የሥራና ክህሎት ሚኒስቴር
Ministry of Labor and Skills

Crop Production

Level-I

Based on March 2022, Version 4 Occupational standard



Module Title: Identifying Important Crop Pests

LG Code: AGR CRP1 M0 7 LO (1-3) LG (27-29)

TTLM Code: AGR CRP1 M07 TTLM 0922v1

September, 2022

Addis Ababa, Ethiopia

Table of Contents

Introduction to the Module 1

LO #1- Applying Workplace Requirements and 2

Instructions Concerning Crop Pest Identifications 2

Instruction sheet 2

Information Sheet 1 37

Self-check 1 8

Operation Sheet -1 9

LAP Test 10

LO #2- Conducting Field Assessment 11

Instruction sheet 11

Information Sheet 2 12

Self-Check – 2 21

Operation Sheet -2 22

LAP TEST-2 25

LO #3- Recognizing crop pest. 26

Instruction sheet 26

Information Sheet 3 27

Self-Check – 3 47

Operation Sheet -3 49

LAP TEST-3 50

Reference Materials 51

Introduction to the Module

This module covers the knowledge, skills and attitude required to apply workplace requirements and instructions concerning crop pest identifications, conduct field assessment and recognize crop pest. This competency involves the application of knowledge and skills in recognizing common crop pests, sign and symptoms, recording the severity of the pest and relevant information.

LG #27	LO #1- Applying Workplace Requirements and Instructions Concerning Crop Pest Identifications

Instruction sheet

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

- Identifying roles and responsibilities of people
- Recognizing and following principles and guide of crop pest identifications
- Identifying and reporting occupational health and safety hazards
- Following organizational procedures

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

- Identify Roles and responsibilities of people in the workplace
- Recognize and follow principles and guide lines in crop pest identifications
- Identify and report occupational health and safety hazards
- Follow Organizational procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1

1.1 Identifying roles and responsibilities of people

The responsibilities of a supervisor are the major tasks they complete ensuring a team of people perform according to the occurrence of crop pests. A supervisor oversees the day-to-day performance of employees. Depending on the company, a supervisor may manage a team, a shift or an entire department.

Pest control workers remove unwanted pests, such as roaches, rats, ants, bedbugs, mosquitoes, ticks, and termites that infest buildings and surrounding areas. Unwanted pests that infest buildings and surrounding areas can pose serious risks to the health and safety of occupants. Pest control workers control, manage, and remove these creatures from homes, apartments, offices, and other structures to protect people and to maintain the structural integrity of buildings. To design and carry out integrated pest management plans, pest control workers must know the identity and biology of a wide range of pests. They must also know the best ways to control and remove the pests.

Pest control workers typically do the following:

- Inspect buildings and premises for signs of pests or infestation
- Determine the type of treatment needed to eliminate pests
- Measure the dimensions of the area needing treatment
- Estimate the cost of their services
- Use baits and set traps to remove, control, or eliminate pests
- Apply pesticides in and around buildings and other structures
- Design and carry out pest management plans
- Drive trucks equipped with power spraying equipment
- Create barriers to prevent pests from entering a building

1.2 Recognizing and following principles and guide of crop pest identifications

Definition of terms

Pests: - are any organisms which interfere with human activities

- They are reducing quality and quantity of crops. Pest includes

I. Insects: - are small animals which belongs to Anthropoid phylum. Their body is divided into three sections, head, thorax and abdomen. Most adult insects have three pairs of legs and one or two pair of functional wings.

II. Disease: - is an abnormal deviation in physiological, biochemical processed in plant.

- It results in retardation of development of the plant.
- Reduction In quality and quantity.

III. Weed: - means plants that grow out of the place.

The first step in controlling insect pests, diseases, weeds and disorders should be identification (recognition) or accurate diagnosis. To effectively control a pest, it is important to accurately identify it. Pests can look different as they go through their life cycles. For example an immature beetle may look like a caterpillar or worm. Because of this, pests can easily be mistaken for non-pests, and vice versa. You may find out that your "pest" is actually a beneficial organism, harmless, or only a temporary problem. It is important to differentiate between infectious diseases (e.g. those caused by fungi, bacteria, viruses, and nematodes that can spread from plant to plant) and noninfectious diseases or disorders (e.g., damage caused by mites and insects, physiological disorders, air pollutants, nutrient imbalances, and herbicide injury).

Growers who have a reasonably good understanding of plant diseases, their symptoms, and the infectious and noninfectious disorders that can affect a particular crop, are more likely to make the correct disease control decisions.

The choice of a proper management tactic must be based on accurate knowledge of the pathogen causing the disease; its life cycle; time of infection; the part of the plant involved; the method of agent distribution; past, present, and future environmental conditions; and certain economic

considerations. Effective management techniques include: use of resistant varieties; use of non-infested soil or long rotations; sterilization of soil with steam or chemicals; use of clean seed, either certified or grown in disease-free areas; treatment of seed with heat or chemicals; control of insects and weed hosts; monitoring of weather conditions; use of biological control agents; and proper timing and application of fungicides or nematicides.

- Identification of the weeds

  - ✓ Identification is the first and most important step in pest control.
  - ✓ Identification is concerned with recognizing and giving names to individual weed species.
  - ✓ Accurate identification of pests can provide correct information about the pest.

- Steps in identification of pests:

  - ✓ Observe their physical features & the characteristics of the damage they cause.
  - ✓ Observe their growth pattern.
  - ✓ Refer related books for proper identification

- Tools to aid in identification:

  - ✓ Hand lens - aids in identification of tiny insects and arthropods like thrips, minute pirate bugs and mites
  - ✓ Digital camera - you can use a digital camera to take and record insect images that can be sent to the local extension office for identification. Once the insect is identified the digital image can be labelled and saved for future reference
  - ✓ Small vials with alcohol - useful for preserving specimens that are sent off for identification

1.3 Identifying and reporting occupational health and safety hazards

A. Noise

Noise limits for different working environments are provided. No employee may be exposed to a noise level greater than 85 dB (A) for a duration of more than 8 hours per day. In

addition no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dBC.

B. Vibration

Exposure to hand-arm vibration from equipment such as hand and power tools or whole-body vibrations from surfaces on which the worker stands or sits shall be controlled through selection of equipment and limitation of time of exposure.

C. Illumination, Light Radiation and Reflections

Work area light intensity must be adequate for the general purpose of the location and type of activity and must be supplemented with dedicated work station illumination as needed. All light sources should be energy efficient with minimum heat emission. The employer shall take measures to eliminate reflections and flickering of lights.

D. Temperature

The employer shall maintain indoor temperatures that are reasonable and appropriate for the type of work. Risks of heat or cold related stress must be adequately addressed and feasible control measures implemented for work in adverse environments.

E. Biological agents

The employer shall avoid the use of any harmful biological agent by replacing it with an agent that, under its normal conditions of use, is not dangerous or less dangerous to the workers, if the nature of the activity so permits. Precautions must be taken to keep the risk of exposure as low as possible. Work processes, engineering and administrative controls must be designed, maintained and operated to avoid or minimize release of biological agents into the working environment. The number of employees exposed or likely to become exposed must be kept at a minimum. Levels of exposure must be maintained below internationally established/recognized exposure limits.

F. Ionizing radiation

Places of work involving occupational24 and/or natural25 exposure to ionizing radiation shall be established and operated in accordance with the, "International Basic Safety Standard for protection against Ionizing Radiation and for the Safety of Radiation Sources,"26 and its three interrelated Safety Guides.

1.4 Following organizational procedures

Policies and procedures are important as they help clarify and reinforce the standards expected of the employee in all their professional dealings. On the other hand, they also help employers manage staff effectively by defining what is acceptable and unacceptable in the workplace. A workplace policy clearly defines an organization's expectations regarding employee behavior and performance. A workplace procedure tells employees how to implement those policies. When used together, policies and procedures give employees a well-rounded understanding of their workplace. In this article, we discuss some examples of policies and procedures in the workplace.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (2 pt. each)

1. The first step in controlling plant pests, diseases and disorders should be _____

A. Identification or accurate diagnosis C) Injection

B. Applying chemicals D) All

2._____are small animals which belongs to Anthropoid phylum

A. weed C. disease

B. insect D. nematodes

3. Which one of the following is occupational health and safety hazards?

A. Nosie C. temperature

B. vibration D. All

_____is a plant that grow out of the place.

A. Insect C. disease

B. Weed D. All

5._____is an abnormal deviation in physiological, biochemical processed in plant.

A. weed C. Insect

B. disease D. All

Note: **Satisfactory rating – 5 points** **Unsatisfactory – below 5 points**

Operation Sheet -1

1.1 Techniques/Procedures/Methods of weed identifications

A. Tools and equipment's used

I. Hand lances
II. Digital camera
III. Small vials with alcohol
IV. Reference books
V. Personal protective equipment

B. Procedures/Steps of weed identifications

i. Wear appropriated personal protective equipment
ii. Observe leaf shape, leaf margins, and venation (branching pattern of leaf veins)
iii. Leaf structure (simple or compound)
iv. Arrangement of leaves on the stem
v. Presence or absence of hairs on leaves or other parts of the plant
vi. Flower structure, color, size
vii. Inflorescence (arrangement of flowers or flower clusters on plant)
viii. Size, shape, structure, color, and arrangement of fruits and seeds
ix. Roots, rhizomes, and other underground structures
x. Life cycle (annual, biennial, perennial)
xi. Habit of growth (erect, prostrate, climbing, etc.)

LAP Test	Practical demonstrations

Name _____ Date _____

Time started _____ Time finished _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. The project is expected from each trainee to do it.

Task-1 perform weed identifications.

LG #28 LO #2- Conducting Field Assessment

Instruction sheet

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

- Selecting and preparing equipment for scouting
- Carrying out Field scouting
- Reporting observed crop pests and disorders

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

- Select and prepare equipment for scouting
- carry out field scouting
- Report crop pests and disorders

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1 Selecting and preparing equipment for scouting

Definition; - Scouting: - means observing of any field and plant conditions in order to gain information about the visible signs and symptoms of pests and diseases.

Scouting and monitoring are critical steps in pest management that allow managers to quantify pest pressure and the potential for crop damage. Information gathered in the scouting process can be used to determine if pest control measures are warranted, select appropriate control technologies and time them for maximum effect.

Scouting in field crops may target insects, weeds, disease or even abiotic stresses not caused by pests. Regardless of the target in mind, a scout's primary goal should be regular, systematic monitoring of a crop that permits accurate and timely decision-making. Achieving this goal is dependent on adhering to the following four core practices:

I. Collect necessary background information.
II. Use the proper tools.
III. Be timely and use representative sampling methods.
IV. Keep proper records.

2.1.1 Background information

One of the most fundamental and challenging aspects of scouting is recognizing visual cues indicating something is damaging a crop and linking that damage to possible causes. For this reason, scouting must be based on prior knowledge of field conditions and management history, the crop being grown and common pest species. This information is frequently drawn from personal experience, but can also be accessed through the following resources:

- Local weather data.
- Soil survey maps.
- Aerial or satellite imagery.
- Farm management records.

- Crop and pest management reference materials.
- Private consultants and scouts.
- Farm input suppliers.
- Other farm managers.

2.1.2 Tools for scouting

Collecting high quality, useable information requires the right tools. The following items should be assembled in a carrying case for field use:

- clipboard
- sampling frame
- record sheets
- alcohol
- tweezers
- clear plastic bags
- 10X hand lens
- paper bags
- hand trowel
- sweep net
- pocket knife
- sieve
- vials
- labels for identification
- resource material
- flagging tape

Use these tools to collect samples, and to record, examine, and preserve them for reference or identification. You will find all these items are essential when you are on your hands and knees with a pest in your hand and nowhere to put it.

2.1.3 Methods for scouting

To collect representative information and make the most out of time spent scouting, it is recommended scouts consider the basic procedures outlined below:

- Scouting should begin as soon as plants begin to grow or pests become active and should continue until the crop is harvested or the risk of pest pressure has passed.

- Scouting fields weekly is recommended. If degree day tools or biological information is available to predict the emergence or arrival of certain pests, use them to gauge when you might scout more intensively.
- Section fields into manageable portions based on location, size, crop or variety and scout them separately.
- Walk a path in the field that allows you to assess the crop broadly. Common approaches are walking in an X or a W pattern to cover the whole field. Walk a different pattern each time you scout, but also remember to reexamine hotpots where you have previously encountered high pest pressure.
- Within a broad scouting pattern, select five widely spaced points and at each point check a minimum of 10 plants and 100 square feet of surrounding ground for signs and symptoms of pest pressure or abiotic stress. Examine all parts of crop plants including leaves, stems, roots and reproductive portions.
- Determine the distribution of issues encountered. Is the problem scattered randomly throughout the field or occurring in a recognizable pattern that could be attributed to a particular pest species or past management operation?
- Attempt to identify any signs or symptoms of pests encountered in scouting. Consult reference materials and pest management professionals for assistance. Once an issue is identified, use information regarding its abundance or damage to the crop to make control decisions.

2.1.4 Recordkeeping

Scouts should keep records of their scouting to indicate where exactly a problem was identified, how common the problem was, how damaging the problem was and what, if any, control measures were utilized. Scouting data sheets are available through various sources, including some that are crop- and pest-specific. Including a field map in scouting records is a simple way to show scouting patterns and the location of identified issues. Keeping good records will improve the effectiveness of future scouting activities.

2.2 Carrying out field scouting

Field scouting is the regular examination of fields in a prescribed fashion to measure pest levels. To properly scout for pests, you must know:-

- ✓ where they live,
- ✓ what they look like
- ✓ how to find and
- ✓ Count them.

This information is provided in the sections on specific pests. A combination of basic scouting procedures and a good knowledge of pest biology allows you to collect the information required to make sound pest management decisions. When scouting, you can also assess whether your management strategies are working, or in themselves, causing problems.

2.2.1 Why Scout Fields

Field scouting is an economically and environmentally sound prerequisite to pest management decision-making. No good is achieved by treating a pest where damage is insignificant. On the other hand, treatment when the damage is too far along is economically and environmentally irresponsible. A farmer can only collect the information needed to make timely management decisions by regular scouting. Regular scouting also prevents unnecessary treatments and reduces the uncertainty associated with pest management

2.2.2 Scouting Frequency

Scouting should be done weekly during the growing season and even daily when infestations approach economic levels or weather conditions favour rapid development of specific pests. With some plant diseases, daily scouting is necessary when it is warm and humid. With weeds, competition is normally most critical during the seedling stage, but this can vary with the species.

2.2.3 What to Look for

When scouting you should note all the pests and beneficial insects that you find. You want to detect problems that will affect this year's crop and future crops so you can make short- and

long-term pest management decisions. For example, you want to detect a high population of grasshoppers so you can take action, but you also want to detect a low level of cleavers so you can keep the field in a cereal rotation to clean-up the problem. Assess the overall appearance of the field, then examine specific plants including seed heads, stems, leaves and roots. Cut them open and check for signs of damage by insects and diseases. Besides the pests themselves, you should watch for typical damage symptoms that are caused by pests and pesticides. These symptoms are not exclusive to pests and control products but may be caused by environmental and soil factors. The following symptoms are commonly associated with pests and pesticide damage.

2. 3 Reporting observed crop pests and disorders

A. Plant Pests: Plant pests are organisms that cause damage crops/plants by feeding and / or reproductive habits lead to a reduction in the quantity and quality of the crop produced. It includes insects, diseases, weeds, rodents, birds, and mammals.

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

I. Economic pests mean pests cause a crop loss of about 5-10%, or even more in a definite field.
II. Non-economic pests mean pests cause a crop loss of less than 5% in a definite field. There are two main categories of that causes plant disease.

B. Abiotic Disorders of Plant

When the cause of a problem is an environmental condition, cultural practice, or chemical exposure, the causal agent is abiotic (nonliving). Disorders caused by abiotic factors are not contagious, but such disorders can severely damage plants. In these cases, it is more appropriate to use the term injury or disorder rather than disease. Most environmental problems are caused by deficiencies or excesses of factors that support life (including soil moisture, light, and temperature). Simple actions such as soil testing, finding out if a plant prefers sun or shade, loosening the edges of the root ball when planting, watering during dry weather, mulching, and knowing when to lime, fertilize, and prune are major factors in preventing many plant problems.

Symptoms such as leaf yellowing, poor vigor, and dieback are the plant's signal something is wrong with its environment. The main causes of plant disorders are:-

a. Moisture

Both excess moisture and lack of moisture can damage plant. Extreme waterlogging results in root death because of reduced oxygen levels in the root zone. More commonly, excess soil moisture is a contributing factor to root disease. Another disorder that sometimes occurs under high moisture conditions is edema, which appears as numerous swollen bumps on the lower side of leaves .These swellings later turn brown and corky.

Edema is common on certain thick-leaved herbaceous and woody plants such as geraniums, camellia, and euonymus. At the other extreme, insufficient moisture can result in scorch symptoms on foliage, stunting, leaf yellowing, leaf drop, and abortion of flowers and fruits. Necrosis can occur on the tips, margins, and inter venial regions of leaves, for example, on sycamore and dogwood trees. Under certain circumstances, potting mixes, mulches, or soils can become hydrophobic (water-repellent). Rain and irrigation will not be effective at getting water to the roots once a hydrophobic condition has occurred. Another type of moisture problem is winter burn. Roots cannot extract water from frozen soil, so foliage of evergreen trees and shrubs can get a scorched appearance when winter winds dry them out.

b. Plant Nutrition

Excessive fertilization can result in root burn and plant damage from high concentrations of soluble salts. Lower-than-optimum levels of nutrients usually result in diminished growth and a wide variety of foliar symptoms, depending on the nutrients involved. Even when nutrients are present in the soil, they may be unavailable to plants if the soil pH is not in the correct range. One common nutritional problem that can be mistaken for a disease is blossom end rot of tomatoes and peppers. Flattened, tan-colored dead spots appear on the fruit, around the point where the flower was attached. This often happens on the first cluster produced on a given tomato plant. In peppers, the damage can also appear elsewhere on the fruit



Figure 2.1 blossom end rot of pepper

The affected areas may become dark if secondary molds develop in the affected tissue



Figure 2.2. Secondary molds can sometimes infect areas with blossom end rot damage.

The cause is a localized calcium deficiency in the developing fruit. It can be brought on by water stress or by low levels of calcium in the soil. High levels of fertilizer salts especially ammonium nitrogen—can also contribute to the disorder.

c. Light, Temperature, Wind, and Weather

Some plants require shade. Sensitive plants such as aucuba can show burn on those leaves most exposed to the sun. Fleshy vegetables such as peppers and tomatoes can show sunscald on fruit



(Figure 2.3 Sun scald on a tomato).

Cold can damage plants that are grown out of their area of adaptation or plants exposed to rapid drops in temperature. Tropical indoor plants are prone to injury from low temperatures—both in the home and while in transport. This kind of chilling injury usually shows up as a blackening of plant tissues soon after the exposure.

Perennial and woody plants develop some tolerance too cold as fall and winter progress but lose this hardiness with the onset of spring. In the fall, cold hardiness first occurs in the terminal buds. The last tissues to go dormant are at the base of the main stem. An early freeze in the fall or late freeze in the spring results in bark splitting or loss in those lower stems. The plant may not show distress until the heat of summer when the damaged stems are unable to move sufficient water to the foliage. Late frosts often damage the flower buds of peaches, cherries, apricots, and strawberries. Frost damage to new conifer needles will uniformly kill all needles of the same age back to the same point.

Dry winds can pull moisture from leaves, resulting in a scorched appearance. Heavy winds can remove leaves and limbs and effectively sandblast plants. Ice storms can result in broken limbs. Hail can punch holes in leaves or knock plants down. In addition, lightning strikes, fire, and high temperatures can damage or even kill a plant.

All of the abiotic plant problems described above occur naturally. Several other abiotic problems are caused by humans. Examples include air pollution, herbicide injury, and mechanical damage (for example, when a lawn mower hits a tree). Other human-caused abiotic problems include

roots girdling on plants left too long in a small pot and compacted soil. Noninfectious diseases are diseases those are caused by nonliving, environmental factor.

Non-infectious disease is sometimes termed as disorders and characterized by:

- Occurring in the absence of the pathogen (no sign of disease);
- Can't transmitting from diseased plant to the healthy plant;
- Infecting the plant in all stage (seed, seedling, and mature plant);
- Distributing 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
- ✓ Lack or excess of water or moisture in soil or air
- ✓ Lack or excess of nutrient element;
- ✓ Air pollution;
- ✓ Misuse of pesticides or chemical products;
- ✓ Improper cultural practices.

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short answer questions (3pt.each)

1. Define plant disorder?

2. Define what does mean - Scouting:

3. What is the difference between infectious and non-infectious disease?

4. What is the functions of field scouting?

5. List at least 6 tools that used for field scouting?

6. Give at least 4 factors that cause plant disorder?

Test II: Multiple choice (2pt each)

1. Which one of the following is not the characteristic of Non-infectious disease?

A, Occurring in the absence of the pathogen C, Have sign of disease

B, occurred by nutrient toxicity and deficiency plant D, Infecting the plant in all stage

2. Which one of the following is not factors that cause non-infectious diseases?

A, Pathogen B, too high a temperature C, excess of nutrient element D, excess moisture

3._____ means observing orchard and plant conditions in order to gain information about the visible signs and symptoms of pests and diseases.

A, disorder B, scouting C, biotic D, abiotic

4. Which one of the following is not factors that cause plant disorder?

A, moisture B, nutrient deficiency C, excessive nutrient D, pathogen

5. Tools that used for field scouting?

A. Clipboard C. record sheets

B. Alcohol D. sampling frame

E. All

Note: **Satisfactory rating – 19 points** **Unsatisfactory – below 19 points**

Operation Sheet -2

2.1 Techniques/Procedures/Methods of Methods for field scouting

A. Tools and equipment's

- clipboard
- sampling frame
- record sheets
- alcohol
- tweezers
- clear plastic bags
- 10X hand lens
- paper bags
- hand trowel
- sweep net
- pocket knife
- sieve
- vials
- labels for identification
- resource material
- flagging tape

B. Procedures /methods of scouting

I. Scouting should begin as soon as plants begin to grow or pests become active.

II. Scouting fields weekly is recommended.

III. If biological information is available to predict the emergence or arrival of certain pests, use them to gauge when you might scout more intensively.

IV. Section fields into manageable portions based on location, size, crop or variety and scout them separately.

V. Walk a path in the field that allows you to assess the crop broadly.

VI. Walking in an X or a W pattern to cover the whole field.

VII. Walk a different pattern each time you scout, but also remember to reexamine hotpots where you have previously encountered high pest pressure.

VIII. Select five widely spaced points

IX. Check a minimum of 10 plants and 100 square feet of surrounding ground for signs and symptoms of pest pressure or abiotic stress.

X. Examine all parts of crop plants including leaves, stems, roots and reproductive portions.

XI. Determine the distribution of issues encountered.

XII. Attempt to identify any signs or symptoms of pests encountered in scouting.

XIII. Consult reference materials and pest management professionals for assistance.

XIV. Once an issue is identified, use information regarding its abundance or damage to the crop to make control decisions.

LAP TEST-2	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. If the area of the land is 50mx50m. Then the project is expected from each trainee to do it.

Task-1 carry out field scouting.

LG #29	LO #3- Recognizing crop pest.

Instruction sheet

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

- Collecting and identifying crop pests
- Identifying sign and symptoms of common crop pests
- Distinguishing sign and symptoms of common crop insect pests
- Recognizing common crop weeds
- Identifying soil born crop pests
- Identifying vertebrate and migratory crop pests
- Selecting, using, maintaining and storing PPE
- Maintaining records and reports

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

- Collect and identify Crop pests
- Identify sign and symptoms of common crop pests
- Distinguish sign and symptoms of common crop insect pests
- Recognize common crop weeds pests
- Identify soil born crop pests
- Identify vertebrate and migratory crop pests
- Select, maintain and store suitable personal protective equipment (PPE)
- Maintain records and reports

Learning Instructions:

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below.
9. Read the information written in the information Sheets
10. Accomplish the Self-checks
11. Perform Operation Sheets
12. Do the “LAP test”

Information Sheet 3

3.1 Collecting and identifying crop pests

Always label specimens with complete collection data in or on each container. Larvae of most insects should be collected, boiled in water to "fix" their proteins and prevent them from turning black, and placed in alcohol. Larvae should be left in hot water for 1–5 minutes, depending on the size of the specimens, and then transferred to 70% to 80% alcohol. Thrips and most mites are best collected in an alcohol-glycerin-acetic acid.

Larvae and most soft-bodied adult insects and mites can be kept almost indefinitely in liquid preservatives; however, for a permanent collection, mites, aphids, thrips, whiteflies, fleas, and lice usually are mounted on microscope slides. Larvae are usually kept permanently in alcohol, but some may be mounted by the freeze-drying technique or by inflation. Many insects collected in alcohol are later pinned for placement in a permanent collection. Hard-bodied insects such as beetles can be pinned directly after removing them from alcohol, but for softer insects, such as flies and wasps, special procedures must be followed.

Methods of collecting insects:

- Berlese funnels.
- Flight intercept traps
- Hand netting
- Light traps.
- Pitfall traps
- Yellow pan trap



Figure 3.1 Beetle collection beautiful colors and shapes

- Labels should contain:

✓ Common Name:
✓ Scientific Name:
✓ Collection Date:
✓ Collector Name:
✓ Location:
✓ Any other data

. Types of storage specimen's

- Temporary storage of specimens

After specimens have been collected, there are several ways to keep them in good condition until they can be prepared properly. The method used depends largely on the length of time that the specimens may have to be stored temporarily.

- Refrigeration and freezing

Medium to large specimens may be left in tightly closed bottles for several days in a refrigerator and remain in good condition for pinning, as will smaller specimens if left overnight. Place absorbent paper between the jar and the insects to keep them dry. Some moisture must be present in the containers so that the specimens do not become "freeze-dried." But if there is too much moisture, it will condense on the inside of the bottle as soon as it becomes chilled. Place absorbent paper between the jar and the insects to keep them dry. When removing specimens for further treatment, place them immediately on absorbent paper to prevent moisture from condensing on them.

- Alcohol

Insects may be placed in alcohol and kept for several years before they are pinned or otherwise treated. However, it has been shown that many insects, especially small ones, can deteriorate in alcohol stored at room temperature. Store these specimens in a freezer for the long term. Even though the alcohol will not freeze at the temperatures obtained by most freezers, the lower temperature seems to slow or stop deterioration.

- Dry preservation

It is standard practice to place many kinds of insects in small boxes, paper tubes, triangles, or envelopes for an indefinite period, allowing them to become dry. However, soft-bodied insects stored by such methods can shrivel and break. Diptera should never be dried in this manner because the head, legs, and most of all the antennae detach easily.



Figure 3.2 a collection of pinned, preserved insects (beetles

Forms for insect preservation
Administrative region: _____ Order _____ Family: _____ Scientific name: _____ Local name: _____language: _____ Uses or economic value: _____ Locality: Altitude:____ Latitude:____ longitude: _____ Habitat:_____ Description: _____ Collector name: _____ Date: _____ Specimen no: _____

3.2 Identifying sign and symptoms of common crop pests

Most plant diseases – around 85 percent – are caused by fungal or fungal-like organisms. However, other serious diseases of food and feed crops are caused by viral and bacterial organisms. Certain nematodes also cause plant disease. Some plant diseases are classified as "abiotic," or diseases that are non-infectious and include damage from air pollution, nutritional deficiencies or toxicities, and grow under less than optimal conditions. For now, we'll look at diseases caused by the three main pathogenic microbes: fungus, bacteria and virus. If plant disease is suspected, careful attention to plant appearance can give a good clue regarding the type of pathogen involved.

A sign of plant disease is physical evidence of the pathogen. For example, fungal fruiting bodies are a sign of disease. When you look at powdery mildew on a lilac leaf, you're actually looking at the parasitic fungal disease organism itself (Microsphaera alni). Bacterial canker of stone fruits causes gummosis, a bacterial exudate emerging from the cankers. The thick, liquid exudate is primarily composed of bacteria and is a sign of the disease, although the canker itself is composed of plant tissue and is a symptom.

A symptom of plant disease is a visible effect of disease on the plant. Symptoms may include a detectable change in color, shape or function of the plant as it responds to the pathogen. Leaf wilting is a typical symptom of verticilium wilt, caused by the fungal plant pathogens Verticillium albo-atrum and V. dahliae. Common bacterial blight symptoms include brown, necrotic lesions surrounded by a bright yellow halo at the leaf margin or interior of the leaf on bean plants. You are not actually seeing the disease pathogen, but rather a symptom that is being caused by the pathogen.

Here are a few examples of common signs and symptoms of fungal, bacterial and viral plant diseases:

Fungal disease signs:

- Leaf rust (common leaf rust in corn)
- Stem rust (wheat stem rust)
- Sclerotinia (white mold)

- Powdery mildew

Fungal disease symptoms:

- Birds-eye spot on berries (anthracnose)
- Damping off of seedlings (phytophthora)
- Leaf spot (septoria brown spot)
- Chlorosis (yellowing of leaves)



Figure 3.1Stripe rust pustules on a winter wheat leaf is a symptom.

Bacterial disease signs (difficult to observe, but can include):

- Bacterial ooze
- Water-soaked lesions
- Bacterial streaming in water from a cut stem

Bacterial disease symptoms:

- Leaf spot with yellow halo
- Fruit spot
- Canker
- Crown gall
- Sheperd's crook stem ends on woody plants

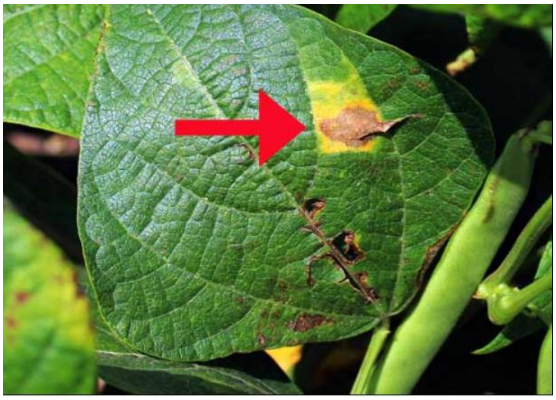


Figure 3.2 Dark red kidney bean leaf showing bacterial leaf spot symptom (brown leaf spot with yellow halo)

Viral disease signs:

- None – the viruses themselves can't be seen

Viral disease symptoms:

- Mosaic leaf pattern
- Crinkled leaves
- Yellowed leaves
- Plant stunting

3.3 Distinguishing sign and symptoms of common crop insect pests

Insects: - belong to that great subdivision of the Animal kingdom called Arthropoda which are characterized by the possession of an external jointed skeleton encasing the body in a virtual suit of armor, like many other groups of animals, arthropods are segmented creatures, and that is, the body is composed of a number of similar repeating units. In insects these body segments are grouped into three more or less distinct regions comprising head, thorax, and abdomen. Three pair of legs, single pair of antennae. Tracheal system present (except in low forms).Although entomology in the strict sense is concerned solely with insects, the practicing entomologist is expected to deal with related animals such as mites and spiders (or even more remote slugs and snails), where these are of economic significance.

Although the number of species of insects that are regarded as pests is not large, their activities have major impact on human welfare. The FAO has estimated that one third of all food grown is lost to pests and diseases, either from the growing crop in the field or in store after harvest. Although this figure includes losses from disease organisms as well as pests it may be safely claimed that at least half these losses are due to insects.

In a world in which many people still go hungry, insects thus still claim more than their fair share. Some plant feeding insects are important, not so much because they directly reduce plant yield and quality, but because they transmit disease organisms. This is particularly the case with plant virus diseases many of which can only spread from plant to plant by means of suitable insect vectors. In temperate climates aphids of various kinds are the most important vectors while in the tropics leafhoppers are the main culprits. As there is at present no practical cure for a virus infected plant, control is usually aimed at preventing infection through control of the insect vector.

3.3.1 Insect mouthparts

Among plant feeding insects two main patterns of mouthparts are recognized---the biting and chewing pattern in those that consume solid plant tissues, and the piercing and sucking pattern in those that are sap feeders. A third type, usually referred to as the rasping pattern, also occurs but is less important.

(a) Biting and chewing mouthparts

The basic biting and chewing mouthpart pattern is present in crickets and cockroaches. There are four main parts. In front, a flap-like front lip (labrum) acts as a protective cover to the large biting jaws (mandibles) which we immediately behind it. Behind the mandibles and slightly to each side are a pair of supplementary jaws (maxillae). Behind the maxillae in the form of a hind lip is the labium.

(b) Piercing and sucking mouthparts

Mouthparts adapted for piercing plants and sucking out the sap are found primarily in the insect order Hemiptera and Homoptera which includes cicadas, leaf hoppers, plant bugs, aphids and

mealy bugs, the structure of the mouthparts is much the same in all cases though their size and relative ability to penetrate plant surfaces varies greatly. From the lower part of the head there is a long finger-like extension which at rest tends to be folded back along the underside of the insect. This the proboscis or rostrum and is formed from the hind lip (labium). It is tubular in form with a groove lie two pairs of hard but flexible bristles. These are the stylets and are formed formed from the mandibles and maxillae. When the insect feeds they are extended from the tip of the rostrum and penetrate the plant. Normally the inner two stylets are firmly locked together and their inner surface so shaped that they form two canals. One canal allows the insect to pump saliva into the plant, the other the feeding canal, is for uptake of plant sap. Within the head of the insect the first portion of the gut (pharynx) is distended into a sucking pump (cibarium) which assists in the feeding process.

(c) Rasping mouthparts

Rasping mouthparts found among plant feeding insects is that which occurs in the larvae (maggots) of higher flies. The entire insect is soft bodied except for some dark portions embedded in the fore part of the gut and visible through the semitransparent body. The tips of these hard parts protrude from the mouth in the form of a pair of mouth hooks. These are used to shred food material which is then ingested in a semi-liquid state.

(d) Siphoning pattern

Moths and butterflies, like honey bees, feed primarily on nectar but have adopted a different approach to the problem of obtaining it from flowers. Their mouthparts are in the form of a long narrow tube (formed from the maxillae) open only at the tip. Thus is usually coiled like a watch spring at rest but can be extended and inserted into a flower opening. It acts like a drinking straw up which nectar can be drawn. A pair of palps (labial) are the only other parts present.

3.3.2 Some possible reasons for insects' success

(a) Power of flight

Besides the insects only birds and bats among present day animals have succeeded in developing the power of flight. Flight imparts great mobility to an organism and enables it quickly to colonies new sources of food as they become available. Conversely, flight facilitates rapid escape from unfavorable conditions.

(b) Adaptability

Insects as a group have adapted to all environments capable of supporting life (other than marine) and moreover can utilize almost any organic material as food.

(c) Possession of an external skeleton

Although a handicap is some respects (such as not allowing for growth), an external skeleton provides a small animal with a valuable protective easing. What is perhaps more important than its mechanical strength is the physical property of its outermost layer (cuticle) in providing a very effective barrier against water loss, a constant problem for any small land animal.

(d) Small size

There are disadvantages in being small, in particular a limited brain size and thus limited capacity for the development of intelligence, for insects, however, the low food requirement per individual and ease of concealment consequent on small size appear to outweigh such a disadvantage.

(e) Rapid reproduction

The ability of insects to multiply rapidly (due to short life cycles and many offspring per female) is probably a key factor in their success. Food resources can be quickly exploited as they become available, and furthermore there is the capacity for revolutionary change as shown dramatically by the development of insecticide resistant strains in many species. example some sign of insect on crop plant.





Figure 3.4 thrips

Figure 3.3 Leafhoppers and Sharpshooters.

3.4 Recognizing common crop weeds

Definition: - Weeds are often called as plants, which grow where they are not wanted. Or plants that grow out of the place.

Weed interference with crop production:

- competing for water, nutrients, light, and space,
- contaminating the product at harvest,
- harboring pest insects, mites, vertebrates, or plant disease causing agents,
- Releasing toxic substances in to the soil that inhibit growth of desirable plants.

Weed classification

Weeds are classified in to different groups based on various criteria. Based on; their morphology, life span, habitat and parasitic or poisonous nature.

A. Based on plant morphology

Classification of weeds based on morphology is very important and useful in weed control.

i. Grasses

- Botanically: Plants of the family poaceae (Graminea)

- Grasses are monocots and are propagated by seeds; rhizomes, stolons and stem cuttings.
  e.g Cynodon dactylon (Bermuda grass), Sorghum halepense (johason grass), Digitaria spp; and wild oat (Avena fatua).

ii. Sedges

- Monocots and the stems are solid and triangular in cross section
- Propagation is through modified rhizomes
  e.g Cyperus spp

iii. Broad leaved weeds

- These weed species are dicotyledonous plants
- The leaves are usually broad with netted veins.
  E.g. Amaranthus spp. Chenopodium album, Convoulus arvensis.

B. Based on life span

i. Annuals: These weeds complete their life cycle in one season.

- Propagation is through seeds, which are produced in a single growing suasion.
- Most annual weeds are easy to control. The prime concern is to prevent these weeds from going to seed.
  E.g Commelna beghalensis

ii. Biennials: These weeds complete their life cycle in two years or two growing seasons.

- In the first season they produce flowers and seeds.
- More effective when the plants are in the rosette stage of their first season of growth.

E.g. wild carrot Daucas carrota

iii. Perennials: These weeds live in more than two years, propagated by seeds or asexual means.

- They store food in the subterranean part which produce new shoot when condition is favorable.
- These weeds are very difficult to control by common methods.

E.g. Cynodom dactylen – stolen; Cyperus spp – tuber

C. Based on their habitat

i. Terrestrial weeds

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

E,g Amaranthus spp

ii. Aquatic weeds

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

D. Special weeds

i. Poisonous weeds

Reducing the milk yield/quality in cow. Poisonous to both human and animals.
E.g. Datura stramonium (Jamestown – weed), Sorghum halepense (Johnson grass) – containing at its tillering stage enough prussic acid to poison cattle.

ii. Problem or noxious weeds

In the world, FAO has named 18 species belong to noxious weeds, in Ethiopia, 10 of them exist. They;

- Persist in adverse condition.
- Reduce yield even at very low density because of their high competitive nature
- Hard to control.

E.g. Cyperus rotundus (purple nutsedge), Cynodon dactylon (Bermuda grass), Parthenium hysterophorus (congress weed).

Parasitic weed

Weeds that depend entirely or partly on the host for their existence are called parasitic weeds. Parasitic plants include dodder, mistletoe, witch weed, and broomrape. Parasitic plants derive nourishment from the host plant's vascular system. A number of flowering plants are parasites of other plants. Among the more important ones are mistletoe, dodder, and witch weed.

Dodder More than 100 species of dodder (Cuscuta) are widely distributed and called such names as strangle weed, devil's-hair, pull down, hell-bind, love vine, and goldthread. The leafless, yellow-orange, threadlike stems twine around a number of field and garden host plants. By extending to nearby plants, it may draw them together and downward until a tangled yellowish orange patch is formed. The infested area is usually less than three meters across the first year; it spreads more rapidly in succeeding years. Dodder is widely distributed as a contaminant with field seed; hence the losses in clover, alfalfa, and flax fields.

Dodder is controlled by planting certified, properly cleaned seed and by mowing patches of dodder in the field well before the seeds form. The dried patches are sprinkled with fuel oil and burned. Careful application of selective herbicides or a soil fumigant and sowing heavily infested areas with resistant plants (e.g., garden beans, soybean, corn, cowpea, pea, grasses, or small grains) are also control methods.

The common examples of parasitic weeds are:

- ✓ . Cuscuta spp e.g dodders
- ✓ Orobanche spp e.g. witch-weeds
- ✓ Striga spp



Figure 3.5 parasitic dodder

Jimsonweed, (Datura stramonium), contains toxic compounds in its leaves, stems, and roots. The weed favors fields and pastures in which livestock graze and the toxins it contains are strong enough to sicken or kill some livestock



Figure 3.6 Jimsonweed

3.5 Identifying soil born crop pests

Soil-borne diseases in the garden include pre and post-emergence damping-off, like Fusarium, Pythium and Rhizoctonia species, root rot, including Phytophthora, vascular wilts caused by fungi including Verticillium and nematodes.

Nematode, also called roundworm, any worm of the phylum Nematoda. Nematodes are among the most abundant animals on Earth. They occur as parasites in animals and plants or as free-living forms in soil, fresh water, marine environments, and even such unusual places as vinegar, beer malts, and water-filled cracks deep within Earth's crust.

Nematodes parasitic on plants obtain food by sucking juices from them. Feeding is accomplished through a hollow, needlelike mouthpart called a spear or stylet. The nematode pushes the stylet into plant cells and injects a liquid containing enzymes, which digest plant cell contents. The liquefied contents are then sucked back into the nematode's digestive tract through the stylet. Nematode feeding lowers natural resistance, reduces vigour and yield of plants, and affords easy entrance for wilt-producing or root rot-producing fungi or bacteria and other nematodes. Nematode-infested plants are weak and often appear to suffer from drought, excessive soil moisture, sunburn or frost, a mineral deficiency or imbalance, insect injury to roots or stems, or disease.

Common symptoms of nematode injury include stunting, loss of green color and yellowing; dieback of twigs and shoots; slow general decline; wilting on hot, bright days; and lack of response to water and fertilizer. Feeder root systems are reduced; they may be stubby or excessively branched, often discolored, and decayed. Winter kill of orchard trees, raspberries, strawberries, ornamentals, and other perennials is commonly associated with nematode infestations.

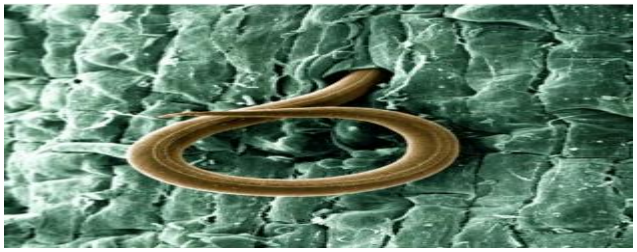


Figure 3.7 root knot nematode

Fusarium wilt, widespread plant disease caused by many forms of the soil-inhabiting fungus Fusarium oxysporum. Several hundred plant species are susceptible, including economically important food crops such as sweet potatoes, tomatoes, legumes, melons, and bananas (in which the infection is known as Panama disease).



Figure 3.8 fusarium wilt

3.6 Identifying vertebrate and migratory crop pest

3.6.1 Vertebrate Pests

Vertebrate pests can be defined as any vertebrate, native or introduced, domestic or feral, that periodically or consistently has an adverse effect on human health and well-being or conflicts in some significant way with human activities or interests. Many vertebrate animals expose humans to dangerous pathogens that have public-health significance. Vertebrate pests are a diverse group of animals and include amphibians, reptiles, birds, and mammals

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.



Gopher vole squirrels brown rat house mouse

Figure 3.9 different types of rodents

3.6.2 Migratory Pests

Definition: - Avian migration is a natural process, whereby different birds fly over distances of hundreds and thousands of kilometers in order to find the best ecological conditions and habitats for feeding, breeding and raising their young.

Migratory connectivity describes the degree of linkage between different parts of an animal's migratory range due to the movement trajectories of individuals. High connectivity occurs when individuals from one particular part of the migratory range move almost exclusively to another localized part of the migratory range with little mixing with individuals from other regions. Conversely, low migratory connectivity describes the situation where individuals spread over a wide area during migration and experience a large degree of mixing with individuals from elsewhere. The migratory connectivity concept is frequently applied to vertebrate migrants (especially birds), and it is highly relevant to conservation and management of populations. However, it is rarely employed in the insect migration literature, largely because much less is known about the migration circuits of most migratory insects than is known about birds.

3.6.2.1 Locusts

Locust are the oldest migratory pest in the world. They differ from ordinary grasshoppers in their ability to change behavior (gregarize) and to migrate over large distances. The most devastating of all locust species is the Desert Locust (Schistocerca gregaria) because it can easily affect 20 percent of the Earth's land and more than 65 of the world's poorest countries.

Desert Locusts live in the desert areas between West Africa and India where they normally survive in isolation. But if heavy rains fall and ecological conditions become favorable, they can increase rapidly, gregarize and form swarms. If the infestations are not detected and controlled, devastating plagues can develop that often have severe consequences on the livelihoods of millions of affected people.



Figure 3.10 locust migration

3.6.2.2 Birds

Birds of various types may do considerable damage to grain crop farms by eating both developing and dry grains. Quelea quelea birds are by far the most populous and destructive birds in Africa. They invade crops and cause heavy damage. Attacking the birds at their nesting and resting sites provides the most effective method of control. Toxic chemicals sprayed at dusk, has been found to be cheap and effective.

3.7 Selecting, using, maintaining and storing PPE

Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garment or equipment designed to protect the wearer's body from injury by blunt impacts,

electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes, and in sports, martial arts, combat, etc.

Your employees may need personal protective equipment to evacuate during an emergency. Personal protective equipment must be based on the potential hazards in the workplace. Assess your workplace to determine potential hazards and the appropriate controls and protective equipment for those hazards.

PPE may include items such as the following:

- Safety glasses, goggles, or face shields for eye protection;
- Hard hats and safety shoes for head and foot protection;
- Proper respirators;
- Chemical suits, gloves, hoods, and boots for body protection from chemicals;
- Special body protection for abnormal environmental conditions such as extreme temperatures; and
- Any other special equipment or warning devices necessary for hazards unique to your worksite

3.8 Maintaining records and reports

All required work place records should be completed accurately and promptly in accordance with enterprise requirements. Recording and documenting your work activities in an area serves you for several purposes simultaneously. It helps you in evaluating and learning from past field crop maintenance efforts. It also helps you to organize your own work for the future and allows you more closely monitor your activities.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer questions (3pt each)

1. What information that include during labelling of insect collections?

2. Define what does mean weed?

3. What are the most parasitic weeds?

4. What is the difference between sign and symptoms?

5. What are the examples of migratory pests?

6. List least 4 personal protective equipment (PPE)

Test II: Multiple choice (2pt each)

1. Which one of the following is/are parasitic weed?

A, dodders C, witch-weeds

B, Striga spp D, Cuscuta spp E, all

2. Which one of the following is soil born pest?

A, nematodes B, insect C, weed D, all

3._____ is the pathogen or its part or product seen on diseased plant?

A, disorder B, scouting C, sign D, symptoms

4. Which one is /are storage specimen of insects?

A, Alcohol B, Refrigeration and freezing

C, Dry preservation D, all

5. Which one is migratory pest?

A, bird B, locust C, rodent D, A&C E, All

Note: Satisfactory rating – 19 points Unsatisfactory – below 19 points

Operation Sheet -3

3.1 Techniques/ Methods Collection of insect Specimens for Preservation

A. Tools and equipment

I. Protective clothes, goggles, boot,
II. Different types of nets
III. Beaker
IV. Chemical like malathine
V. Cartoon/boards and thin paper (newspaper)
VI. Note books, pen and pencil

B. Procedures/Steps/Techniques

Forms for insect preservation
Administrative region: _____
Order _____
Family: _____
Scientific name: _____
Local name: _____language: _____
Uses or economic value: _____
Locality: Altitude:____ Latitude:____ longitude: _____
Habitat:_____
Description: _____
Collector name: _____
Date: _____
Specimen no: _____

LAP TEST-3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. Then the project is expected from each trainee to do it.

Task-1 perform insect Specimens for Preservation

Reference Materials

Books:

James De Decker November 23, 2015

Munster, M. 2018. Diseases, Chapter 5. In: K.A. Moore, and L.K. Bradley (eds). North Carolina Extension Gardener Handbook. NC State Extension, Raleigh, NC

Web addresses

https://content.ces.ncsu.edu/extension-gardener-handbook/5-diseases-and-disorders(August 24/22)

https://www.canr.msu.edu/news/signs_and_symptoms_of_plant_disease_is_it_fungal_viral_or_bacterial#:~:text=A%20symptom%20of%20plant%20disease,dahliae.(Aguust 24/22)

https://www.britannica.com/science/witches-broom(August 26/22)

https://content.ces.ncsu.edu/extension-gardener-handbook/5-diseases-and-disorders(August 23/22)

file:///C:/Users/Administrator/Downloads/Documents/chap08.pdf(August 24/22)

https://movementecologyjournal.biomedcentral.com/articles/10.1186/s40462-020-00235-5#Sec1(August 28/22)

https://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/migratory-pests/en(August /25/22)

http://content.ces.ncsu.edu/5-diseases-and-disorders(August 27/22)

AKNOWLEDGEMENT

Ministry of Labor and Skills to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

The experts who developed the learning guide

No	Name	Qualification	Educational background	Region	Phone number	E-mail
1	**Eyaya Tigabie**	**MSc**	**Agronomy**	**Afar**	**+251-921944452**	**eyayatigabie@gmail.com**
2	Fikadu Tilahun	BSc	Plant science	Afar	+251-917363367	Fikadutilahun80@gimail.com
3	Imam Mohamed	BSc	Plant science	Oromia	0913624360	leylasalo@gimail.com
4	Gosa Shura	MSc	Horticulture	Oromia	0923041032	Gossashura@gimail.com
5	Tilahun Getu	MSc	Biotechnology	Amhara	0918726766	Tile21eme@gimail.com
6	Degefa Guluma	MSc	Soil science	Oromia	0913440464	deguluma@gimail.com
7	Bayisa Abeshu	MSc	Agronomy	South west	0921434086	bayoabeshu@gimail.com
8	Birhanu Asefa	BSc	Plant science	South west	0922182673	berehanuasefa@gimail.com
9	Wendimu Tefera	BSc	Plant science	Oromia	0911266570	gurachoterfa@gimail.com
10	Taka Megersa	MSC	Horticulture	Oromia	0917210371	Takamagarsa430@gimail.com
11	Elias Mohammed	BSc	Horticulture	Oromia	0946706670	rewedal@gimail.com