 larval instars within 0-15 days.
- ✓ Pupation take place in 10-12 days
- ✓ Adult has characteristic black spots in anterior wing.
- ✓ The life cycle: 25-40 days depending on °C.
- ✓ High reproductive potential,
- ✓ About 10–12 generations per year.
- ✓ Main host: Tomato, Potato, Beans…
- ✓ Crop losses up to 100 %!!!!
- ✓ Around 250 eggs per female
- ✓ 4 larval instars within 0-15 days.
- ✓ Pupation take place in 10-12 days
- ✓ Adult has characteristic black spots in anterior wing.
- ✓ The life cycle: 25-40 days depending on °C.
- ✓ High reproductive potential,
- ✓ About 10–12 generations per year.
- ✓ Main host: Tomato, Potato, Beans…
- ✓ -Croplossesupto100%!!!!

- **IPM Measures**

- ✓ Monitoring (field inspection, use of pheromone traps, etc)
- ✓ Adequate identification/monitoring of different life stages and damage symptoms
- ✓ Use of pheromones traps for mass trapping
- ✓ Removal of egg infested leaves (check large mines in the leaf)
- ✓ Selective removal (burning) of infested fruits and other plant parts
- ✓ Rotation with non- solanaceous crops
- ✓ Removal of wild host plants

- ✓ Use recommended and registered chemicals
  - Azadirachtin 0.03%
  - Flubendiamide 480 g/L
  - Chlorantraniliprole 200 g/L
  - Spinosad 480g/L
  - Spinetoram 250g/L
- ✓ Allow natural enemies to flourish
  - Trichogramma pertiosum or T. achaeae,
  - Macrolophus pygmaeus, Nesidiocoris tenuis, Nabis pseudoferus)

2. Bollworm (Helicoverpa armigera)

- **Damage Symptom**

- ✓ Severity varies between locations, regions and seasons
- ✓ Caterpillars feed on leaves, buds, growing points, flowers and fruits
- ✓ It bores clean and circular holes through fruits
- ✓ Faeces of feeding caterpillars are placed away from damaged plant parts
- ✓ Holes serve as entry points for secondary infections

- **IPM Measures**

- ✓ Adequate identification/monitoring of different life stages and damage symptoms
- ✓ Monitoring (field inspection, use of pheromone traps, etc)
- ✓ Use a trap crop (e.g. African marigold) planted every 8 rows
- ✓ Remove and destroy infected fruit and infested plants after harvest (burn or make compost)
- ✓ Plough soil after harvesting to expose pupae to sunlight and natural enemies.
- ✓ Conserve natural enemies (Trichogramma pertiosum or T. achaeae, Macrolophus pygmaeus)
- ✓ Use recommended and registered chemicals
  - Flubendiamide 480 g/L
  - Chlorantraniliprole 200 g/L
  - Spinosad 480g/L
  - Spinetoram 250g/L
  - Azadirachtin 0.03%

3. Cut Worms

Damage Symptom

- Damage occur early in the season when the plants are small
- Clipping off seedling stems or young plants near or just below the soil surface
- Entire row of plants might be cut off during the night
- -Climbing caterpillars can damage foliage, buds and shoot

IPM Measures

- ✓ Regular and consistent field monitoring from seedling emergence stage
- ✓ Monitoring is good late afternoon or in the evening when they are active
- ✓ Check the damage early in the morning when it is fresh
- ✓ With the damage symptoms dig around the plants with a depth of 5 cm in the soil to find the cut worms
- ✓ Apply ash around the seedlings
- ✓ Handpicking of larvae late afternoon or in the evening (early morning)
- ✓ Preserve natural predators, parasites and birds that feed on cutworms
- ✓ Remove weeds and plant residues that serve as egg-laying sites and food sources
- ✓ Insecticide spray is not very effective
- ✓ Bait application: For 16 beds (25m), Diazinon (100cc) + wheat bran or maize flour(1kg)+ molasses (100cc)+2lit water (Needs safe handling)

4. Whitefly (Bemisia tabaci, Trialeurodes vaporarorium)

Damage Symptom

- ✓ Feed by sucking sap from the leaves of plants
- ✓ Characteristic wilting, yellowing, defoliation of leaves
- ✓ Secretion of honeydew by the pest encourages sooty mold growth
- ✓ Interferes with the photosynthesis and reduce plant vigor

Biology

- ✓ Females can lay 200+ tiny spindle-shaped eggs
- ✓ Often laid in semi-circles on the under surface of the leaves
- ✓ Eggs usually take 7 days to hatch (10-12 days at 18-24˚C)
- ✓ Nymphs crawl a few millimeters and start feeding on the leaf and become sedentary
- ✓ Complete the rest of the nymph life stages that usually takes 14-35 days

- ✓ Pupate then, in 9-23 days
- ✓ Life cycle is considerably faster at warmer conditions
- ✓ Not necessary for adults to mate for egg production

IPM Measures

- ✓ Adequate identification/monitoring of different life stages and damage symptoms
- ✓ Completely clean the production area at the end of the crop
- ✓ Inspect new plant material before introducing
- ✓ Use resistant varieties where possible.
- ✓ Use insecticides selectively
- ✓ Alternate classes of insecticides to prolong use and to avoid chemical resistance developing. Thorough coverage on leaf surfaces, particularly the undersides of leaves for effective control.
- ✓ Target susceptible stages, usually adults and early nymphs
- ✓ Soaps and oil sprays can give an effective control
- ✓ Persistent infestations consider using systemic sprays
- ✓ Use recommended and registered chemicals

* Azadirachtin 0.03%
* Lambda-cyhalothrin 50 g/l
* Alpha-cymermethrin 100 g/l
* Thiamethoxam 250g/kg
* Thiocyclam SP50%

5. Red Spider mite (*Tetranychus urticae*)

Damage Symptom

- ✓ Larvae, nymphs and adults feed by sucking the contents of the underside of leaves
- ✓ High population sizes can cause severe damage to the entire plant
- ✓ First the damages show up as a stippling of light dots on the leaves
- ✓ Gradually changes to a bronze color, and as the feeding intensifies the leaves turn yellowish and defoliate.
- ✓ Often, large amounts of webbing cover leaves and twigs and damages can even deteriorate when compounded by water stress.
- ✓ High mite population can decrease plant growth and production and gradually kill the entire plant.

Biology

- ✓ Undergoes five different life stages
- ✓ Egg, larva, first nymph stage (protonymph), second nymphal stage (deutonymph) and adult
- ✓ Eggs are spherical and translucent, like tiny droplets
- ✓ Immature resemble adults except their small sizes. Adults: have oval body with two red eye spots near the head and four pairs of legs.

IPM Measures

- ✓ Adequate identification/monitoring of different life stages and damage symptoms
- ✓ Good hygiene practices/Sanitation
- ✓ Removing debris and other plant residues
- ✓ Cutting off highly infested plant parts and proper removal
- ✓ Use healthy planting materials
- ✓ Avoid water stress: correct fertigation
- ✓ Use recommended and registered chemicals (these products are not registered for vegetables in Ethiopia)

* Azocyclotin, Bifenazet, Clofentezine, Fenbutatinoxide, Flufenoxuron, Hexythiazox, Tetradifon
* Fenpyroximate, Milbermectin, Propargite, Pyribaden, Abamectin, Silwet (trisiloxane ethoxylate)

6. Cabbage Aphids (Brevicoryne brassica)

Damage symptoms

- ✓ Don’t affect seedlings but build up after thinning or transplanting
- ✓ Continuous feeding cause yellowing, wilting and stunted plants
- ✓ Severe infestation covered with mass of sticky aphids cause leaf death and decay
- ✓ Feeding is on the underside of leaves and on centre of cabbage head

IPM measures

- ✓ Field scouting every week
- ✓ Cool and dry conditions can favour severe infestation
- ✓ Remove alternate hosts and weeds in the surrounding areas
- ✓ Dispose of plant debris at the end of the season
- ✓ Crop rotation with non-host plants

- ✓ Conserve natural enemies in the field
- ✓ It is possible to delay pesticide application before head formation, save expenses and conserve natural enemies
- ✓ Apply insecticide only if population is high on young seedlings (up to 7 leaf stage) or on plants close to harvest
- ✓ Allow thorough spraying due to waxy nature of the pest
- ✓ Use recommended and registered insecticides
  - ∗ Deltamethrin 25 g/l
  - ∗ Alpha-cymermethrin 100 g/l
  - ∗ Azadirachtin 0.03%
  - ∗ Lambda-cyhalothrin 50 g/l
  - ∗ Imidachloprid 200g/l

Diseases

1. Late blight (*Phytophthora infestans*)

- ✓ Host: potato and tomato
- ✓ Pathogen: fungi
- ✓ Infected plant parts: foliage. fruits, tubers on the field and in the store
- ✓ Symptoms: irregular or circular water soaked lesions. In cloudy or humid weather, the lesions increase quickly and form dark brown, blighted areas with indefinite borders. Under favorable conditions, all above ground parts of the plant are blighted and rot away rapidly; sometimes bad smell is released.
- ✓ Source of inoculums: infected tubers and plant parts left on the field; infected soil.
- ✓ Dispersal: wind borne and rain splash.
- ✓ **Management options:** field sanitation, fungicidal sprays and resistant varieties.

2. Bacterial wilts (*Psuedomonas solanacearuml Ralstonia solanacearum*)

- ✓ Host: potato, tomato, banana, tobacco, and groundnuts
- ✓ Pathogen: bacteria
- ✓ Infected plant parts: stems, leaves, tubers' eyes, leaves and seeds
- ✓ Symptoms: wilting, stunting, and yellowing of the leaves followed by collapse of the entire plant. During long rain, sudden drooping of leaves and rotting of stem from any point occur. If the infected stems or tubers are cut across and squeezed, grayish white

bacterial ooze comes out of the vascular ring. Eye buds of infected tubers will be blackened during sever infection.

- ✓ Source of inoculums: infected crop debris, infected soil and seed.
- ✓ Dispersal: wind borne and rain splash.
- ✓ **Management options**: field sanitation, crop rotation, and resistant varieties.

3. **Bacterial canker (*Corynebacterium michiganense/ Clavibacter michiganense*)**

- ✓ Host: tomato
- ✓ Pathogen: bacteria
- ✓ Infected plant parts: leaves, stems, fruits and seeds
- ✓ Symptoms: leaf veins turn brown, wilt and finally die out. Brown streaks develop on the stems which may crack to reveal brown discoloration of internal tissues. When infected stem is cut creamy white, yellow or grown line is seen under the phloem vessel. Infected fruits become brown and develop lesions. Green fruits develop water soaked spots which are soon surrounded with a white halo.
- ✓ Source of inoculums: infected crop debris, infected seeds
- ✓ Dispersal: rain splash.
- ✓ **Management options**: field sanitation, crop rotation, disease free seeds and transplants and resistant varieties.

4. **Downy mildew (*Peronospora destructor*)**

- ✓ Host: onions, garlic, leek and shallot
- ✓ Pathogen: fungi
- ✓ Infected plant parts: leaf and stem
- ✓ Symptoms: at first, yellowish spots on the upper half of the leaves appear. When the humidity gets higher, the fungus grows and appears as bluish-gray, hairy mildew. Spots lesions enlarge and merge together. Lesions may consist of alternating chlorotic and green layers of tissue on the leaves and stem. Finally the affected leaves wilt and die.
- ✓ Source of inoculums: infected bulbs, soil and seed.
- ✓ Dispersal: rain splash.
- ✓ **Management options**: clean cultivation, crop rotation, seed dressing, and fungicides.

5. **Onion rust (*Puccinia allil Puccinia porri*)**

- ✓ Host: onions, garlic, leek and shallot

- ✓ Pathogen: fungi
- ✓ Infected plant parts: leaf and stem
- ✓ Symptoms: longitudinal pustules on the leaves which up on rupturing expose yellowish-brown spores. Black pustules are produced at later stage.
- ✓ Source of inoculums volunteer onion crops.
- ✓ Dispersal : wind born
- ✓ **Management options**: resistant varieties, crop rotation, soil drainage, rouging infected plants and fungicides.

6. **Purples blotch (*Alternaria porri*)**

- ✓ Host: onions, garlic, tomato, leek and shallot
- ✓ Pathogen: fungi
- ✓ Infected plant parts: leaf and stem
- ✓ Symptoms: first small white lesions with purple center appear on the leaves. Later the lesions enlarge rapidly, girdling leaf and stem which fall down. Bulb rotting will follow in the store.
- ✓ Source of inoculums crop debris, infected seeds and soil
- ✓ Dispersal : rain splash, wind born
- ✓ **Management options**: field sanitation, seed dressing, resistant varieties, increase spacing, and fungicides.

Fig 2.5: Tomato blotch

7. **Late blight of potatoes**

- ✓ Pathogen: fungi (*Phytophthora infestans*)
- ✓ Host: potato, tomato, pepper, carrot etc.
- ✓ Affected plant parts: foliages, stems, fruits, tubers

- ✓ Damage: causes total destruction of the crops within a short period of time (a week) if weather
- ✓ Conditions are favorable and no control measures are taken.
- ✓ Symptoms: circular or irregular water soaked spots appear at the tips or edges of the lower.
- ✓ Leaves. They later enlarge rapidly and form brown blighted areas with indefinite boarders in moist conditions.
- ✓ Source of inoculums: infected tubers used for planting, wild solanaceuos plants, volunteer potato plants.
- ✓ Control: planting disease free tubers destroy all volunteer potatoes and other hosts, use of resistant varieties, fungicides.

Fig 2.6: Symptoms of leaf blight on carrot and potato plants at the end of vegetation

8. **Tobacco mosaic virus (TMV)**

- ✓ Pathogen: virus
- ✓ Host: tobacco, tomato, pepper and other dicotyledonous plants.
- ✓ Damage: affects the leaves, flowers, and fruits and causes stunting of the plants
- ✓ Symptoms: on tobacco; mottled dark- green and light-green areas on leaves developing after inoculation. On tomato; mottling of the older leaves.
- ✓ Over wintering: the virus over winters on infected tobacco stalks and leaves in the soil, on the surface of contaminated tobacco seeds.
- ✓ Control: use of resistant varieties, sanitation, control of vectors

Fig 2.7 Pepper leaves affected by tobacco mosaic virus

9. **Bacterial spot of tomato and pepper**

- ✓ Pathogen: bacteria (*Xanthomonas compestris* pv. Vesicatoria)
- ✓ Affected plant parts: leaves, stems, seedlings, and fruits.
- ✓ Symptoms: small irregular purplish gray spots with black center and a narrow yellow halo appear on the leaves.
- ✓ Over wintering: on seeds contaminated during extraction, infected plant debris in soil, on weeds and other hosts.
- ✓ **Control**: use of disease free seeds and seedlings, use of resistant varieties, crop rotation, and spray copper maneb pre mixed pesticides.

10. **Damping Off**

Disease Symptom

- ✓ Caused by fungus or fungus-like microorganisms, Pythium spp, Fusarium spp and Rhizoctonia spp.
- ✓ It kills seedlings before or soon after they emerge
- ✓ Seedlings that emerge develop a lesion at the soil line and seedlings collapse.
- ✓ In few cases, the griddled stem continues to grow but it eventually dies

IPM Measures

- ✓ Proper diagnosis of the disease causing pathogen
- ✓ Drain the soil water properly
- ✓ Prepare raised field and seedbed
- ✓ Use disease free seeds
- ✓ Avoid planting when the soil is cool
- ✓ Use water sprinklers in seedling preparation
- ✓ Apply light irrigation to avoid overwatering

- ✓ In heavy soil, apply alternative furrow irrigation

11. **Tomato Early Blight (Alternaria solani)**

Disease Symptom

- ✓ Symptoms of early blight occur on fruit, stem and foliage of tomatoes
- ✓ Small black or brown lesions of 1-2 mm appear on the leaves
- ✓ Under conducive environment the lesions will enlarge and are often surrounded by a yellow halo larger lesions have dark pigmented concentric rings – so called “bullseye”.

IPM Measures

- ✓ Use of tolerant/resistant varieties
- ✓ Destroy tomato/potato debris
- ✓ Remove alternate hosts (volunteer plants) before planting
- ✓ Follow wider planting space
- ✓ Closely monitor crops (lower portion & underside of leaves) for disease symptoms
- ✓ Stake plants to improve air circulation
- ✓ Adjust watering time to early morning and don’t over water
- ✓ Apply preventative sprays in likely rainy seasons
- ✓ Apply additional sprays with shorter and regular intervals.
- ✓ Use recommended and registered chemicals
- ∗ Mancozeb 80% WP
- ∗ Mancozeb 64% + Metalaxyl (Mefenoxam) 8% WP/WG
- ∗ Copper Hydroxide or Copper oxychloride

12. Powdery mildew (Pseudoidium neolycopersici, Leveillula taurica)

Disease Symptom

- Forms white, chalky spots all over the plant, including stems, flowers and fruit
- It spread rapidly, affecting large areas of the leaves and stems
- Leaves will then turn yellow, die and drop off
- Plants will have a lower yield and shortened fruiting season
- Reduced fruit quality flavor

IPM Measures

- ✓ Use of tolerant/resistant varieties
- ✓ Adequate diagnosis of the problem
- ✓ Follow wider plant spacing
- ✓ Stake plants to improve air circulation
- ✓ Proper and early weeding of any other plants
- ✓ Apply fertilizer at a regular interval, high nitrogen encourages mildew
- ✓ Avoid plant stress which favors mildew
- ✓ Apply preventative sprays
- ✓ Use recommended and registered chemicals
- ∗ Kresoxim-methyl 500 g / l
- ∗ Triadimefon 500 g a.i./kg.
- ∗ Trifloxystrobin + Tebuconazole
- ∗ Buprimate
- ∗ Copper Hydroxide or Copper oxychloride

12. Tomato Bacterial Spot and Speck (Xanthomonas sp., Pseudomonas sp.)

Disease symptoms

Bacterial spot

- ✓ Infected leaves show small, irregular, dark lesions
- ✓ Later, they coalesce and cause the leaves to develop a general yellowing
- ✓ Both, spot and speck occur on stems and petioles where they are indistinguishable
- ✓ Flower infection is quite serious, causing early blossom drop on green fruit, small water-soaked spots are first noticed and later slightly
- ✓ raised and enlarged centre becomes irregular, brown, slightly sunken, with a rough, scabby surface

Bacterial speck

- ✓ Foliar symptoms of small black lesions, often with a discrete yellow halo
- ✓ Lesions are similar to bacterial spot but with greasy appearance
- ✓ Speck seems to curl the leaves more severely than spot
- ✓ Bacterial speck and spot are more clearly differentiated by symptom development on the fruit
- ✓ Lesions are very superficial and do not crack or become scaly.

IPM Measures

- ✓ Good quality seed
- ✓ Adequate diagnosis of the problem
- ✓ Avoid too much water
- ✓ Rotate crops (non-solanaceous) - other than tomato and pepper
- ✓ Preventative application of fungicides (after planting seeds, before transplanting, before and after rains)
- ✓ Preventative sprays a week after transplanting, early flowering or fruit setting
- ✓ Reduce spray intervals by half during rainy season.
- ✓ Use recommended and registered chemicals
- ∗ Mancozeb 80%WP,

12. **Tomato Spotted Wilt Virus (TSWV)**

Disease Symptom

- ✓ Small, light brown flecks first appear on leaves.
- ✓ Spots later turn brown, followed browning of leaves that die and appear drooped on stems.
- ✓ Plant are often stunted, and with the droopy leaves, give one the impression that they are wilted.
- ✓ Green fruit show concentric rings of yellow or brown alternating with the background green color, and striking brown rings occur on red-ripe fruit.
- ✓ Severe when young plants are infected

Biology

- ✓ Many plant species (>1000) can be hosts for this virus including tomato, pepper, potato, tobacco, lettuce and many other plants.
- ✓ It is not transmitted by infected seeds
- ✓ Thrips are the only vectors for TSWV and it is acquired at larval stage

IPM Measures

- ✓ Use TSWV resistance varieties
- ✓ Proper thrips control or avoidance
- ✓ Regulate the planting time to avoid major thrips migration during the early plant growth stage
- ✓ Do not plant tomatoes and peppers near TSWV susceptible crops (i.e. peanut, tobacco)

- ✓ Uprooting and proper removal of virus infected plants as early as possible
- ✓ Effective weed control in and around tomato or pepper fields
- ✓ Maintain plant-free border (10m) around the production fields to prevent the spread of TSWV

2.4 Approaches to disorder treatments

Plant disorder is the confusion of plant due to problem (toxic) soil, air and toxic water. Some problems render the soil unfit for cultivation. Even if the total element contents in such soil are high, these may not be fertile because of poor soil health. The term soil refers among other things, to the often-encountered soil problems like soil alkalinity/sod city, salinity and acidity. Salt-affected soil (saline, saline-alkali and alkali) develop in arid and semi arid regions, while acidic soils is found in high rainfall areas where a considerable loss of alkaline earth metal cat ions takes place by way of leaching.

Saline, saline-alkali and alkali soils

P^H refers to hydrogen ion concentration in the soil solution, which is considered neutral when the pH is at 7. Soils with ph below 7 are termed acid and those above it, alkaline. Many plants have definite range of ph within which they are grown successfully. If it is out of range, it may cause disorder or toxic to plants.

Reclamation of Saline, saline-alkali and alkali soils

- Since soil salinity refers to the presence of excess soluble salts, the reclamation of such soil is based on the removal these salts, by leaching with good quality irrigation water having low salinity level.
- Soils with high Ph (greater than 8.5) (alkaline soil) may be reclaimed by treating them with a suitable amendment like gypsum, pyrites, sulphur etc…
- Soil having PH less than 6.0,(acidic soil) nutrient availability is affected adversely by liming, is usually practiced for keeping the soil PH in the optimum range for making nutrient available in appropriate quantities

Water Quality for Irrigation

The quality of irrigation water is a crucial factor for long-term soil productivity. Poor quality water if used for a long time can make the less productive, or even barren depending on the amount and type of constituents present in it and the texture of the soil in question. Low or marginally saline waters sometimes appear to stimulate crop growth because of the higher amount of nutrients ions presents. However, excess of the soluble salts in water leads to

their accumulation in the surface layer particularly in fine textured or poorly drained soils. Many areas in the country are facing a serious problem of not only scarcity of water, but also of its extremely poor quality. It is therefore advisable to get the water tested for quality while installing tube instead of repenting later.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. List and describe 10 major insects with controlling mechanisms (10 points).
2. Describe at least 5 major diseases for horticultural crops? (10 points).

Note: Satisfactory rating - 20 points and above Unsatisfactory - below 20 points

You can ask your teacher for the copy of the correct answers

Operation Sheet-1	Applying controlling mechanisms for weeds, insects, diseases and disorders

Objectives:

- To identify controlling methods for weeds, insects, diseases and disorders
- To explain how to apply controlling measures for weeds, insects, diseases and disorders

Materials: - buckets, sacks, canvas, grass mulching materials, knapsack sprayers, chemicals (pesticides), lime, limestone, hoe, notebooks and pencils, flip chart; marker pens and tape.

Procedure

1) Confirm identified weeds, insects, diseases and disorders.
2) Choose best controlling mechanisms based on intensity and amount of weeds, insects, diseases and disorders
3) Apply controlling measures
4) Record each every activities after completion of task

Data recording and reporting format

No	Type of pest	Controlling method used	For which crop	Controlled by	Remark
1					
2					
3					

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Follow above procedures

Task 1 Apply controlling mechanisms for weeds, insects, diseases and disorders

Information Sheet 3	Undertaking Implementation of Integrated Pest Management Activities

In Ethiopia, Farms are encouraged, by Law and training in International 'good practices' to implement acceptable standards when managing crop pests.

Farms that are involved in export may also comply with international market Label standards, e.g. GLOBAL GAP or MPS. These are voluntary standards that may be required for market access and are generally higher that 'basic good practice'.

Essential requirements for good practice when implementing IPM are:

- Establishment of a management system with clear identification of responsibilities
- Use of an appropriate package of cultural controls, e.g. crop rotation, use of resistant varieties and maintaining good field hygiene, to minimize the risk of pest and disease infestation / infection.
- Routine crop inspection to identify pest and disease problems at an early stage so that timely intervention is possible.
- Maintaining records of crop inspection for future reference.
- Use of physical, biological or cultural control where appropriate.
- Use of chemical control only when justified
- Selection of pesticide products with due regard to:
    - Registration in Ethiopia for target pest in crop to be treated
    - Selection of the safest product for operators and the environment, (First choice: Green Label, low leaching potential/danger to fish and selective action)
- Provision, maintenance and use of appropriate PPE
- Completion of local Risk assessment, development of safe working procedures and implementation of these procedures
- Pesticide handling, storage and application operation are restricted to trained staff
- Implementation of Safe and correct storage Practices in the pesticide stores
- Restricted access to stores
- Pesticides are only released from store in response to authorized instructions in writing and release is only to authorized personnel

- Calibration and maintenance of spraying equipment to ensure that the correct amount of pesticide is applied safely
- Use of correct application techniques for the pesticide product and target pest
- Records of application
- Communication of REI and PHI to concerned personnel
- Cleaning and maintenance of application equipment
- Minimizing waste and use of safe waste disposal

3.1 Implementation of IPM Activities according to OSH requirements

Regular monitoring of implementation of Safe Working Practices and prompt action to correct any problems identified is essential to maintain the safety of operators and others in the workplace.

Problem that cannot be rectified immediately should be reported by the Supervisor, in writing to management.

Remember the key points when using integrated pest management:

- The eemployers must provide training and PPE and must maintain equipment in safe working order and the Employee must follow safe working practices, use and care for the PPE correctly and report all problems relating to Occupational Health and Safety
- Wear PPE as directed by the Product Label
- Handle pesticides with care to avoid spillage
- Minimize spray drift
- Inform concerned staff and observe Re-Entry Intervals & Pre-Harvest Intervals
- Dispose of wastes correctly to minimize environmental pollution and to safeguard water supplies

Bio-pesticides should be handled as for pesticides and label recommendations followed.

Dressed seed should be held in a bowl not your hand whilst sowing. Wear gloves to handle and or wash your hands on completion of the sowing activity.

Biological Agents in use for pest management are not dangerous to humans so have no special OSH requirements for handling and application.

Land preparation and pruning tools should be used carefully to avoid physical injury. Remove non-participants to a safe distance and wear suitable clothing and foot wear.

Do not allow tools and equipment to make contact with electrical power lines and

Please turn equipment off before attempting to do maintenance and repair work.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Define integrated pest management. (10 points).
2. When using integrated pest management what should be rremember? (10 points).
3. When implementing IPM, what are eessential requirements for good practice? (10 points).

Note: Satisfactory rating - 30 points and above Unsatisfactory - below 30 points

You can ask your teacher for the copy of the correct answers

Information Sheet 4	Maintaining a clean and safe work area

A clean and tidy workplace is good for staff morale sends a message to all staff that standards are important and attention to detail is expected.

Keeping a work place clean and tidy is also important for operator safety and efficient work operation:

- Adequate access to stores and equipment and keeping the floor clear of slip and trip hazards helps prevents accidents
- Adequate access and to fire extinguishers and doors and facilitates prompt action if an accident happens
- Cleaning PPE after use ensures that it is ready and safe to use next time and also prolongs the useful life of the equipment
- Cleaning spraying equipment (tank, hoses, filters and nozzles), thoroughly after use helps to prevent blockages, corrosion and cross contamination of products
- Attention to detail when cleaning and maintaining spraying equipment ensures that small parts do not become 'lost'.

The correct procedures for cleaning should be followed:

- **Spillage of pesticide must be cleaned up promptly**
  - Contain the spillage and move unprotected people to a safe distance
  - Soak up the spillage with dry sand or soil
  - Bag the contaminated material until disposal in the designated pit is possible
- **PPE must be cleaned immediately after use**
  - Rinse your spray suit and gloves before removal
  - Wash clothing in soapy water … wash separately, not with the family laundry
  - Dry thoroughly before returning to the store
  - Respirator masks should be wiped clean … do not get water in the filter cartridge
- **Measuring equipment must be triple rinsed at the time of use and the rinsate put into the spray mix**
- **Spraying equipment must be washed immediately after spraying is complete**
  - Ensure that the tank is empty
  - Triple rinse the inside of the tank and spray out to clean the hoses and nozzles

- Spray the rinsate out under the crop that has been sprayed or put the rinsate into a soak away
- Remove and clean filters
- Turn of the power and unplug from the mains as necessary before rinsing the outside of the equipment
- Store spraying equipment in an area which is secure and has restricted access.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. What are correct procedures for cleaning? (10 points).
2. What mean by work area cleaning (10 points)

Note: Satisfactory rating - 20 points and above Unsatisfactory - below 20 points

You can ask your teacher for the copy of the correct answers

References

1. Environmental Protection Agency, (2012). Pesticides and food: why children may be especially sensitive to pesticides. http://www.epa.gov/pesticides/food/pest.htm
2. Schafer, K.S., Marquez, E.C., (2012). A generation in jeopardy: how pesticides are undermining our children's health and intelligence. Pesticide Action Network North America. 44pp.
3. Trotel-Aziz, M. Coudechet, S. Biagianti, and A. Aziz, 2008. Characterization of new bacterial biocontrol agent Acinetobater, Bacillus, Pantoeaand Pseudomonasspp. mediating grape vine resistance against Botrytis cinerea. Environmental and Experimental Botany, 64 (1): 21-32.
4. University of Sydney, 2003. Disease management using biological control. http:// bugs.bio.usyd.edu,au/PlantPathology/disease_mgmt/biological_ctrl.l (Date accessed October 5, 2007].

HORTICULTURAL CROPS PRODUCTION

Level-III

Learning Guide-67

Unit of Competence: Control Weeds, Plant Insects, Diseases and Disorders

Module Title: Controlling Weeds, Plant Insects, Diseases and Disorders

LG Code: AGR HCP3 M15 LO1-LG-67

TTLM Code: AGR HCP3 TTLM 0120v1

LO4. Monitor control methods

Instruction Sheet	Learning Guide 67

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Monitoring control methods
- Assessing effectiveness of control method
- Implementing adjustments for Integrated Pest Management

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Monitor control methods
- Assess effectiveness of control method
- Implement adjustments for Integrated Pest Management

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, 2, and 3”.
4. Accomplish the “Self-check 1, 2, and 3”.

Information Sheet 1	Monitoring Control Methods

1.1. Monitor side effects of treatment

Side effects of pest control measures applied include the possible detrimental effects of treatments used on other crops, farm workers (spray team members and general workers), the local community, consumers and biodiversity. All farmers, farm managers, crop protection team leaders/supervisors and extension officers (DAs), have a responsibility to ensure that treatments used for crop protection have **minimal effect on the environment** and that practices used give sufficient **protection to operators, general farm workers and consumers o**f crops produced.

It is useful to understand how pesticides **move within the environment**

- **Absorption by the crop**

Some pesticide is absorbed by the crop (leaves after spraying and roots after drenching of run off).

Some of this pesticide will breakdown within the plant and the some will be sold when the produce is harvested (residue) and some will be incorporated into the soil with the crop residue.Pesticide that is consumed when plants are eaten may bioaccumulate in the food chain

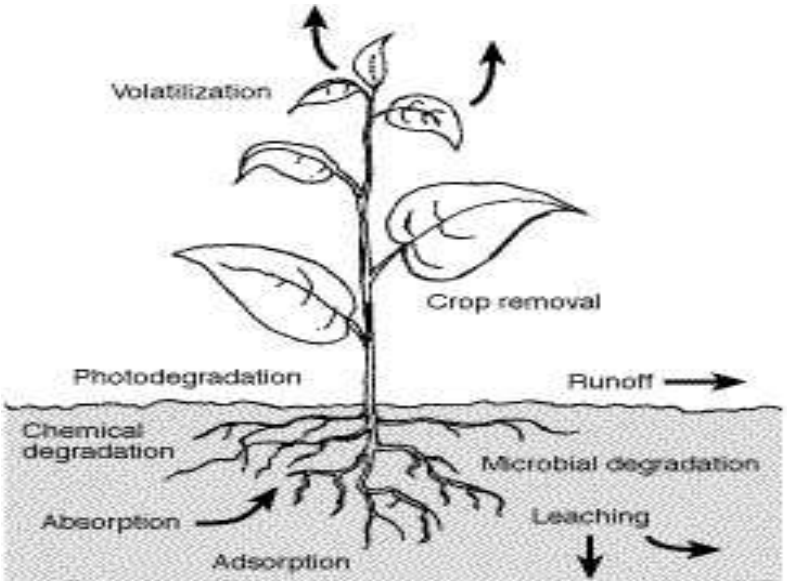

Fig How pesticides move within the environment

- **Volatilization:** Volatilization means that the pesticide escapes into the atmosphere. This is a bigger problem when pesticide application is made in hot sunny conditions

- **Spray drift:** Pesticide is blown on to other plants or water during application. What happens to this pesticide will depend on where it lands
- **Photodegredation:** Pesticide is decomposed by exposure to sunlight.
- **Run Off:** Pesticide that drips off the leaves during spraying. This pesticide may be washed off the soil surface by flooding of may drain into the soil. Run Off can be minimized by using good spraying technique
- **Absorption by soil:** Pesticides may bind to soil particles or react chemically with minerals in the soil to become 'fixed' in the soil
- **Microbial degredation:** Pesticides are degraded by soil micro flora and fauna. This is most active when the soil is rich in organic matter.
- **Leaching:** Leaching is the movement of pesticides in water that drains from the soil. This is the biggest cause of pesticides entering surface and ground water sources and can be minimized by reduction of runoff, minimization of waste and careful selection of waste disposal sites.

Monitoring for the impact of crop protection treatments used will include observation of operations as they are carried out and investigation of problems that arise. Maintenance of records is important, as some problems may only become apparent months after the completion of the operation.

Remember that monitoring is a continuous process and is only beneficial if findings are reported and problems found are resolved.…

1.1.1 Impact on biodiversity and livestock

Here we are interested in the effects of control measure applied on non-target species. This may include:

- The impact of pesticides used on pollinators e.g. neonicotinoid pesticides on bees
- The impact of pesticide residues leaching into water courses and affecting fish or wildlife ,
- The impact of seed dressings on non-target insects and the
- Effect that high run off from poor application practices has on beneficial soil micro flora and fauna and on the leaching of these pesticide residues into water sources used by animals and local communities.

Formal monitoring of the impact of treatments used on biodiversity is in practice quite a scientific and time-consuming process so is outside the remit of most farmers.

Practical measures that will help to protect the environment include:

- Only Pesticide Products that are registered in Ethiopia and imported beneficial organisms, that are permitted in Ethiopia for the target pest and crop to be treated are being used.
- Use where possible of only pesticides that are selective and not harmful to wildlife and fish.
- Application pesticides at the rate recommended on the label and **minimization of 'Runoff'.** Be particularly careful when spraying close to open water courses and drainage channels.
- Minimizing pesticide wastage by only mixing the actual amount that you need
- No spraying **in windy conditions** so drift is minimized and workers, crops in neighboring fields and surface water sources are not contaminated
- Responsible dispose of excess solution and tank washings; use a proper soak away or disposal pit or spray out onto a designated area of fallow land. DO NOT empty or wash your sprayer and wash PPE in the river.

1.1.2 Impact on Operators

These persons are most at risk of contamination and potential poisoning as they are handling concentrated products and or applying dilute products regularly. Common effects of exposure include headache, nausea, convulsions (fits), fainting, skin irritation, sore eyes or throat and in rare cases birth defects or death.

Note that these are also symptoms of many other illnesses and thorough investigation is needed to establish the real cause of the problems experienced.

Measures that will help to protect pesticide handlers and spray men include:

- Only Pesticide Products Registered in Ethiopia for the target pest and crop to be treated are being used.
- Adequate PPE has been provided, is used correctly, cleaned after use and stored as per the Farm Management Plan or industry good practice.
- Pesticide store men and spray men are trained in safe working practices.
- Operators work with due regard to their own safety; avoiding splashes and skin contact and not standing in their own or a colleagues' spray drift.
- Spray men wash their bodies after they have completed spray application.

- Accidents and illness that may be related to the use of pesticides is recorded, reported, investigated and appropriate action is taken to treat the casualty and to prevent re-occurrence of the incident.

1.1.3 Impact on General Farm Workers

This group is at risk of accidental contamination with pesticides used on the farm. Farmers are not expected to make routine monitoring of this client group but research studies conducted by stakeholders indicate significant levels of contamination do occur as a result of any of the following:

- Empty pesticide containers being used for food and water
- Workers being in the crop when spraying takes place or re-entering the field before the re-entry time has elapsed.
- Workers being affected by spray drift from neighboring fields

1.1.4 Impact on clients and consumers of crops

Unfortunately studies carried out by stakeholders also indicate that the incidence of pesticide residues at above permitted levels is quite common in produce offered for sale in the local market in Ethiopia. Consumers of these products are therefore at risk of pesticide poisoning.

To minimize this problem all Farmers should be implementing preventative measures, for example:

- Maintaining accurate and up to date records of application of pesticides
- Using only Pesticide Products that are Registered in Ethiopia for the target pest and crop to be treated
- Apply pesticides at the rate recommended on the label
- Not Spraying in windy conditions so crops in neighboring fields are not contaminated
- The pre-harvest Interval (PHI) is observed (Notices in the field, worker testimony and reference to spraying and harvesting records.

Therefore in Ethiopia, representatives from the Government Environmental Agencies, Federal MoEF and the Regional Environmental Bureaus are responsible for monitoring water pollution.

In addition to this Commercial Farmers engaged in Export, who is certified for Global GAP or MPS ABC & MPS GAP will be required to show that they are monitoring the environmental effects of the pesticides that they are using.

All Farmers should however be aware of potential impacts of pest management practices on the environment and should implement appropriate precautionary measures to protect the environment.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Explain methods of how pesticides move within the environment? (10pts)
2. Which organization is responsible for management of environmental pollution? (5pts)
3. What are impact of treatment methods on biodiversity and livestock, operators, workers, clients and consumers? (10 points).
4. How you can manage above impact for each factor? (10 points).

Note: Satisfactory rating - 35 points and above Unsatisfactory - below 35 points

You can ask your teacher for the copy of the correct answers

Information Sheet 2	Assessing Effectiveness of Control Method

Monitoring the effectiveness of any pest control treatment applied to crops is essential. Farmers are quick to complain that a particular pesticide 'has not worked' and to re-apply at a higher dose or to quickly apply a different product. This adds significant cost to the production of the crop and can also contribute to the development of pesticide resistance.

Measuring effectiveness of control measures applied means establishing to what extent the target pest or disease has been controlled.

Is the level of pest or disease infection now below the accepted threshold level for the crop, crop growth stage and client requirements as stated in the farm IPM plan?

Monitoring operations that are required are:

- Weekly assessment of pest and disease levels in the crop. Crop scout inspection reports and records.
- Weekly observations of other factors affecting crop growth e.g. weather conditions, irrigation, weed growth and crop growth.

Information gathered during the monitoring process will be used to adjust the IPM plan and to design plan and implement any further treatments or adjustment to treatment that may be necessary.

In the small farmer sector, the records of monitoring will be used by the DA to help the farmer to evaluate the situation in his/her crop and to decide on appropriate action. In the commercial farming sector, the crop protection supervisor will discuss findings with their line Manager and decide on appropriate follow on action.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. What mean by assessing effectiveness of control method? (5pts)
2. When monitoring operations that are required? (5pts)

Note: Satisfactory rating - 10 points and above Unsatisfactory - below 10 points

You can ask your teacher for the copy of the correct answers

Information Sheet 3	Implementing Adjustments for Integrated Pest Management

It is essential that monitoring is carried out after each crop treatment to check that the treatment has been effective. Remember that some pesticides need several days before an effect is seen.

The results of monitoring may show;

Either:

The population of the target pest or disease is reduced as a result of treatment applied and is now below the accepted threshold level for the crop, crop growth stage and client requirements as stated in the farm IPM plan. If this is the case, no further control treatment is required at this stage and monitoring should be continued on a weekly basis.

Or

That treatment has been applied but the pest or disease level is still high or is increasing rapidly.

In this case the DA and small farmer or the Commercial Farm Crop Protection Supervisor and Line Manager need to evaluate the information available and to decide:

- Is this because the treatment applied has not worked as expected or
- Is the problem due to the treatment not being applied correctly and
- What adjustment to the IPM plan or what further treatment is necessary.

Data that is required for making adjustment to the pest control programme includes:

- Assessment of pest level in the crop, (crop scout reports for this week and at least two previous weeks).
- Records of crop protection treatments applied.
- Weather records and weather forecast for coming week.
- Observation about other factors affecting crop performance and pest occurrence, e.g. weed growth, flooding, irrigation failure etc.
- Observation of actual crop population and stage of crop growth

A sample investigation and possible actions to be taken are described overleaf:

A Small farmer has applied Product X and has not achieved the control required Investigation and appropriate action:

Questions to ask	Action required
Is Product X registered for use on the target pest and crop in Ethiopia	If the product is not the correct for the target pest on the crop advise the farmer about what products are suitable.
Is product X real or counterfeit product	Check the label and ask about where the product was purchased. Many counterfeit products will not work. Explain the problem to the farmer.
Has the correct amount of product X been used?	Check the label recommendations and the record of application to see if the correct application rate was used. If not explain the problem to the farmer and give advice about calibration
Has product X been applied correctly	Ask about measuring and mixing procedures used and about application technique. If the answers are not correct give appropriate advice.
Was the spraying process supervised	Explain to the farmer why supervision is necessary to ensure that the product is actually applied and applied correctly

Table 3.1 Asking for clearance

If the product selection and application procedures used are correct, then the reason for lack of control may be pest resistance to product X. In this case explain to the farmer that he should select a different product from a different chemical group and give him/her some examples of suitable products.

Also explain that reapplication of product X at a higher concentration is not the answer due to the risk of still no control, crop scorching and residues in the produce at harvest.

Note: you should always inspect the crop to establish whether application of treatment is still appropriate and discuss your recommendations and advice with the farmer.

Remember: If the crop is close to harvest or the pest population/crop loss incurred, is now very high, further treatment may not be justified.

The same line of investigation can also be conducted on a commercial farm when scouting records show that adequate control is not being achieved. When this occurs the crop protection supervisor will carry out the investigation and will discuss what action to take with the line manager.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. When adjustments for integrated pest management required? (5pts)
2. What are monitoring procedures for adjustment for pest management? (5pts)
3. If certain controlling measure is not effective for farmers, then how you can treat?(5pts)

Note: Satisfactory rating - 15 points and above Unsatisfactory - below 15 points

You can ask your teacher for the copy of the correct answers

References

1. Environmental Protection Agency, (2012). Pesticides and food: why children may be especially sensitive to pesticides. http://www.epa.gov/pesticides/food/pest.htm

2. Schafer, K.S., Marquez, E.C., (2012). A generation in jeopardy: how pesticides are undermining our children's health and intelligence. Pesticide Action Network North America. 44pp.

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Profile of trainers participate on special Horticultural Crop Production TTLM development for level I at Adama 2019