Crop Production Level -IV

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Module Title: Planning and implementing Crop Pest Management Practices

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Contents **page**

LO#1 Plan to perform field surveillance for a specific Pest 5
Instruction sheet: 5
Information Sheet-1 6
Self-check-1 24
LO#2 Identify pest management options and prepare action plan 25
Instruction sheet: 25
Information Sheet-2 27
Self-check-2 47
LO#3 Apply cultural and biological crop pest management methods 49
Instruction sheet: 49
Information Sheet-3 51
Self-check-3 63
LO#4 Implement chemical use program 65
Instruction sheet: 65
Information Sheet-4 67
Self-check-4 104
Operation sheet 4 105
LAP Test 106
LO#5 Ensure the correct selection and application of chemicals 107
Instruction sheet: 107
Information Sheet-5 109
Self-check-5 128
Operation sheet 5 129
LAP Test 130
LO#6 Coordinate contingency plan and document reports 131
Instruction sheet: 131

Information Sheet-6 133
Self-check-6 152
Reference 153

Introduction to the module

This unit competency knowledge, skills and attitude required to Plan and perform field surveillance for a specific Pest, implement pest management action plan, identify resources for pest management, Plan and apply cultural methods of crop pest management, Plan and implement chemical use program, ensure the correct selection and application of the chemical, Coordinate activities, Prepare Reports and document the data.

LG #27	LO#1 Plan to perform field surveillance for a specific Pest

Instruction sheet:

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

- Recognizing signs or symptoms for *crop pests*
- Collecting, handling, packaging and dispatching diagnostic samples according to relevant standards and protocols.
- Identifying appropriate measures to manage pest out break
- Collecting and reporting relevant information to management of plant pest outbreak to surveillance coordinator

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:

- Recognize signs or symptoms for crop pests
- Collect, handle, package and dispatch diagnostic samples according to relevant standards and protocols.
- Identify appropriate measures to manage pest out break
- Collect and report relevant information to management of plant pest outbreak to surveillance coordinator

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

Information Sheet-1

1.1. Recognizing signs or symptoms for crop pests.

Definition

Surveillance: An official process which collects and records data on pest occurrence or absence by survey, monitoring or other procedures. Pest surveillance involves: looking for and recording the presence, absence, distribution and population levels of a pest; is conducted over a period of time or in a scientific manner.

Most plant diseases – around 85% – 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)

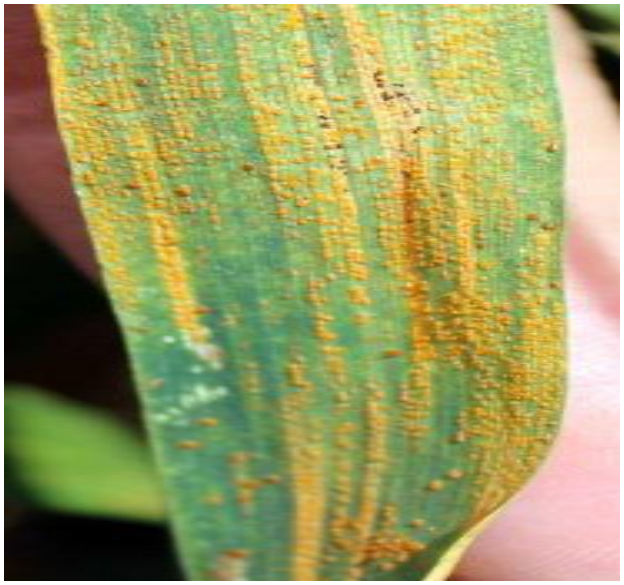


Figure 1.1 Stripe rust pustules on a winter wheat leaf is a symptom. Photo by Fred Springborn, MSU Extension.

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

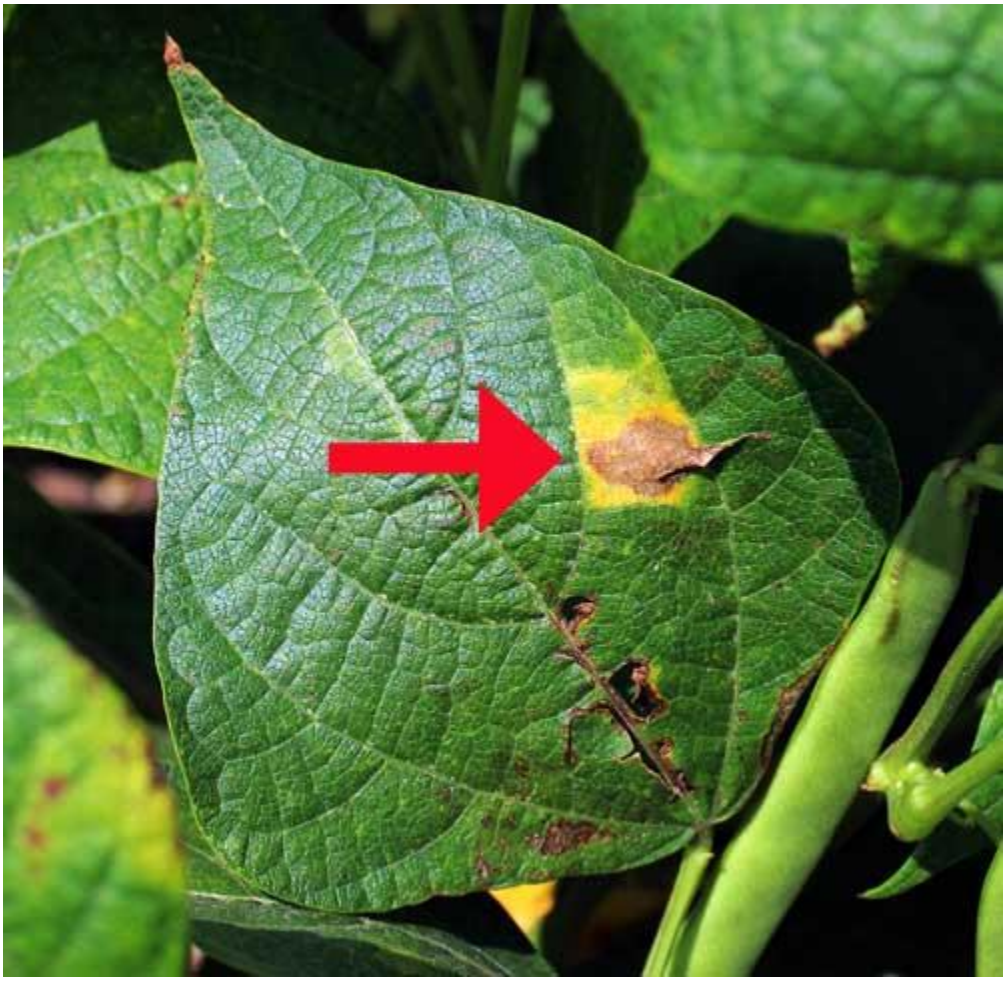


Figure 1.2 Dark red kidney bean leaf showing bacterial leaf spot symptom (brown leaf spot with yellow halo). Photo by Fred Spring born, MSU Extension.

Viral disease signs:

- None – the viruses themselves can't be seen

Viral disease symptoms:

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

Note: You can see that there is a lot of overlap between fungal, bacterial and viral disease symptoms. Also, abiotic diseases, herbicide injury and nematode problems must be considered possibilities when an unknown plant problem appears. These lists are **not** complete or exhaustive, only examples.

Table 1.1 Common Signs and Symptoms on Plants Damaged by Pest Insects, Mites, Slugs, and Snails (Arthropods) and the Probable Causes

Symptoms	Causes
arthropod by-products	• cast skins (translucent or whitish): aphids, leafhoppers, lace bugs, spider mites • dark fecal specks: lace bugs, leaf miner adults, plant bugs, shore fly adults, thrips • flocculence (cottony, waxy material): adelgids, certain aphids, lerp psyllids, mealybugs,

Symptoms	Causes
	certain scale insects, whiteflies • large excrement (frass) particles: caterpillars, leaf beetles • pale foam or spittle: spittlebugs • pitch masses: larvae of certain moths e.g., Sequoia pitch moth • pitch tubes: certain bark beetles (Scolytinae) • shiny trails or slime: fungus gnat larvae, slugs, snails • silken mats, tents, or webs or rolled leaves: leafrollers, tent caterpillars, webworms • sticky honeydew and blackish sooty mold: aphids, mealybugs, psyllids, soft scales, whiteflies
bleached, bronzed, stippled, or yellowed foliage	• eriophyid mites e.g., blister, bud, erineum, gall, or rust mites • lace bugs • leafhoppers • plant bugs • spider mites • thrips

Symptoms	Causes
Chewed or tattered blossoms or foliage	• adults and larvae of leaf-feeding beetles • crickets, grasshoppers, or katydids • larvae (caterpillars) of butterflies and moths (Lepidoptera) e.g., armyworms, cabbage looper, cutworms, diamondback moth, European pepper moth (Dufo moth) • larvae of sawflies (broad-waisted wasps) e.g., rose slugs • leafcutting bees, which are important pollinators and should not be killed. Where these bees have been collecting material for their nests covering those plants with cheesecloth or other screening prevents further damage. Place out these barriers when leaf cutting is first observed or the time of year (late winter or spring) when damage first occurred during previous seasons. Barriers can be removed about midsummer when the mother bees are no longer active. • snails or slugs e.g., brown garden snail

Symptoms	Causes
dieback of plant parts	• armored scales • gall wasps • katydids • larvae of boring beetles or moths • sharpshooters (large leafhoppers) • weevils
distortion of plant parts	• aphids • eriophyid or tarsonemid mites e.g., broad, cyclamen, blister, bud, erineum, gall, or rust mites • gall wasps • larvae of certain moths • lygus bugs or stink bugs • other true bugs (Heteroptera) • psyllids • thrips
foliage	• larvae of certain flies, moths, or sawflies (broad-waisted wasps)

Symptoms	Causes
mines	
holes in stems, bark or twigs	• adult beetles e.g., bark beetles, flatheaded borers, longhorned beetles • larvae of boring beetles or caterpillars (e.g., clearwing moths) feeding hidden in plants
Adapted from *Container Nursery Production and Business Management Manual*, UC ANR Publ. 3540	

1.2. Collecting, handling, packaging and dispatching diagnostic samples according to relevant standards and protocols

Collecting, handling, packaging and dispatching diagnostic samples of crops are important steps to ensure the quality and reliability of plant analysis. Plant analysis is a method of assessing the nutritional status and health of crops by measuring the concentration of nutrients and other substances in plant tissues. Plant analysis can be used for various purposes, such as diagnosing nutrient deficiencies or toxicities, monitoring fertilizer programs, evaluating crop performance, and researching plant physiology.

Different crops may have different sampling methods, depending on the stage of growth, the plant part, and the number of plants to sample. However, these methods may vary depending on the specific objectives and protocols of the plant analysis program. Therefore, it is advisable to consult with the laboratory or the extension service before collecting samples

1.2.1. Collecting diagnostic samples according to relevant standards and protocols

Collecting diagnostic diseased crop samples is an important step in identifying the cause of crop damage. The first step is to identify the symptoms of the disease and select plant material showing the symptoms you are actually concerned about [3]. If possible, also bring in a healthy sample to compare it to [3]. For small plants, bring all parts of the plant, including roots when possible. Enclose the roots and soil in a plastic bag.

It is important to gather the best plant samples possible and to record all pertinent background information for the diagnostician. Examine the entire plant for symptoms. Diseased plants generally have been infected by one or more pathogenic microorganisms, although they may also have an abiotic disease that does not involve a plant pathogen. Plants affected often display a range of symptoms visual signs of the infection. Often, not all symptoms of a particular disease will appear on any one plant within a diseased crop, and more than one plant organ may be affected by a given disease. Examine all of the main plant organs for disease symptoms: roots, stems, leaves, and blossoms. Collect samples from various plant organs as needed. Plants may suffer from more than one disease simultaneously. Segregate different types of symptoms into different samples. Collect several plant specimens.

A single plant sample may not be enough to allow a correct diagnosis of the problem; several plant samples showing the range of symptoms may be needed. If possible, select samples with various stages of disease development (early and late stages). Samples should be as typical or representative of the overall problem as possible. The best plant tissues for diagnosis are the ones showing the symptoms in various stages of disease development, and adequate amounts of them are important, but submitting excessive amounts of leaves or soil should be avoided. Do not collect dead plants or plant organs. Dead plants or plant organs may not be useful for diagnosis. Often their tissues have been invaded by decomposing fungi and bacteria and the original

pathogens are no longer detectable. Always select plant samples from living tissues and focus your attention on plants or plant organs that are still alive

Some general principles for collecting samples are:

- Sample only representative plants that are damaged, diseased, stressed, or abnormal.
- Sample the same plant part and at the same stage of growth for all plants in a sample.
- Collect enough plant material to meet the laboratory requirements, usually about 200-500 g of fresh weight.
- Use clean and appropriate tools and containers, such as scissors, knives, paper bags, or plastic bags, depending on the type of sample and the analysis to be performed.
- Label each sample clearly and accurately, indicating the crop, the field, the date, and any other relevant information.
- Keep the samples cool and dry, avoiding exposure to heat, light, or moisture, which may affect the quality of the samples.
- Send the samples to the laboratory as soon as possible, preferably within 24 hours of collection, or store them in a refrigerator or freezer until shipment.

1.2.2. Handling diagnostic samples according to relevant standards and protocols

The principle of handling diagnostic samples according to relevant standards and protocols is to ensure the quality and reliability of the laboratory testing process and the accuracy of the test results. This involves proper collection, labeling, transportation, storage, and disposal of samples, as well as adherence to safety and ethical guidelines.

Some of the key aspects of sample management are:

- Using appropriate containers and collection supplies for different types of samples

- Labeling samples with clear and accurate information, such as patient name, identification number, date and time of collection, type of sample, and tests requested
- Transporting samples to the laboratory as soon as possible, using suitable packaging and temperature conditions
- Storing samples in the laboratory according to their stability and testing requirements, and using the first in–first out (FIFO) principle
- Disposing of samples and waste materials in a safe and environmentally friendly manner, following the local regulations and policies
- Following the standard precautions and personal protective equipment (PPE) to prevent exposure to infectious agents or hazardous substances
- Respecting the confidentiality and privacy of the patients and their test results
- By following these principles, the laboratory can ensure the validity and integrity of the samples, and provide accurate and timely diagnosis and treatment for the patients.

1.2.3. Packaging and dispatching diagnostic samples according to relevant standards

Packaging and dispatching samples should follow the laboratory instructions and the regulations for transporting biological materials.

Some general guidelines are:

- Use sturdy and leak-proof containers, such as plastic bags, bottles, or tubes, to hold the samples, and seal them properly.
- Use absorbent materials, such as paper towels or cotton, to wrap the samples and prevent leakage.
- Use cushioning materials, such as bubble wrap or foam, to protect the samples from damage during transit.

- Use secondary containers, such as cardboard boxes or coolers, to hold the primary containers, and secure them with tape or straps.
- Use labels, stickers, or symbols to indicate the nature and contents of the samples, such as “Biological Substance, Category B”, “Diagnostic Specimen”, or “UN 3373”.
- Use appropriate temperature control, such as ice packs or dry ice, to maintain the samples at the required temperature, usually between 2°C and 8°C, or below -20°C for frozen samples.
- Use tracking and delivery confirmation services to monitor the shipment and ensure timely delivery of the samples to the laboratory.

1.3. Identifying appropriate measures to manage pest outbreak

What is an Insect Pest Outbreak?

An insect pest outbreak is a large and sporadic population of insect pests. They occur when the pest population rises significantly above its general equilibrium level and becomes a threat to human interests and endeavors. Four common scenarios lead to insect pest outbreaks:

- Environmental change – Insect populations have a large gene pool and a high reproductive rate which allows them to adapt and exploit changing conditions in the natural environment. Changes in climate, habitat, or community structure may provide an insect population with a reproductive opportunity that enables a rapid increase in population. Monoculture cultivation of crops and housing of livestock in modern rearing facilities are common practices in the US that lead to periodic insect outbreaks.
- Introduction from abroad – International travel and trade is an opportunity for the spread of insects from one part of the world to another. In their new niche, the insects will take the absence of parasites and predators as an opportunity to increase their population and outcompete or displace native insects.

- Destruction of natural enemies – Pest populations can reach outbreak levels if their parasites and predators are suppressed or eradicated. When pesticides are used to control a pest population, they may kill or repel beneficial insects. Thereafter, when the effects of the pesticide wear off, resurgence in the pest population may lead to an insect outbreak.
- Development of resistance – Insect pests can develop resistance to the control tactic being used, which is usually insecticide. Unless the control tactic is varied, the insect population may reach outbreak proportions quickly.

How can an insect outbreak be prevented?

An orderly process of decision-making must be used when devising insect control plans, especially when attempting to manage a new and unfamiliar insect problem.

The steps of insect outbreak prevention are:

- **Detection** – Keeping a watchful eye for insects that are likely to be troublesome is an important first step. Early detection of an insect infestation helps prevent irreparable damage before it is too late.
- **Identification** – Accurate identification of an insect is necessary for control measures to be effective. Misidentification may impair control and lead to an insect outbreak.
- **Biology and habits** – Knowledge of seasonal life cycle attributes of an insect pest within a habitat is important to pinpoint the most effective time for treatment. By understanding the biology of the insect pest, the insect's life cycle's most vulnerable stages can be determined which will help direct the control effort to obtain the most effective and economical control.
- **Economic significance** – Before control efforts are initiated, a reasonable determination must be made whether it is necessary to control the targeted insect pest. There needs to be a return on the investment in controlling the insect pest.

- **Selection of control method** – The proper method or combination of methods should be selected to provide effective, practical, economical, and safe control of the insect pest. **Control methods** include:
  - ✓ Cultural control – e.g., use of crop rotation, tillage methods, and resistant or tolerant varieties.
  - ✓ Mechanical control – e.g., use of screens, traps, light, and sound.
  - ✓ Biological control – e.g., use of parasites, predators, diseases, male sterility, temperature, and moisture.
  - ✓ Chemical – e.g., use of insecticides and other chemical compounds that kill, repel, attract, and disrupt the growth and development of insects.
  - ✓ Integrated control – using a combination of all possible compatible techniques to manage insect populations at sub-economic levels, e.g. using an artificial or natural biological method in combination with a selective chemical and cultural control method.
- **Application** – The control methods selected must be applied appropriately and timely to be effective and safe. If chemicals are applied, the applicator must read and follow the instructions on the labels of all chemicals used. Applying insecticide with an adjuvant to increase control efficacy.
- **Evaluation**–An important step in insect control is determining whether the control operation was successful. This can be accomplished by making comparisons of before and after treatments were applied. For example, using insect counts and comparative damage ratings.
- **Recording**–A record of insect management provides a basis to gain from past experiences.

If the insect pest is well-known, some of the preceding steps can be skipped.

Managing insect outbreaks requires proper planning and control of insect pests once they are detected and properly identified.

1.4. Collecting and reporting relevant information to management of plant pest outbreak to surveillance coordinator

Collecting and reporting relevant information to management of plant pest outbreak to surveillance coordinator is an important part of pest management. The International Plant Protection Convention (IPPC) provides guidelines on plant pest surveillance that support diagnostic decisions by showing relationships between common symptoms on plants and the various possible causes. This guide provides information to support the surveillance activities that national plant protection organizations (NPPOs) need to undertake as part of national phytosanitary systems and as obligations under the IPPC .

1.4.1 **Collecting relevant information to management of plant pest outbreak**

Collecting relevant information is an important step in managing plant pest outbreaks. The first step is to identify the pest and the symptoms. Use the PestSmart Diagnostic Field Guide to identify the pest and the symptoms. Monitor the pest population to determine if it is increasing or decreasing. Choose the appropriate control method based on the pest and the severity of the infestation. Some control methods include cultural control, biological control, and chemical control. Implement the chosen control method and monitor the results.

Here are some additional resources that can help you manage plant pest outbreaks:

- Strategies to manage tree pest and disease outbreaks: This article provides information on effective prevention and mitigation strategies for tree diseases [3].
- Training for pest and disease outbreak responses: This website provides training for various industries on how to respond to plant or animal pest or disease outbreaks [4] .
- Database contributes to synoptic review of plant disease epidemics: This article provides information on open access tools and resources to support pest management.

- Funding call: Tackling outbreaks of plant pests: This website provides information on funding opportunities for research on plant pest outbreaks.

It is important to note that the use of pesticides should be a last resort and should be used only when necessary. Overuse of pesticides can lead to the development of pesticide-resistant pests and can harm beneficial insects. If you are handling pesticides, it is important to follow the instructions on the label and wear protective clothing. If you experience symptoms of poisoning, seek medical attention immediately.

1.4.2. Reporting relevant information to management of plant pest outbreak to surveillance coordinator

Reporting relevant information to the management of plant pest outbreaks is crucial for effective pest management. The first step is to identify the pest and the symptoms. Use the PestSmart Diagnostic Field Guide to identify the pest and the symptoms [1]. Monitor the pest population to determine if it is increasing or decreasing [2]. Choose the appropriate control method based on the pest and the severity of the infestation. Some control methods include cultural control, biological control, and chemical control Implement the chosen control method and monitor the results.

Here are some additional resources that can help you report relevant information to the management of plant pest outbreaks:

- **Plant Pest Surveillance Guide**: This guide provides information to support the surveillance activities that national plant protection organizations (NPPOs) need to undertake as part of national phytosanitary systems and as obligations under the International Plant Protection Convention (IPPC)

- **Carry out field surveillance for a specific emergency disease or plant pest**: This training program provides information on how to carry out field surveillance for a specific emergency disease or plant pest
- **IPPC Technical Resources Plant Pest Surveillance**: This website provides technical resources on plant pest surveillance operations, technical support, and management support [3].

It is important to note that the use of pesticides should be a last resort and should be used only when necessary. Overuse of pesticides can lead to the development of pesticide-resistant pests and can harm beneficial insects. If you are handling pesticides, it is important to follow the instructions on the label and wear protective clothing. If you experience symptoms of poisoning, seek medical attention immediately.

https://www.youtube.com/watch?v=T3S2PZ8s8T8

Self-check-1	Written test

Part I: Write true if the statement is correct or false if the statement is incorrect

1. Plant analysis is a method of assessing the nutritional status and health of crops by measuring the concentration of nutrients and other substances in plant tissues.
2. An insect pest outbreak is a large and sporadic population of insect pests.
3. Knowledge of seasonal life cycle attributes of an insect pest within a habitat is important to pinpoint the most effective time for treatment.
4. The proper pest control method or combination of methods should be selected to provide effective, practical, economical, and safe control of the insect pest
5. Water-soaked lesions are one of the fungal sign.

Part II: Choose the correct answers from the given alternatives

1. Which one is not Viral disease symptom:
   A. Mosaic leaf pattern B. Crinkled leaves C. Yellowed leaves D. Canker
2. Which one is Fungal disease sign? A. Leaf rust B. Stem rust C. Powdery mildew D. All
3. A visible effect of disease on the plant is: A. symptom B. Sign C. Disease D. None

Part III. Give short answers for the following questions

1. Define Surveillance
2. Write the sign and symptoms of fungal diseases?
3. List and explain the pest control measures?
4. What are the four common scenarios lead to insect pest outbreaks?
5. Write the steps of insect outbreak prevention?

LG #28	LO#2 Identify pest management options and prepare action plan

Instruction sheet:

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

- Identifying resources, personals, machineries, materials and tools to carry out crop pest management's activities
- Identifying Crop pest management options
- Consulting Relevant stakeholders regarding the scheduling of activities
- Scheduling and planning pest management activities in consideration with pest management strategy, community attitudes, and in accordance with relevant legislations and regulations
- Checking Materials and Personal protective equipment for compliance with OHS standards
- Selecting and scheduling monitoring and measurement activities to comply with the crop pests

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:

- Identifying resources, personals, machineries, materials and tools to carry out crop pest management's activities
- Identify Crop pest management options
- Consult Relevant stakeholders regarding the scheduling of activities
- Schedule and plan pest management activities in consideration with pest management strategy, community attitudes, and in accordance with relevant legislations and regulations

• Check Materials and Personal protective equipment for compliance with OHS standards • Select and schedule, monitoring and measurement activities to comply with the crop pests
Learning Instructions:
5. Read the specific objectives of this Learning Guide. **6.** Follow the instructions described below. **7.** Read the information written in the information Sheets **8.** Accomplish the Self-checks

Information Sheet-2

2.1. Identifying resources, personals, machineries, materials and tools to carry out crop pest management's activities

To carry out crop pest management activities, you need various resources, personnel, machinery, materials, and tools. Some examples are:

- **Resources**: These are the inputs or assets that are needed to support the pest management plan, such as land, water, energy, money, information, etc. For example, you may need to access reliable sources of water for irrigation, or to budget for the costs of pest control methods.
- **Personnel**: These are the people who are involved in the pest management plan, such as farmers, workers, technicians, consultants, extension agents, researchers, etc. For example, you may need to hire skilled workers to operate the machinery, or to consult with experts to diagnose and identify the pests.
- **Machinery**: These are the machines or equipment that are used to perform the pest management tasks, such as tractors, plows, cultivators, sprayers, harvesters, etc. For example, you may need to use a tractor to prepare the soil, or a sprayer to apply pesticides.
- **Materials**: These are the substances or products that are used to prevent, control, or eradicate the pests, such as seeds, fertilizers, pesticides, bio control agents, etc. For example, you may need to use resistant or tolerant varieties of seeds, or organic or synthetic pesticides.
- **Tools**: These are the instruments or devices that are used to assist the pest management tasks, such as hand tools, measuring tools, diagnostic tools, etc. For example, you may need to use a hoe to weed, a thermometer to measure the temperature, or a magnifying glass to observe the pests.

Creating an action plan for pest management involves identifying suitable pest management options and developing a systematic approach to control and mitigate the impact of pests.

Here's a step-by-step guide to help you prepare an action plan:

- **Assessment and Identification:**
  - ✓ **Identify the Pest:**- Determine the specific pest species causing the problem. Consider consulting with entomologists or pest management experts for accurate identification.
  - ✓ **Assess Severity:**- Evaluate the severity of the infestation. Consider the extent of damage, the affected area, and the potential for the pest to spread.
- **Integrated Pest Management (IPM) Strategies:**
  https://www.youtube.com/watch?v=Uo05345F1C8
  - ✓ **Biological Control**:- Explore the use of natural predators, parasites, or pathogens that can control the pest population.
  - ✓ **Cultural Control:**- Implement cultural practices such as crop rotation, selecting resistant varieties, adjusting planting dates, and optimizing irrigation to disrupt the pest's life cycle.
  - ✓ **Mechanical and Physical Control:**- Use physical barriers, traps, or manual removal methods to reduce pest populations.
  - ✓ **Chemical Control:**- If necessary, consider the judicious use of pesticides. Select the appropriate chemical based on the identified pest, and follow recommended guidelines to minimize environmental impact.
- **Environmental Management:**
  - ✓ **Habitat Modification:**- Modify the environment to make it less conducive to the pest. This could include altering temperature, humidity, or other factors that affect the pest's life cycle.
- **Preserve Beneficial Species:**- Promote the presence of natural enemies or beneficial organisms that can help control the pest population.
- **Quarantine Measures:**
  - ✓ **Isolate Infested Areas:**- Implement quarantine measures to prevent the spread of pests to uninfected areas.
  - ✓ **Inspect and Regulate Movement:**- Inspect and regulate the movement of plants, soil, or other materials that could harbour pests.

- **Communication and Education:**
  - ✓ **Stakeholder Engagement:** - Engage with farmers, community members, and relevant stakeholders. Provide education on pest identification, monitoring, and control measures.
  - ✓ **Early Reporting: -** Encourage early reporting of pest sightings to facilitate rapid response.
- **Monitoring and Evaluation:**
  - ✓ **Establish Monitoring Protocols: -** Implement monitoring systems to track pest populations and assess the effectiveness of control measures.
  - ✓ **Regular Surveillance:-** Conduct regular surveillance to detect any resurgence of pest populations or the emergence of new pest threats.
- **Emergency Response:**
  - ✓ **Develop Emergency Protocols**: - Prepare protocols for emergency responses in case of sudden outbreaks or unexpected developments.
  - ✓ **Coordination with Authorities: -** Coordinate with relevant authorities for assistance, resources, or guidance during emergency situations.
- **Documentation:**
  - ✓ **Keep Detailed Records**: - Maintain detailed records of pest management activities, including the types and quantities of control measures used, monitoring results, and outcomes.
  - ✓ **Document Lessons Learned: -** Document lessons learned and successes to improve future pest management strategies.
- **Budget and Resource Allocation:**
  - ✓ **Budget Planning:-** Develop a budget for pest management activities, considering the cost of materials, labour, and other resources.
  - ✓ **Allocate Resources: -** Allocate resources effectively to ensure that all aspects of the action plan are adequately addressed.
- **Regular Review and Adjustments:**

- ✓ **Review Action Plan:-** Periodically review the action plan to assess its effectiveness and identify areas for improvement.
- ✓ **Adapt Strategies:-** Adjust pest management strategies based on new information, changing pest dynamics, or the introduction of new technologies.

- **Communication with Management:**
  - ✓ **Regular Reporting**:- Establish a reporting schedule to keep management informed about pest management activities, progress, and outcomes.
  - ✓ **Summarize Key Findings:-** Provide regular summaries of key findings, including the impact of pest control measures on crop health and yields.

By following these steps, you can develop a comprehensive action plan for pest management that addresses the specific challenges posed by the identified pest, promotes sustainable practices, and allows for adaptability in response to changing conditions.

2.2. Identifying Crop pest management options

Definitions

Pest: In the context of agriculture and crop management, a pest is an organism, typically an animal or plant that poses a threat to the health and well-being of crops. Pests can cause damage by feeding on crops, transmitting diseases, or competing with plants for nutrients and resources. They are considered undesirable and can lead to reduced crop yields, economic losses, and other negative impacts on agricultural production.

Weeds: Unwanted plants that grow alongside cultivated crops, competing for water, nutrients, and sunlight.

Crop: A crop is a cultivated plant or agricultural produce that is grown and harvested for food, feed, fiber, medicinal purposes, or other uses. Crops are a fundamental component of agriculture and play a

crucial role in meeting the dietary, economic, and industrial needs of human societies. The cultivation of crops involves the intentional planting, nurturing, and harvesting of specific plants, and it is a key activity in modern and traditional farming systems.

Pests in a garden or landscape may include insects, mites, weeds, plant diseases, mammals, and birds. It is not possible—or even desirable—to rid gardens of all pests. Monitoring and managing pest levels instead of eliminating pests can preserve the environment, reduce costs, protect the health of humans and animals, and maintain beneficial organisms such as birds, bees, butterflies, predaceous bugs, and other pollinators. This topic discusses integrated pest management (IPM), an approach that uses knowledge about pests and their life cycles, cultural practices, non-chemical methods, and pesticides to manage pest problems.

Integrated pest management was first suggested by entomologists because insects were the first group of pests to prove difficult to manage with chemicals alone. Early proponents of IPM suggested using five basic strategies to improve insect management:

Step1. Monitor and scout insects to determine insect types and population levels.

Step2. Identify pest and host accurately.

Step3. Assess and consider economic or aesthetic injury thresholds. A threshold is the point at which action should be taken.

Step4. Implement a treatment strategy using mechanical, cultural, biological, or chemical controls, or a combination of these strategies.

Step5. Evaluate success of treatments.

IPM has extended beyond insects to management of all pest populations: weeds, disease organisms, and mammals. Integrated pest management regulates pests by using a variety of control measures, including mechanical, cultural, biological, and chemical. Management rather than eradication of pests is the goal.

An IPM plan begins with a careful evaluation of each pest infestation. Only then can one decide about the appropriate tactics necessary to suppress pest activities. The life cycle of the pest, possible damage, natural enemies, and effects of weather, among other factors, are considered before a control plan is implemented. For example, weeds like Queen Anne's lace (Daucus carota) or London rocket (Sisymbrium irio) can harbor beneficial insects such as lacewing or lady beetle larvae that help keep aphid and other pest populations at acceptable levels.

Clover growing in a lawn may be viewed as an unwanted weed, but as a legume it is synthesizing nitrogen for the soil and the flowers are providing nectar to honey bees and other pollinators. Tolerance for some weeds may be part of an IPM plan. Caterpillars may be eating the leaves of a plant, but when they are identified as the larvae of Eastern tiger swallowtail butterflies, their damage may be tolerated so we can enjoy the beautiful butterfly. A woodpecker may be putting holes in the trunk of a peach tree, but at the same time it is eating insect larvae that may do more damage to the tree.

- **Cultural Management**

Keeping plants healthy and preventing plant stress helps plants to better withstand and repair the damage caused by an insect or mite pest. Some evidence indicates that healthy plants resist infestation by pests better than plants with low vigor. The most effective and most important of all practices is to observe what is going on in the garden. Many serious disease or insect problems can be halted or slowed by regularly visiting the garden, knowing what to look for, recognizing potential problems, and intervening early. Cultural methods of suppressing insect and mite problems in the landscape include preparing the soil; choosing plants that are adapted to the site conditions, that are not attractive to pests, and that are tolerant of insects and diseases; rotating crops; inter-planting; timing planting dates to avoid pests; managing weeds; and planting trap crops.

- ✓ **Crop Rotation:** - Rotate crops to disrupt the life cycle of pests that are specific to certain plants.

- ✓ **Polyculture:-** Grow multiple crops in proximity to reduce pest vulnerability through biodiversity.
- ✓ **Trap Crops**:- Plant attractive crops to divert pests away from main crops, acting as a trap for the pests.

Limitations of Cultural Management

The use of cultural controls for pest management requires advanced planning on the gardener's part. Although it may sound simple to plant resistant landscape plants or vegetable varieties, these varieties must be located and purchased in advance.

In some cases, varieties may not be available locally but special orders can sometimes be placed at a nursery or ordered online.

Crop rotation is a valuable cultural method for reducing insect and disease issues, but many gardeners do not have the room to sufficiently implement this practice. Where space is limited, it may be best to allow the garden to lay fallow for a year or two or more. Consider raised beds with new soil or plant in containers when you know a disease problem exists. At the very least, skip growing the crops, and crop families, that have experienced pest issues.

Identifying crop pest management options is essential for maintaining healthy crops and ensuring optimal yields. Here are various pest management options that you can consider:

- **Biological Control:**
  - ✓ **Predators and Parasitoids:-** Introduce or conserve natural enemies like ladybugs, predatory beetles, parasitic wasps, or nematodes that feed on pests.
  - ✓ **Microbial Control:-** Use microbial agents such as Bacillus thuringiensis (Bt) or beneficial fungi (e.g., Beauveria bassiana) to control specific pests.
- **Mechanical and Physical Control:**

- ✓ **Handpicking:**- Physically remove pests by hand from plants.
- ✓ **Barriers**:- Use physical barriers such as row covers or screens to prevent pests from reaching plants.
- ✓ **Traps**: - Deploy traps, such as sticky traps or pheromone traps, to capture pests.

- **Chemical Control:**
  - ✓ **Insecticides:** - Apply insecticides selectively and judiciously, considering their impact on non-target organisms and the environment.
  - ✓ **Herbicides**:- Use herbicides to control weeds that may serve as hosts for pests.
  - ✓ **Fungicides**: - Apply fungicides to control fungal diseases that can affect crops.
- **Genetic Control:**
  - ✓ **Resistant Varieties** - Develop or plant crop varieties that are genetically resistant or tolerant to specific pests.
  - ✓ **Genetically Modified (GM) Crops:** - Use genetically modified crops with built-in pest resistance.
- **Environmental Management:**
  - ✓ **Irrigation Management:** - Optimize irrigation practices to discourage water-loving pests.
  - ✓ **Temperature and Humidity Control:**- Adjust environmental conditions to make them less favorable for pests.
- **Organic Farming Practices:**
  - ✓ **Neem Oil and Botanicals:** - Use neem oil or botanical extracts as natural pesticides.
  - ✓ **Companion Planting:**- Plant crops that repel pests or attract beneficial insects.
- **Trained Natural Enemies:**
  - ✓ **Biological Augmentation:**- Introduce and manage populations of natural enemies for sustained pest control.
  - ✓ **Using Birds and Predatory Insects:**- Encourage the presence of birds and predatory insects that feed on pests.

- **Quarantine and Sanitation:**
  - ✓ **Quarantine Measures:** - Implement measures to prevent the introduction or spread of pests through contaminated tools, equipment, or plant material.
  - ✓ **Crop Residue Management:**- Remove and properly dispose of crop residues to reduce overwintering sites for pests.
- **Precision Agriculture:**
  - ✓ **Remote Sensing:** - Use technology such as drones and satellite imagery for early detection of pest infestations.
  - ✓ **Variable Rate Technology:**- Apply pest control measures at variable rates based on real-time data.
- **Community and Farmer Education:**
  - ✓ **Integrated Pest Management (IPM) Training:** - Educate farmers on IPM principles, pest identification, and environmentally friendly pest control methods.
  - ✓ **Early Reporting Systems:**- Encourage farmers to report pest sightings promptly for timely intervention.
- **Monitoring and Surveillance:**
  - ✓ **Regular Field Inspections:** - Conduct routine field inspections to monitor pest populations and identify signs of infestation.
  - ✓ **Pheromone Traps:** - Use pheromone traps for monitoring and capturing specific pests.
- **Post-Harvest Management:**
  - ✓ **Proper Storage:** - Ensure proper storage conditions to prevent post-harvest pest infestations.
  - ✓ **Integrated Pest Management (IPM) in Storage:**- Implement IPM practices in storage facilities to control pests after harvest.
- **Regulatory Measures:**
  - ✓ **Compliance with Regulations:** - Adhere to regulatory measures regarding the use of pesticides and other pest control methods.

- ✓ **Quarantine Enforcement:-** Collaborate with regulatory agencies to enforce quarantine measures.

When developing a pest management plan, it's crucial to consider the specific characteristics of the pest, the crop, and the local environment. A holistic and integrated approach that combines several of these options is often the most effective in sustaining crop health and minimizing environmental impact. Regular monitoring and adaptability are key components of successful pest management.

https://www.youtube.com/watch?v=AVSs-EkYTCo

2.3. Consulting Relevant stakeholders regarding the scheduling of activities

What is a stakeholder?

Stakeholders are groups who have an interest in an organization's work, and to whom the organization has an ethical duty. Association stakeholders include members, employees, related organizations, potential partners, suppliers, the public, regulatory bodies, and the government. Not-for-profits and the voluntary sector may also add clients, community groups, community leaders, volunteers, funders and donors to this list while in the business world; customers and owners are also included as key stakeholders.

Whether your organization is working on a strategic plan, policy development, or creating a new program, consulting with key stakeholders is an important factor in achieving ultimate success.

Some information and tips on how to consult relevant stakeholders regarding the scheduling of pest control activities.

According to the Department of Agriculture and Fisheries, you should consider asking pest management experts, such as Biosecurity Queensland or local government officers, and those who will be affected by the plan, for their input, ideas and opinions. You should also identify the objectives,

scope, and expected outcomes of your pest management plan, as well as the roles and responsibilities of the stakeholders involved.

Some of the benefits of consulting stakeholders are:

- You can gain valuable insights and feedback from different perspectives and experiences
- You can build trust and collaboration among the stakeholders and foster a sense of ownership and commitment to the plan
- You can avoid potential conflicts and misunderstandings that may arise from lack of communication or consultation
- You can increase the effectiveness and efficiency of your pest management plan by aligning it with the needs and expectations of the stakeholders

Some of the challenges of consulting stakeholders are:

- You may encounter different or conflicting interests, opinions, or agendas among the stakeholders
- You may have to deal with a large number of stakeholders with diverse backgrounds, knowledge, and skills
- You may have to balance the time, cost, and resources required for consultation with the urgency and feasibility of the plan
- You may have to manage the expectations and satisfaction of the stakeholders and ensure that they are adequately informed and involved throughout the process

Some of the best practices for consulting stakeholders are:

- Identify and prioritize the key stakeholders and their level of influence and interest in the plan

- Develop a stakeholder engagement strategy that outlines the purpose, methods, frequency, and outcomes of the consultation
- Use appropriate and effective communication tools and channels, such as meetings, webinars, surveys, or social media, to reach out to the stakeholders and solicit their input
- Provide clear and concise information and guidance to the stakeholders and explain the rationale and benefits of the plan
- Acknowledge and address the concerns and issues raised by the stakeholders and incorporate their feedback into the plan
- Monitor and evaluate the consultation process and its impact on the plan and the stakeholders
- Report back to the stakeholders on the progress and results of the plan and thank them for their participation and contribution.

2.4. Scheduling and planning pest management with relevant legislations and regulations

Scheduling and planning pest management activities in consideration with pest management strategy, community attitudes, and in accordance with relevant legislations and regulations is an important part of pest management. The International Plant Protection Convention (IPPC) provides guidelines on plant pest surveillance that support diagnostic decisions by showing relationships between common symptoms on plants and the various possible causes . This guide provides information to support the surveillance activities that national plant protection organizations (NPPOs) need to undertake as part of national phytosanitary systems and as obligations under the IPPC .

The guidelines emphasize the importance of organizational arrangements, national legislation, funding and sustainability, management, human resources, and training. The guidelines also provide information on surveillance approaches and application, specific surveillance, and engagement mechanisms.

To schedule and plan pest management activities in consideration with pest management strategy, community attitudes, and in accordance with relevant legislations and regulations, it is important to follow the guidelines provided by the IPPC. The guidelines provide information on how to establish a plant pest surveillance program, including planning, conducting, reporting, auditing, and verifying a plant pest surveillance program. The guidelines also provide technical support for plant pest diagnostics, surveillance tools, information management, laboratory procedures, and diagnostics.

Scheduling and planning pest management activities involve a comprehensive approach that considers various factors, including the chosen pest management strategy, community attitudes, and adherence to relevant legislations and regulations.

Here's a guide on how to effectively schedule and plan pest management activities in consideration of these factors:

- **Understand Pest Management Strategy:**
  - ✓ **Identify Pest Species:** - Clearly identify the pest species you are targeting. Different pests may require different management strategies.
  - ✓ **Choose Pest Management Methods:-** Select appropriate pest management methods, considering integrated pest management (IPM) principles. This may involve biological, cultural, physical, and chemical control methods.
  - ✓ **Consider Environmental Impact:** - Evaluate the environmental impact of chosen methods and prioritize strategies that minimize harm to non-target species and ecosystems.
- **Community Engagement and Attitudes:**
  - ✓ **Community Outreach:** - Engage with the local community through outreach programs, workshops, or informational campaigns to raise awareness about the pest issue and the chosen management strategy.

- ✓ **Assess Community Attitudes:-** Understand community attitudes toward pest management. Consider factors such as cultural preferences, concerns, and potential conflicts with proposed strategies.
- ✓ **Address Concerns and Provide Information:-** Address community concerns by providing transparent and accurate information about the chosen pest management strategy, its benefits, and potential risks.

- **Legal and Regulatory Compliance:**
  - ✓ **Know Applicable Laws and Regulations: -** Understand and comply with local, regional, and national laws and regulations related to pest management. This includes regulations on the use of pesticides, environmental protection, and public safety.
  - ✓ **Permitting Process:-** Determine if any permits or approvals are required for the chosen pest management activities. Initiate the permitting process as needed.
  - ✓ **Integrated Pest Management (IPM) Compliance:-** Ensure that the pest management plan aligns with integrated pest management (IPM) principles and any regulatory requirements related to sustainable pest control.
- **Scheduling Activities:**
  - ✓ **Consider Pest Life Cycle:-** Schedule activities based on the life cycle and behavior of the target pest. Timing is crucial for effective control.
  - ✓ **Weather Conditions:-** Consider weather conditions during the scheduling process, as they can impact the effectiveness of certain pest management methods, such as the application of pesticides.
  - ✓ **Prioritize High-Risk Areas:-** Prioritize activities in high-risk areas where pest infestations are likely to cause the most damage.
- **Resource Allocation:**
  - ✓ **Allocate Resources Wisely:-** Ensure that resources, including personnel, equipment, and materials, are allocated efficiently to support the scheduled activities.

- ✓ **Budget Planning:-** Develop a budget that accounts for the costs associated with the chosen pest management strategy and scheduled activities.

- **Monitoring and Evaluation:**
  - ✓ **Establish Monitoring Protocols:-** Set up monitoring protocols to assess the effectiveness of the pest management activities. Regularly evaluate and adjust the plan based on monitoring results.
  - ✓ **Data Collection:-** Collect data on pest populations, treatment outcomes, and any unintended consequences to inform future pest management decisions.
- **Communication and Reporting:**
  - ✓ **Communication Plan:-** Develop a communication plan to keep stakeholders, including the community and relevant authorities, informed about the scheduled pest management activities.
  - ✓ **Reporting:** Provide regular reports on the progress of pest management activities, highlighting key milestones, challenges, and outcomes.
- **Emergency Response Plan:**
  - ✓ **Develop Emergency Protocols:** Prepare emergency response protocols in case unexpected challenges or adverse effects arise during pest management activities.
  - ✓ **Stakeholder Communication During Emergencies:-** Establish communication channels to promptly inform stakeholders about any changes in the schedule due to emergencies or unforeseen circumstances.
- **Post-Activity Evaluation:**
  - ✓ **Evaluate Outcomes:** After completing scheduled activities, conduct a thorough evaluation to assess the outcomes, learn from the experience, and identify areas for improvement.
  - ✓ **Feedback from Stakeholders:** Seek feedback from stakeholders, including the community, to understand their perceptions of the pest management activities and address any concerns.

    By carefully considering the pest management strategy, community attitudes, and legal and regulatory requirements during the scheduling and planning process, you can develop a

comprehensive and sustainable approach to pest control that minimizes risks and maximizes effectiveness. Regular communication and collaboration with stakeholders are key elements for successful pest management in any community.

2.5. checking Materials and Personal protective equipment for compliance with OHS standards

OHS stands for Occupational Health and Safety, which refers to the set of rules, guidelines and measures for the prevention and control of occupational hazards to safeguard the workers' social and economic well-being as well as their physical safety and health. OHS standards are established and enforced by various authorities, such as the International Labor Organization (ILO), the International Organization for Standardization (ISO), and national governments.

Checking materials and personal protective equipment (PPE) for compliance with OHS standards is an important process to ensure that the workers are not exposed to unnecessary risks and hazards in their work environment.

The steps involved in this process are:

- Identify the potential hazards associated with the materials and PPE, such as flammability, toxicity, corrosiveness, electrical conductivity, etc.
- Assess the level of risk posed by the hazards, taking into account the frequency and duration of exposure, the severity of the consequences, and the availability of control measures.
- Select the appropriate materials and PPE that meet the OHS standards and requirements for the specific work activity and context, such as fire-resistant clothing, gloves, goggles, helmets, etc.
- Inspect the materials and PPE before use to ensure that they are in good condition and functioning properly, and replace or repair any defective or damaged items.
- Use the materials and PPE correctly and consistently, following the manufacturer's instructions and the employer's policies and procedures.

- Maintain the materials and PPE regularly, cleaning, storing and disposing of them as per the guidelines and regulations.
- Report any incidents, accidents or near-misses involving the materials and PPE to the supervisor or the OHS committee, and participate in any investigations or corrective actions.

By following these steps, the workers can reduce the likelihood and impact of occupational injuries, illnesses and incidents, and improve their health and safety performance.

2.6. selecting and scheduling Monitoring and measurement activities to comply with the crop pests

Definition

- **Crop pests** are any organisms that can cause damage to crop plants, such as insects, birds, rodents, monkeys, nematodes, etc.
- **Monitoring and measurement activities** are methods to assess the status and impact of crop pests, and to evaluate the effectiveness of pest management strategies.
- **Selecting and scheduling monitoring and measurement activities** to comply with the crop pests involves the following steps:
  - ✓ Identify the crop pests and their potential damage to the crops.
  - ✓ Determine the pest thresholds, which are the levels of pest infestation or damage that justify the use of pest control measures.[34]
  - ✓ Choose the appropriate monitoring and measurement techniques, such as visual inspection, trapping, sampling, counting, etc. Plan the frequency and timing of monitoring and measurement activities, based on the crop growth stage, pest life cycle, environmental conditions, and pest management objectives.[34]
  - ✓ Record and analyze the monitoring and measurement data, and use it to make informed decisions on pest management actions.

Selecting and scheduling monitoring and measurement activities is crucial for effective pest management in crops. These activities help track pest populations, assess the effectiveness of control measures, and make informed decisions to prevent and manage infestations.

Here's a guide on how to select and schedule monitoring and measurement activities for compliance with crop pest management:

- **Identify Target Pests:**
  - ✓ **Species Identification:-** Clearly identify the specific pests affecting the crops. Different pests may require different monitoring methods and control measures.
  - ✓ **Threshold Levels:-** Determine threshold levels for each pest species – the point at which action should be taken to prevent economic damage.
- **Select Monitoring Methods:**
  - ✓ **Visual Inspections:-** Regularly inspect crops visually to identify signs of pest presence, such as feeding damage, egg masses, or adult insects.
  - ✓ **Traps and Baits:-** Deploy traps and baits strategically to capture and monitor pest populations. This can include pheromone traps, sticky traps, or insect light traps.
  - ✓ **Biological Monitoring:-** Use biological indicators, such as beneficial insects or natural enemies of pests, to monitor pest populations.
  - ✓ **Remote Sensing Technology:-** Utilize remote sensing technologies, including drones or satellite imagery, to monitor large agricultural areas for signs of stress or pest infestations.
- **Define Monitoring Frequency:**
  - ✓ **Regular Schedule:-** Establish a regular monitoring schedule based on the pest's life cycle, seasonal patterns, and known periods of vulnerability.
  - ✓ **Integrate with Crop Stages: -** Integrate monitoring activities with critical crop stages, such as planting, flowering, and harvesting, to identify vulnerabilities and adjust pest management strategies accordingly.

- **Data Collection and Recording:**
  - ✓ **Standardized Data Collection:-** Standardize the methods for collecting data during monitoring activities to ensure consistency and reliability.
  - ✓ **Record Keeping:-** Maintain detailed records of monitoring activities, including the type and number of pests observed, their life stages, and the location within the crop.
- **Utilize Pest Models:**
  - ✓ **Degree-Day Models:-** Use degree-day models to predict pest development based on temperature accumulation. This helps in scheduling monitoring activities at critical times.
  - ✓ **Forecasting Tools:-** Leverage pest forecasting tools and models that integrate weather data and pest biology to predict potential outbreaks.
- **Adjust Monitoring Based on Risk:**
  - ✓ **Dynamic Monitoring: -** Implement dynamic monitoring protocols that can be adjusted based on factors such as weather conditions, historical pest data, or changes in cropping systems.
  - ✓ **Prioritize High-Risk Areas:-** Concentrate monitoring efforts in high-risk areas where pest infestations are more likely to occur.
- **Implement Early Warning Systems:**
  - ✓ **Set Action Thresholds: -** Establish action thresholds based on monitoring data to trigger early intervention before pest populations reach economically damaging levels.
  - ✓ **Rapid Response:-** Develop rapid response plans that outline specific actions to be taken when pest populations exceed predetermined thresholds.
- **Engage Stakeholders:**
  - ✓ **Training and Education: -** Train farmers and agricultural workers in pest identification and monitoring techniques. Encourage them to report unusual observations.
  - ✓ **Community Engagement:-** Foster community engagement by sharing monitoring results and involving stakeholders in decision-making processes.
- **Regular Review and Adaptation:**

- ✓ **Review Monitoring Protocols:-** Regularly review monitoring protocols to assess their effectiveness and make adjustments based on lessons learned and changing pest dynamics.
- ✓ **Adapt Strategies: -** Adapt pest management strategies based on the insights gained from monitoring activities to improve overall efficacy.

- **Compliance with Regulations:**
  - ✓ **Follow Legal Requirements:-** Ensure that monitoring activities comply with relevant regulations and pesticide application guidelines. Adhere to reporting requirements.
  - ✓ **Documentation for Audits:-** Maintain documentation of monitoring activities, data, and any actions taken to demonstrate compliance during audits or inspections.

By carefully selecting and scheduling monitoring and measurement activities, agricultural professionals can detect and manage pest issues in a timely and efficient manner, ultimately supporting sustainable crop production while minimizing the use of pesticides. Regular assessment and adaptation of monitoring strategies are key elements for successful pest management.

Self-check-2	Written test

Part I: Write true If the statements is correct or false statement is incorrect (2pts each)

1. Crop pests are any organisms that can cause damage to crop plants, such as insects, birds, rodents, monkeys, and nematodes.
2. Stakeholders are groups who have an interest in an organization's work, and to whom the organization has an ethical duty.
3. Removing and properly disposing of crop residues improve overwintering sites for pests.
4. Neem oil or botanical extract is used as a natural pesticides

Part II: Choose the correct answers from the given alternatives (2pts each)

1. Which one is not biological pest control
   A. Predators and Parasitoids B. Microbial Control C. Handpicking D. None
2. Unwanted plants that grow alongside cultivated crops, competing for water, nutrients, and sunlight are: A. weeds B. Crops C. Pests D. None
3. The inputs or assets that are needed to support the pest management plan is: A. Resource B. Materials C. Tools D. Personals
4. Which one is pest Monitoring Methods: A. Visual Inspections B. Traps and Baits
   C. Biological Monitoring D. All
5. Understanding Pest Management Strategy may include: A. Identify Pest Species:.
   B. Choose Pest Management Methods C. Consider Environmental Impact D. All

Part III. Give short answers for the following questions

1. Explain crop pest management options

2. What are the five basic strategies of IPM used to improve insect management?

3. What are crop pests?
4. List the benefits of consulting stakeholders

LG #29	LO#3 Apply cultural and biological crop pest management methods

Instruction sheet:

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

- Identifying the type of pest occurred
- Identifying the suitable cultural and biological pest control methods
- Mobilizing Available resources for crop pest management
- Implementing and evaluating Biological crop pest control methods

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 the type of pest occurred
- Identify the suitable cultural and biological pest control methods
- Mobilize Available resources for crop pest management
- Implement and evaluate Biological crop pest control methods

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the information Sheets
- Accomplish the Self-checks

Information Sheet-3

3.1 Identifying the type of pest occurred

To identify the type of pest that occurred, you need to observe the signs of damage, the appearance and behavior of the pest, and the location and timing of the infestation. You can use various online resources to help you compare your observations with the characteristics of common pests. You can also contact your local County Extension Service or a pest management professional for assistance.

Identifying the type of pest that has occurred is a crucial step in developing an effective pest management strategy. Here's a systematic approach to identify the type of pest:

- **Visual Inspection:**
  - ✓ **Examine the Crop**:- Conduct a thorough visual inspection of the affected crop. Look for signs of damage, discoloration, distorted growth, or presence of pests.
  - ✓ **Check for Physical Evidence**:- Look for physical evidence of pests such as chewed leaves, webs, holes, excrement, or egg masses. Different pests leave distinct signs.
- **Monitoring Traps**
  - ✓ **Deploy Traps**:- Set up monitoring traps, such as pheromone traps, sticky traps, or light traps, to capture and identify flying insects. This can help determine the type of pest and its population density.
- **Insect Identification:**
  - ✓ **Collect Samples**:- Collect samples of the pests for closer examination. This could involve capturing live specimens or collecting damaged plant parts.
  - ✓ **Use Field Guides:-** Refer to field guides, pest identification books, or online resources specific to your region to visually identify the collected specimens

- ✓ **Contact Local Agricultural Extension Services**:- Seek assistance from local agricultural extension services, which often have entomologists or experts who can help identify pests.

- **Digital Tools:**
  - ✓ **Smartphone Apps:-** Utilize smartphone apps designed for pest identification. Some apps use image recognition technology to identify pests based on photos.
  - ✓ **Online Databases**: - Explore online databases and websites that provide information and images of common pests. Many universities and agricultural organizations maintain such resources.
- **Consult with Experts:**
  - ✓ **Local Entomologists:-** Consult with local entomologists or pest control experts who have expertise in identifying pests prevalent in your area.
  - ✓ **Agricultural Extension Officers:-** Contact agricultural extension officers for guidance. They can connect you with specialists or provide valuable insights.
- **Symptom Analysis:**
  - ✓ **Identify Symptoms:-** Analyze the symptoms of damage on the plants. Different pests cause distinct types of damage, such as leaf-chewing, sap-sucking, or tunneling.
  - ✓ **Host Plant Specificity: -** Consider the host plant specificity of the pest. Some pests are specific to certain crops or plant families.
- **Lifecycle and Behavior:**
  - ✓ **Observe Behavior**: - Observe the behavior of the pests. Some pests feed at specific times of the day, while others may have distinct life cycle stages.
  - ✓ **Life Cycle Characteristics:-** Consider the life cycle characteristics, such as egg-laying patterns, larval stages, pupation, and adult behaviors.
- **Molecular Techniques (Advanced):**
  - ✓ **DNA Barcoding:-** In advanced cases, consider DNA barcoding techniques for accurate identification. This involves analyzing the DNA of the pest for species-level identification.

- **Community Engagement:**
  - ✓ **Local Farmers and Community Members: -** Engage with local farmers and community members who may have experience dealing with similar pest issues. They can provide valuable insights based on their observations.
  - ✓ **Share Information**: - Share information about the observed pest with neighboring farmers or agricultural communities to collectively identify and address the issue.
- **Laboratory Analysis:**
  - ✓ **Submit Samples for Analysis**:- If needed, submit samples to a laboratory for professional analysis. This may involve sending specimens to a diagnostic lab for identification.
  - ✓ **PCR and Molecular Techniques**:- Molecular techniques like Polymerase Chain Reaction (PCR) can be used for precise identification in cases where traditional methods may be inconclusive.

Once the pest is identified, you can then proceed to develop a targeted and effective pest management strategy based on the specific characteristics and vulnerabilities of the identified pest species.

3.2. Identifying the suitable cultural and biological pest control methods

3.2.1 Cultural control

When using cultural control, you alter the environment, condition of the host or site to prevent/suppress the pest infestation. By disrupting the normal relationship between the host, site and pest, you make it less likely for the pest to survive, grow or reproduce. Cultural practices which influence the survival of the pest can also include management actions such as selection of varieties, planting and harvest times, irrigation, crop rotation and/or the use of trap crops to keep the pest away from the desirable crop. In some crops, the use of mulches (plastic, shredded bark or wood chips) may also suppress pests, when properly used.

Sanitation can also be an important cultural practice whereby you eliminate the food, water, shelter or other necessities that are important to the pest's survival. In locations where weeds are the pest, removing them before they produce seeds or harbor pest insects may effectively improve crop conditions or the value of the desirable crop for future sale.

- **Crop Rotation**: Crop rotation involves the planned sequence of different crops on the same land to disrupt the life cycles of pests that are specific to particular crops. Plan a rotation schedule that includes crops with different susceptibility to pests. This helps break pest life cycles and reduces soil-borne diseases.
- **Intercropping:-** Intercropping involves planting two or more crops in close proximity to provide mutual benefits, such as pest control. Choose companion plants that naturally repel pests or attract beneficial insects. The diversity disrupts pest patterns and provides natural pest control.
- **Polyculture**:- it involves growing multiple crop species in the same area simultaneously, promoting biodiversity and reducing the risk of pest outbreaks. Design planting schemes that integrate various crops to create a more resilient and pest-resistant agro-ecosystem.
- **Sanitation Practices:** - Sanitation practices involve maintaining clean and weed-free fields to eliminate breeding grounds and hiding places for pests. Remove crop residues, weeds, and other debris that can harbor pests. Proper waste management reduces the likelihood of pest infestations.

- **Trap Cropping**:- Trap cropping involves planting a crop that attracts pests away from the main crop, acting as a sacrificial host. - Choose a trap crop that pests prefer and monitor it regularly. Control measures can be applied to the trap crop without affecting the main crop.
- **Adjusting Planting Dates:** - Planting crops at specific times to avoid periods when pests are most active can reduce pest pressure. Align planting schedules to minimize overlap with peak

pest activity. This disrupts the synchronization between pests and susceptible crops. Therefore its better to implement the suitable pest control method.

3.2.2 Biological control

Most pests found in agricultural settings will have various natural enemies that will control or suppress the pest effectively in many situations. These natural enemies will act as biological control agents to manage insects, mites, fungal pathogens and/or weeds. Biological control can be an effective tool in pest management. Biological control is often targeted against pests that are not native to the geographical area. These non-native or introduced pests can easily become a problem because they lack natural enemies that control or suppress populations to levels that do not pose a risk to the crop being grown. To establish biological control programs, researchers will locate the native home of the introduced pest and then find its natural enemies. Once these natural enemies are found, extensive testing and evaluation is conducted to ensure they do not pose a risk to the sites where they will be released to control the introduced pest. The biological control agent will be reared and then released within a large area to reduce the introduced/targeted pest populations. If the new introduced biological control is well adapted to the new area, additional releases may not be needed. This entire process is highly regulated to prevent organisms that may themselves become introduced pests. Maintaining sufficient populations of natural enemies after their introduction by avoiding detrimental production practices or the excessive use of broad-spectrum pesticides is an important consideration. When selecting a pesticide to apply in your farming operation, choose a product or products that pose the least amount of risk to the natural enemies to minimize damage to their populations or have negative environmental impact.

- **Predatory Insects** - Introducing or encouraging natural predators that feed on pest insects. Release or conserve predatory insects such as ladybugs, lacewings, and predatory beetles. Plant nectar-rich flowers to attract and sustain them.

- **Parasitoids**:- Parasitoids are organisms that lay eggs on or inside pests, eventually killing them. Introduce parasitoids or conserve existing populations. Examples include parasitic wasps that target caterpillars.
- **Beneficial Nematodes:-** Beneficial nematodes are microscopic worms that parasitize and kill soil-dwelling pests. Apply beneficial nematodes to the soil to control pests like root-dwelling larvae. Ensure proper storage and application.
- **Microbial Insecticides:-** Microbial insecticides contain bacteria, fungi, or viruses that specifically target and kill pests. Apply microbial insecticides such as Bacillus thuringiensis (Bt) for caterpillar control. Follow recommended application rates and timing.
- **Bio pesticides**:- Bio pesticides are naturally occurring substances derived from plants, bacteria, fungi, or other organic materials. Utilize bio pesticides for targeted pest control. Examples include neem oil, garlic-based sprays, and plant extracts.
- **Cover Crops**: - Cover crops are grown primarily to manage soil erosion, fertility, and quality. They can also serve as habitat for beneficial insects. Choose cover crops that attract beneficial insects or provide habitat for natural enemies. This enhances overall pest management.
- **Genetic Resistance:** - Developing or planting crop varieties with inherent resistance to specific pests. Select and cultivate crop varieties that are naturally resistant to prevalent pests in the area. Consult with agricultural experts for guidance.
- **Fungal Pathogens**: Fungi that act as pathogens for specific pests, causing diseases and reducing populations. Introduce fungal pathogens or use fungal-based bio pesticides to target pests like aphids or mites.

Tips for Successful Implementation

- **Monitor Regularly:** Regularly monitor crops for signs of pests and beneficial organisms.
- **Thresholds:** Establish action thresholds to determine when intervention is necessary.

- **Record Keeping:** Maintain detailed records of pest occurrences, control measures, and outcomes.
- **Educate and Train**: Educate farmworkers and stakeholders about the importance of cultural and biological pest control methods.
- **Adaptability:** Be adaptable and adjust pest control strategies based on changing conditions and feedback.
- **Consult Experts**:- Seek advice from agricultural extension services, entomologists, and pest management specialists.

By carefully selecting and implementing a combination of cultural and biological pest control methods, farmers can reduce reliance on chemical pesticides, promote sustainability, and maintain a healthy agro-ecosystem.

3.3. Mobilizing Available resources for crop pest management

Crop pest management is the practice of preventing or reducing the damage caused by pests to crops, while minimizing the negative impacts of pest control methods on human health, the environment, and biodiversity. Crop pest management can be achieved through various approaches, such as integrated pest management (IPM), biological control, cultural control, physical control, and chemical control.

One of the most widely recommended and adopted approaches is IPM, which combines different pest control methods in a harmonious and ecological way, based on the knowledge of the pest biology, the crop system, and the local conditions. IPM aims to enhance the natural enemies of pests, diversify the crop system, and use pesticides only as a last resort.

Mobilizing available resources for crop pest management involves efficiently allocating and utilizing various inputs to implement effective pest control strategies.

Here's a guide on how to mobilize resources for crop pest management:

- **Resource Assessment:**
  - ✓ **Identify Available Resources**:- Conduct a thorough assessment of the resources available for pest management. This includes financial resources, personnel, equipment, technology, and knowledge.
  - ✓ **Inventory Existing Tools:-** Take stock of existing tools and equipment that can be used for pest management. This may include sprayers, traps, monitoring devices, and protective gear.
- **Develop a Pest Management Plan:**
  - ✓ **Integrated Pest Management (IPM):-** Design an Integrated Pest Management (IPM) plan that considers a holistic approach, integrating various pest control methods such as cultural, biological, and chemical control.

The benefits of IPM for crop resilience and pest management are:

- Improved resource use efficiency and soil water holding capacity
- Increased diversity and quality of habitat for beneficial insects that provide pollination and natural pest control
- Reduced pest outbreaks and pesticide resistance
- Lowered environmental and health risks from pesticide use
- Increased yield and profitability

The challenges and risks of IPM for resource-limited farmers are:

- Increased management complexity and learning curve
- Site-specific and context-dependent design and implementation
- Uncertainty and variability of pest dynamics and control outcomes
- Lack of technical and financial support and incentives

- Potential trade-offs between pest control and other ecosystem services

To practice IPM effectively, farmers need to monitor the pest population and damage, identify the pest species and their natural enemies, assess the economic threshold and environmental impact of pest control, and select and apply the appropriate control methods[3]. Coordination and communication with other farmers and national institutes are also important to share information and experiences, and to implement IPM at a larger scale.

- ✓ **Set Priorities:-** Prioritize pest management activities based on the severity of the pest infestation, economic impact, and potential risks.

- **Budgeting and Funding:**
  - ✓ **Allocate Budget:-** Allocate a budget for pest management activities, considering the cost of materials, equipment, labor, and any external expertise required.
  - ✓ **Explore Funding Options:-** Explore funding options, including government grants, agricultural programs, and partnerships with agricultural agencies or NGOs that support pest management initiatives.
- **Personnel Training:**
  - ✓ **Training Programs:-** Provide training programs for agricultural workers and farmers on effective pest management techniques, pest identification, and the proper use of pest control tools.
  - ✓ **Skill Development:-** Invest in skill development programs to enhance the capabilities of the workforce in implementing pest management strategies.
- **Technology and Innovation:**
  - ✓ **Utilize Technology:-** Integrate technology, such as remote sensing, drones, and digital monitoring tools, to enhance the efficiency and accuracy of pest monitoring and management.
  - ✓ **Research and Development:-** Invest in research and development to explore innovative and sustainable pest management solutions that align with the latest advancements in the field.

- **Collaboration and Networking:**
  - ✓ **Stakeholder Collaboration:-** Collaborate with local agricultural agencies, research institutions, and extension services to access shared resources, information, and expertise.
  - ✓ **Farmers' Cooperatives**:- Encourage the formation of farmers' cooperatives to pool resources and collectively invest in pest management measures.
- **Ecosystem Services:**
  - ✓ **Promote Natural Ecosystem Services**:- Capitalize on natural ecosystem services, such as the presence of beneficial insects, to support pest control without heavy reliance on external inputs.
  - ✓ **Biodiversity Conservation:-** Implement practices that promote biodiversity, as diverse ecosystems often have built-in mechanisms for pest control.
- **Equipment and Tools:**
  - ✓ **Maintenance and Upgrades:-** Ensure proper maintenance and periodic upgrades of equipment and tools to maximize their efficiency and longevity.
  - ✓ **Invest in Appropriate Tools**:- Invest in tools and equipment that align with the chosen pest management strategies. For example, precision spraying equipment can reduce chemical use.
- **Data Management:**
  - ✓ **Implement Data Collection Systems:-** Establish systems for collecting and managing data related to pest monitoring, treatment outcomes, and the effectiveness of different pest management methods.
  - ✓ **Data Analysis:-** Analyze collected data to make informed decisions, optimize resource allocation, and continually improve pest management strategies.
- **Emergency Response Planning:**
  - ✓ **Develop Emergency Protocols:-** Develop protocols for responding to sudden pest outbreaks or unforeseen challenges. This includes having a contingency plan and access to additional resources if needed.

- ✓ **Communication Channels**:- Establish clear communication channels for rapid mobilization of resources in response to emergent pest threats.

- **Monitoring and Evaluation:**
  - ✓ **Continuous Evaluation:-** Implement a continuous monitoring and evaluation process to assess the effectiveness of pest management activities and make adjustments as needed.
  - ✓ **Feedback Mechanism:-** Establish a feedback mechanism to gather input from stakeholders, farmers, and workers involved in pest management activities.

By strategically mobilizing available resources and adopting a comprehensive approach, farmers and agricultural organizations can enhance the efficiency and sustainability of crop pest management while minimizing environmental impact. Regular monitoring, adaptation, and collaboration with stakeholders are key elements of successful resource mobilization for effective pest control.

3.4. Implementing and evaluating Biological crop pest control methods

Biological crop pest control methods are those that use living organisms or their products to suppress or prevent the damage caused by pests to crops. Biological control agents can be predators, parasitoids, pathogens, competitors, or antagonists of the pests.

Advantages of biological control methods are:

- They are environmentally friendly and reduce the reliance on synthetic pesticides
- They can enhance the biodiversity and resilience of the agro-ecosystem
- They can provide long-term and sustainable pest management
- They can reduce the risk of pest resistance and resurgence

Challenges of biological control methods are:

- They require a thorough knowledge of the pest and its natural enemies

- They are influenced by biotic and abiotic factors that affect their efficacy and persistence
- They may have unintended effects on non-target organisms and ecosystem services
- They may face regulatory and socio-economic barriers for adoption and dissemination

To implement and evaluate biological control methods, some of the steps that can be followed are:

- Identify the pest problem and its economic and environmental impact
- Conduct a survey of the pest and its natural enemies in the field
- Select the most suitable biological control agent and method for the pest and the crop system
- Test the effectiveness and safety of the biological control agent and method in the laboratory and the field
- Monitor the performance and impact of the biological control agent and method over time
- Communicate and disseminate the results and recommendations to the stakeholders

https://www.youtube.com/watch?v=EiEObwJVrpM

Self-check-3	Written test

Part I: Write true If the statements is correct or false statement is incorrect

1. IPM is a holistic approach that combines multiple pest control methods, emphasizing biological control, cultural practices, and minimal pesticide use.
2. Intercropping involves planting two or more crops in close proximity to provide mutual benefits, such as pest control.
3. Biological pest control methods are environmentally friendly and reduce the reliance on synthetic pesticides

Part II: Choose the correct answers from the given alternatives (1pts each)

1. Which one is not the advantage of biological pest control methods?

A. They are environmentally friendly and reduce the reliance on synthetic pesticides

B. They can enhance the biodiversity and resilience of the agro-ecosystem

C. They can provide long-term and sustainable pest management

D. They can reduce the risk of pest resistance and resurgence

E. None

2. The benefits of IPM for crop resilience and pest management are

B. Improved resource use efficiency and soil water holding capacity

C. Reduced pest outbreaks and pesticide resistance

D. Lowered environmental and health risks from pesticide use

E. All

3. The type of pest occurred can be identified by: A. Visual Inspection B. Monitoring Traps

C. Digital tools D. All

4. One of the following is biological pest control method. A. Predatory Insects B. Parasitoids C. Microbial Insecticides D. All

Part III. Give short answers for the following questions (3pts each)

1. Explain Cultural and Biological pest Control methods

2. What are the advantages of biological pest control methods

3. What are the Tips for Successful Implementation of IPM?

4. List the steps followed to implement and evaluate biological pest control methods

LG #30	LO#4 Implement chemical use program

Instruction sheet:

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

- Identifying Chemical requirements for pest managements
- Identifying Safety hazards in the transport, storage and application of the chemicals
- Identifying risk control measures to minimize risk involved in chemical use.
- Applying Chemical to the infested field by considering appropriate time, safety pre-questions and environmental conditions
- Implementing a maintenance program for application and personal protective equipment
- Implementing recording systems for chemical storage and use
- Taking appropriate precautions during handling and disposal of pesticides.

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 Chemical requirements for pest managements
- Identify Safety hazards in the transport, storage and application of the chemicals
- Identify risk control measures to minimize risk involved in chemical use.
- Apply Chemical to the infested field by considering appropriate time, safety pre-questions and environmental conditions
- Implement a maintenance program for application and personal protective equipment
- Implement recording systems for chemical storage and use
- Take appropriate precautions during handling and disposal of pesticides

Learning Instructions:
• Read the specific objectives of this Learning Guide. • Follow the instructions described below. • Read the information written in the information Sheets • Accomplish the Self-checks • Perform Operation Sheets • Do the “LAP test”

Information Sheet-4

4.1. Identifying Chemical requirements for pest managements

Chemical requirements for pest management are the types and amounts of pesticides that are needed to control the pest population and prevent crop damage. Chemical requirements depend on various factors, such as the pest species, the crop system, the environmental conditions, the pesticide formulation, and the application method.

To identify the chemical requirements for pest management, some of the steps that can be followed are:

- Determine the pest threshold, which is the level of pest population or damage that causes economic loss to the crop
- Select the appropriate pesticide that is effective, safe, and compatible with the pest management strategy
- Calculate the pesticide dosage, which is the amount of pesticide that is applied per unit area or volume
- Choose the optimal timing and frequency of pesticide application, based on the pest life cycle, the crop growth stage, and the weather conditions
- Follow the label instructions and safety precautions for pesticide handling, storage, and disposal

By identifying the chemical requirements for pest management, farmers can optimize the use of pesticides and reduce the risks of pest resistance, environmental contamination, and human health hazards.

Identifying chemical requirements for pest management involves a systematic process to select and apply appropriate pesticides while considering safety, efficacy, and environmental impact. Here's a detailed guide on how to identify chemical requirements for pest management:

- **Pest Identification and Monitoring:**
  - ✓ **Identify Target Pests:-** Conduct regular monitoring and surveys to identify the specific pests affecting crops. Use field guides, experts, and monitoring tools to accurately identify pest species.
  - ✓ **Threshold Determination**:- Establish pest threshold levels, indicating when pest populations reach a point where intervention is necessary. Different crops and pests may have varying threshold levels.
- **Integrated Pest Management (IPM) Approach:**
  - ✓ **Holistic Pest Management:-** Adopt an IPM approach that integrates various control methods, including cultural, biological, and mechanical controls, before resorting to chemical options. Prioritize non-chemical methods whenever possible.
  - ✓ **Cultural Practices:-** Implement cultural practices that reduce the likelihood of pest infestations, such as crop rotation, intercropping, and proper sanitation.
- **Chemical Selection Criteria:**
  - ✓ **Mode of Action**:- Consider the mode of action of pesticides and choose chemicals that target specific pest types while minimizing impact on non-target organisms.
  - ✓ **Residual Activity:-** Evaluate the residual activity of pesticides to ensure long-lasting protection against pests.
  - ✓ **Selectivity:-** Choose pesticides that are selective and have minimal impact on beneficial organisms, pollinators, and the environment.
  - ✓ **Resistance Management**:- Rotate or mix chemical classes to mitigate the development of pesticide resistance in pest populations.
- **Environmental Impact Assessment:**

- ✓ **Toxicity and Persistence:-** Assess the toxicity and persistence of pesticides in the environment. Preferentially select chemicals with lower toxicity and shorter persistence.
- ✓ **Ecological Considerations**:- Consider potential impacts on non-target organisms, aquatic ecosystems, and soil health. Evaluate the potential for bioaccumulation and indirect effects on the food chain.

- **Regulatory Compliance:**
  - ✓ **Pesticide Registration:** - Ensure that selected pesticides are registered and approved for use by relevant regulatory authorities. Adhere to legal requirements and restrictions on pesticide use.
  - ✓ **Maximum Residue Limits (MRLs**):- Be aware of and comply with MRLs set by regulatory agencies to avoid violations and ensure food safety.
- **Application Technology:**
  - ✓ **Spray Equipment:-** Choose appropriate spray equipment to ensure accurate and efficient pesticide application. Regularly calibrate equipment to maintain consistent application rates.
  - ✓ **Adjuvants:-** Consider the use of adjuvants (such as surfactants or spreaders) to enhance the efficacy of pesticides. Follow manufacturer recommendations for adjuvant selection and application.
- **Safety Precautions:**
  - ✓ **Personal Protective Equipment (PPE):-** Identify the necessary PPE for handling and applying pesticides. Ensure that applicators and handlers use PPE consistently to prevent exposure.
  - ✓ **Application Timing:-** Time pesticide applications to minimize the risk of drift and ensure optimal effectiveness. Avoid application during adverse weather conditions.
- **Record Keeping:**
  - ✓ **Application Records:-** Maintain detailed records of pesticide applications, including dates, rates, and targeted pests. Record weather conditions during applications.

- ✓ **Observations and Results**:- Document observations of pest populations before and after pesticide applications. Evaluate the effectiveness of treatments and adjust future strategies accordingly.

- **Post-Treatment Monitoring:**
  - ✓ **Resurgence and Secondary Pests:-** Monitor for the resurgence of pest populations or the emergence of secondary pests following pesticide applications. Implement corrective measures if needed.
  - ✓ **Beneficial Organism Impact:-** Assess the impact of pesticides on beneficial organisms, such as natural enemies and pollinators. Consider introducing beneficial organisms after pesticide applications if necessary.
- **Pesticide Storage and Disposal:**
  - ✓ **Storage Facilities**:- Ensure proper storage facilities for pesticides, considering temperature, humidity, and security. Follow safety guidelines to prevent accidents or spills.
  - ✓ **Disposal Practices:-** Adhere to proper disposal practices for empty pesticide containers and leftover chemicals. Comply with local regulations for the disposal of hazardous materials.
- **Training and Education:**
  - ✓ **Applicator Training:-** Provide training for pesticide applicators on the proper use, handling, and storage of pesticides. Emphasize the importance of following label instructions.
  - ✓ **Community Education:-** Educate the local community about the responsible use of pesticides and potential risks. Promote awareness of integrated pest management practices.
- **Review and Adjustment:**
  - ✓ **Periodic Review: -** Periodically review the efficacy and sustainability of the chosen pesticides. Stay informed about new developments in pest management technologies.
  - ✓ **Adaptation of Strategies:-** Be prepared to adapt pest management strategies based on changing pest dynamics, environmental conditions, and emerging technologies.

By carefully considering these factors and adopting a strategic and responsible approach, farmers and pest management practitioners can identify the chemical requirements for pest management that are effective, safe, and environmentally sustainable. Integrating chemical control within a broader IPM framework contributes to the overall success of pest management programs.

4.2 Types of chemical and modes of action

Pesticides can be classified in different ways, but a commonly used classification system is based on the type of pest they target and the mode of action by which they control the pest. Here are some of the most common classifications:

- **Insecticides**: these are pesticides that target insects, such as flies, mosquitoes, and ants.
- **Herbicides**: these are pesticides that target weeds and other unwanted plants. Such as glyphosate, 2,4-D, and atrazine. 3. Fungicides
- **Fungicides**: these are pesticides that target fungi, such as molds and mildews.
- **Rodenticides**: these are pesticides that target rodents, such as rats and mice.
- **Nematicides:** these are pesticides that target nematodes, which are worms that can damage crops.
- **Miticides**: these are pesticides that target mites, which are small arachnids that can damage plants.
- **Bactericides**: these are pesticides that target bacteria, such as those that cause plant diseases.
- **Virucides**: these are pesticides that target viruses, such as those that infect crops. It's important to note that certain pesticides can have multiple modes of action and may target more than one type of pest.

4.2.1. Time of chemical application

A. Pre-emergence

B. Post-emergence

Pre-emergence and post-emergence are two different methods of applying herbicides or other chemicals to control weeds or pathogens in crops.

i. **Pre-emergence** application refers to applying a chemical before the target plants have emerged from the soil. The goal of this method is to create a barrier in the soil that prevents weed seeds from germinating and emerging, or to kill the young seedlings as they emerge. Pre-emergence herbicides are usually applied to the soil surface shortly after planting, before the first irrigation or rainfall, to ensure that the chemical stays in the top layer of soil where the target weed seeds are likely to germinate.

ii. **Post-emergence** application refers to applying a chemical after the target plants have emerged from the soil and developed leaves. This often involves spraying herbicides directly onto the foliage of the target plants. The goal of this method is to kill existing weeds or pathogens in crops, without harming desirable plants which have already established themselves. The timing and frequency of post-emergence applications can vary depending on factors such as weed type, crop type, and environmental conditions.

4.2.2. Mode of action of chemical

Mode of action (MoA) describes a functional or anatomical change, resulting from the exposure of a living organism to a substance. In comparison, a mechanism of action (MOA) describes such changes at the molecular level. A mode of action is important in classifying chemicals, as it represents an intermediate level of complexity in between molecular mechanisms and physiological outcomes.

Chemical pesticides can be broadly categorized based on their mode of action - in other words, how they work to kill or control pests.

A. **Selective pesticides:** These are chemicals that have been manufactured to target specific types of pests, leaving non-target species and beneficial insects unharmed. For example, a pesticide that targets only aphids would be considered selective, since it wouldn't harm ladybugs or other beneficial predators.

B. **Non-selective pesticides**: In contrast to selective chemicals, nonselective pesticides are broad-spectrum and can kill or harm a wide range of pests and organisms. Glyphosate, a herbicide used to kill weeds, is one example of a nonselective chemical which can also be harmful to some crops and potentially toxic to humans.

C. **Contact pesticides**: These chemicals work by coming into direct contact with the target pest, either through physical means (such as by sticking to the surface of the pest's body) or through inhalation or ingestion. Examples of contact pesticides include insecticides like pyrethroids and organophosphates.

D. **Systemic pesticides**: Systemic pesticides are absorbed by a plant's roots or leaves and then travel throughout the plant's vascular system, making all parts of the plant toxic to pests that feed on it. This makes systemic pesticides particularly effective against pests such as aphids or beetles that feed on the leaves or stems of a plant. However, systemic pesticides can also pose a risk to non-target species if they consume parts of the treated plant or if runoff from the pesticide contaminates nearby waterways.

E. **Stomach poisons**: This mode of action involves pesticide chemicals that must be ingested by the target pest in order to be effective. Once ingested, stomach poison chemicals disrupt the pest's digestive system and cause it to stop feeding and ultimately die. Rodenticides, which are used to control rats and mice, are an example of stomach poison pesticides.

Advantages of chemical pest control

- Chemical pesticides tend to work quickly and can provide immediate control of the pest population in the targeted area.
- They tend to be more cost-effective compared to other methods of pest control.
- Chemicals can be applied directly, even in hard-to-reach areas, and can offer a broad-spectrum solution to a variety of pests.
- They can also increase crop yields and lead to higher quality crops.

Disadvantages of chemical pest control

- Pesticides may harm non-target organisms, such as beneficial insects and wildlife.
- Overuse and misuse of pesticides can lead to pesticide resistance and residues that may persist in the environment for a long time.
- These chemicals can also have harmful effects on human health, ranging from minor allergic reactions to serious long-term health issues like cancer, fertility problems or neurological damage.
- Pesticides can also contaminate water sources and negatively impact the water ecosystem.

4.3. Identifying Safety hazards in transport, storage and application

4.3.1. Identifying Safety hazards in transportation of pesticide

Transporting pesticides can be hazardous and requires careful attention to safety. The US Department of Transportation (DOT) has identified certain pesticides as hazardous materials, which are substances or materials that have been determined to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce. The DOT has established regulations to protect transporting employees, people around them, and the environment. The regulations inform shippers how to package the materials safely and drivers how to load, transport, and unload the material .

Here are some tips for transporting pesticides safely:

- **Identify the hazardous materials**: The product's packaging will identify it as a hazardous material. Most noticeably, the packaging will contain one or more diamond-shaped DOT labels. These are known as a "square-on-point" and there will also be a number listed at the bottom of the point .
- **Packaging**: Use appropriate packaging materials to prevent leaks and spills. Make sure the packaging is properly labeled and marked with the appropriate hazard warning labels .

- **Loading and unloading**: Use proper loading and unloading techniques to prevent spills and accidents. Make sure the vehicle is properly equipped with the necessary safety equipment, such as fire extinguishers, spill kits, and personal protective equipment .
- **Transportation**: Follow the DOT regulations for transporting hazardous materials. Make sure the driver is properly trained and licensed to transport hazardous materials.
- **Storage**: Store pesticides in a cool, dry, and well-ventilated area. Keep them away from food, water, and other chemicals.

It is important to note that the use of pesticides should be a last resort and should be used only when necessary. Overuse of pesticides can lead to the development of pesticide-resistant pests and can harm beneficial insects. If you are handling pesticides, it is important to follow the instructions on the label and wear protective clothing. If you experience symptoms of poisoning, seek medical attention immediately.

Tips in transportation of pesticide:

- Never allow children, other passengers and pets with pesticides.
- Never carry pesticides in the passenger section.
- Never transport pesticides with food, clothing, or other things meant to be eaten or in contact with people or animals.
- Never leave your vehicle un attended when transporting pesticides in an unlocked trunk compartment or open –bed truck.
- Consider transporting highly volatile pesticides in separated trips from other chemicals.

4.3.2. In storage

- The Structure should have concrete floor which is impermeable and easy to wash

- The structure should be fire resistance, explosion prove, and located away from other buildings
- Adequate ventilation is needed to prevent exposure of the pesticides to extreme heat and reduces the concentration of toxic or flammable vapors in the building.
- Lighting in the storage facilities must be sufficient to allow easy identification of stored materials.
- Pesticide storage area should not be used for other purpose.
- Pesticides should also be stored separately from protective equipment such as res purgatory goggles and protective clothing
- Running water and material for safety handling small scale pesticide accidents should be located near storage facilities.

4.3.3. On application equipment

The applicator must know the safe operation of application equipment the safe operation of application equipment and that all equipment is inspected and in good operating conditions before use , and choose applicable equipment before use.

4.4. Identifying risk control measures for chemical use

Risk control measures for chemical use are actions or procedures that aim to prevent or minimize the adverse effects of hazardous chemicals on workers, the environment, and the public. Some of the steps involved in identifying risk control measures for chemical use are:

- Identify the hazards and risks associated with the chemical use, such as exposure, fire, explosion, or environmental damage. This can be done by obtaining and reading the safety data sheet (SDS) of the chemical, which contains information on its properties, hazards, and precautions.

- Evaluate the level of risk and prioritize the hazards that need to be controlled. This can be done by considering the likelihood and severity of the harm, the number of people affected, and the frequency and duration of exposure.
- Select the most appropriate control measures according to the hierarchy of control, which ranks the effectiveness of different types of controls from highest to lowest. The hierarchy of control is: elimination, substitution, engineering, administrative, and personal protective equipment (PPE). For example, elimination involves removing the chemical from the workplace, substitution involves replacing it with a less hazardous one, engineering involves modifying the equipment or process to reduce exposure, administrative involves implementing safe work practices or procedures, and PPE involves providing and wearing suitable protective clothing or devices.
- Implement the selected control measures in the workplace and ensure that they are working effectively and maintained properly. This can be done by providing training, supervision, and information to the workers, monitoring the exposure levels and health effects, and reviewing the control measures regularly or when there are changes in the workplace.

Ways to avoid hazards and reduce safety risks

To avoid hazards and reduce safety risks, you need to know how to handle chemicals in a safe way. When dealing with chemicals, you need to observe the following main rules:

- Chemicals must always be clearly labeled and kept in their original container.
- Chemicals must always be stored in the right place.
- Always follow the correct safety procedures when transporting chemicals.
- Always check a chemical's Material Safety Data Sheet (MSDS) before using it.
- Always wear protective gear when dealing with chemicals.
- Never touch, taste or smell chemicals.

- Check with your supervisor before using any chemicals.
- Don't drink, eat or smoke while using chemicals.

Other helpful suggestions

- Use a fume cupboard when handling chemicals. The cupboard will ventilate any harmful fumes given off by the chemical. If your workplace does not have a fume cupboard, then handle chemicals in a well-ventilated area. If you are handling chemicals in a room, open all windows to allow air to move through the room.
- When pipetting or transferring chemical fluids, use a pipette pump, not your mouth, to draw the liquid into the pipette.
- Always have your hand underneath the chemical container when you carry it. Otherwise, it might drop and spill its contents over you.
- Always wash yourself thoroughly after handling chemicals.
- If chemical spills over you, wash it off at once. Some workplaces have a chemical shower that you can use to get cleaned up quickly.
- Don't eat, drink or smoke when you're handling chemicals. You could accidentally swallow some chemicals, or accidentally ignite flammable chemicals if you're smoking.

Identifying risk control measures to minimize the risks involved in chemical use is crucial for ensuring the safety of individuals, protecting the environment, and complying with regulatory standards. Here's a detailed guide on implementing risk control measures at each stage of chemical use:

Risk Assessment:

- **Chemical Hazard Identification:**
  - ✓ Material Safety Data Sheets (MSDS): Review MSDS for each chemical to understand its hazards, toxicity, and proper handling procedures.

- ✓ Chemical Classification: Identify the classification of chemicals (e.g., pesticides, herbicides, fungicides) and associated risks.

- **Exposure Assessment:**
  - ✓ Exposure Routes: Evaluate potential exposure routes, including inhalation, skin contact, and ingestion.
  - ✓ Quantitative Exposure Assessment: Use exposure data to quantify potential risks to individuals during chemical use.

Risk Control Measures:

- **Hierarchy of Controls:**
  - ✓ Elimination/Substitution: Prioritize the elimination or substitution of highly hazardous chemicals when feasible.
  - ✓ Engineering Controls: Implement engineering controls, such as closed systems or ventilation, to minimize exposure.
  - ✓ Administrative Controls: Establish administrative controls, such as work procedures and rotation schedules, to reduce exposure time.
  - ✓ Personal Protective Equipment (PPE): Provide and ensure the proper use of PPE as a last resort.
- **Safe Handling and Storage:**
  - ✓ Segregation: Store chemicals in separate areas based on compatibility to prevent unintended reactions.
  - ✓ Secure Storage: Implement secure storage measures to prevent theft or unauthorized access.
  - ✓ Proper Ventilation: Ensure proper ventilation in storage areas to reduce exposure to vapors.
- **Training and Education:**
  - ✓ Chemical Handling Training: Provide comprehensive training for individuals involved in chemical use, covering hazards, safe handling, and emergency response.

- ✓ Regular Updates: Conduct regular training sessions to keep personnel updated on new chemicals, regulations, and best practices.

- **Emergency Response Plan:**
  - ✓ Detailed Plan: Develop and communicate a comprehensive emergency response plan covering potential scenarios.
  - ✓ Drills: Conduct regular emergency response drills to ensure personnel are familiar with procedures.
- **Personal Protective Equipment (PPE):**
  - ✓ Appropriate Selection: Choose appropriate PPE based on the chemical hazards and exposure routes.
  - ✓ Fit Testing: Ensure proper fit and conduct fit testing for respirators.
  - ✓ Regular Inspection: Regularly inspect and maintain PPE to ensure effectiveness.

Chemical Application:

- **Calibration and Equipment Inspection:**
  - ✓ Regular Calibration: Calibrate application equipment regularly to ensure accurate chemical application rates.
  - ✓ Equipment Inspection: Inspect equipment before each use to identify and address any issues.
- **Weather Conditions:**
  - ✓ Wind Speed and Direction: Consider wind speed and direction before chemical application to avoid drift.
  - ✓ Temperature and Humidity: Evaluate temperature and humidity conditions to optimize chemical effectiveness and minimize risks.
- **Application Techniques:**

- ✓ Proper Application Rate: Follow recommended application rates to avoid overuse or underuse.
- ✓ Nozzle Selection: Choose appropriate nozzles to minimize drift and ensure uniform coverage.
- ✓ Avoid Contamination: Prevent contamination of adjacent areas or water bodies during application.

Post-Application Measures:

- **Post-Treatment Monitoring:**
  - ✓ Residue Testing: Conduct residue testing to ensure compliance with safety standards.
  - ✓ Environmental Monitoring: Monitor for any environmental impact, including effects on non-target organisms.
- **Record Keeping:**
  - ✓ Application Records: Maintain detailed records of chemical applications, including dates, rates, and targeted pests.
  - ✓ Observations: Document any observations of adverse effects on crops or the environment.

General Safety Considerations:

- **Communication:**
  - ✓ Clear Communication: Establish clear communication protocols between individuals involved in chemical use.
  - ✓ Community Notification: Notify nearby residents or stakeholders before chemical applications if required.
- **Environmental Impact Assessment:**
  - ✓ Eco-Friendly Practices: Promote sustainable and eco-friendly chemical use practices.
  - ✓ Ecological Risk Assessment: Assess the potential environmental impact of chemical use, considering the toxicity of active ingredients.
- **Continuous Improvement:**

- ✓ Feedback Mechanism: Establish a feedback mechanism to gather insights from personnel and stakeholders.
- ✓ Adaptation of Strategies: Be prepared to adapt chemical use strategies based on changing circumstances and emerging technologies.

By systematically implementing these risk control measures, agricultural practitioners can minimize the risks associated with chemical use, create a safer working environment, and contribute to sustainable and responsible agricultural practices. Regular monitoring, feedback, and adherence to safety protocols are essential components of an effective risk management strategy.

4.5. Determining threshold level for chemical applications

The threshold level for chemicals is an important factor in determining the safe and effective use of chemicals. The threshold level is the amount of a chemical that can be safely used without causing harm to humans or the environment. There are different methods for determining the threshold level, including dose-response analysis and threshold of toxicological concern (TTC).

- **Dose-response analysis** is a process that involves identifying the dose-effect relationship for a toxic substance. The toxicological threshold levels identified in this process (e.g., no-observed-adverse-effect level, NOAEL) are then used for a quantitative toxicological risk assessment, taking into account the available exposure data.
- **The threshold of toxicological concern** (TTC) is a practical risk assessment tool that is based on the principle of establishing a human exposure threshold value for all chemicals, below which there is a very low probability of an appreciable risk to human health.

4.6 Emergency plant pest control procedures

Emergency plant pest control procedures refer to protocols and strategies implemented to quickly and effectively manage or eradicate plant pests when an unexpected or urgent situation arises. Plant pests

can include insects, pathogens, weeds, and other organisms that can harm crops, plants, or ecosystems. These emergency procedures are crucial to prevent the rapid spread of pests and minimize potential damage to agricultural crops or natural habitats.

These procedures may include:

- Early Detection and Monitoring: Regular monitoring of crops or plant populations to quickly identify the presence of pests. Early detection allows for a more immediate response.
- Quarantine Measures: Isolating and restricting the movement of affected plants or materials to prevent the spread of pests to other areas.
- Rapid Response Teams: Establishing teams that are trained and ready to respond quickly to pest outbreaks. These teams may include experts in entomology, plant pathology, and weed science.
- Integrated Pest Management (IPM): Implementing a holistic approach to pest control that combines biological, cultural, physical, and chemical control methods. This approach aims to minimize the impact on the environment and human health.
- Chemical Control: When necessary, using approved pesticides or herbicides to control or eliminate the pests. This should be done judiciously and following all relevant safety and environmental regulations.
- Public Awareness and Education: Informing farmers, landowners, and the public about the presence of pests, prevention measures, and reporting mechanisms.
- Coordination with Regulatory Authorities: Collaborating with local agricultural or environmental authorities to ensure a coordinated and effective response to pest emergencies.
- Research and Development: Investing in research to develop new and more effective pest control methods, as well as resistant plant varieties.
- Documentation and Reporting: Keeping thorough records of pest outbreaks, control measures implemented, and their effectiveness. This information is valuable for future planning and prevention.

Effective emergency plant pest control procedures require a combination of proactive measures, rapid response capabilities, and collaboration among various stakeholders, including government agencies, farmers, researchers, and the public.

4.7. Life cycle of pests and target stages

The life cycle of pests typically consists of four stages: egg, larva, pupa, and adult. The length of each stage varies depending on the species of pest, as well as environmental factors such as temperature, humidity, and availability of food and shelter.

In terms of target stages, it is important to identify the life stage of the pest that is most susceptible to control measures. For example, in the case of mosquitoes, the larval stage is the most vulnerable stage for control measures. Similarly, for aphids, the nymph stage is the most susceptible stage for control measures.

4.8. Applying chemical for infestation field

When applying pesticides to an infested field, it is important to follow best practices to ensure effective and efficient application.

Here are some general principles that apply to almost all spraying situations:

- Positive identification of the pest(s): Identifying the pest(s) is crucial in selecting the appropriate pesticide and equipment.
- Selecting the pesticide specifically designed to control the identified pest(s): Choosing the right pesticide is important for effective control of the problem.
- Selecting the proper equipment: The correct type and size of nozzle should be selected to ensure uniform application of the pesticide.

- Applying the pesticide at the right time and under the right conditions: The timing of application is critical to ensure maximum efficacy of the pesticide.
- Checking the accuracy of equipment (calibration) periodically: Ensuring that the amount recommended on the pesticide label is applied uniformly onto the target is important for effective control of the pest.

When applying pesticides, certain tasks are required for maximum biological efficacy. These include:

- Uniform mixing of pesticides (especially dry products) in the sprayer tank.
- Choosing a pump with sufficient capacity to deliver the required gallonage (gal/acre) to the nozzles.
- Ensuring hoses and fittings between the pump and nozzles are properly sized to minimize pressure losses.
- Ensuring minimum loss of pesticides as they are delivered from the nozzles to the target.
- Attaining maximum retention of droplets on the target (minimum rebound).
- Providing thorough and uniform coverage of the target with droplets carrying active ingredients.

Applying chemical pesticides to the infested field is a common but risky method of pest management. Chemical pesticides can be effective in reducing pest populations and crop losses, but they can also pose serious threats to human health, the environment, and biodiversity. Therefore, it is important to consider the appropriate time, safety precautions, and environmental conditions before applying chemical pesticides.

When applying pesticides, it is important to follow proper procedures to ensure that the equipment is functioning correctly and safely.

step1 **Equipment serviceability**: Check the equipment for any damage or wear and tear before use.

step2 **Adjustment and control checks**: Ensure that the equipment is properly calibrated and adjusted before use.

step3 **Spray calibration**: Calibrate the sprayer to ensure that the correct amount of pesticide is being applied.

step4 **Tank filling**: Fill the tank with the correct amount of pesticide and water.

step5 **Prior warnings**: A Post warning sign to alert people in the area that pesticide application is taking place.

step6 **Cleaning ("decontamination") of equipment and PPE**: Clean the equipment and personal protective equipment (PPE) after use to prevent contamination [1].

step7 **Disposal of surplus spray**: Dispose of any leftover pesticide in accordance with local regulations [1].

step8 **Disposal of empty chemical containers**: Dispose of empty chemical containers in accordance with local regulations.

step9 **Equipment maintenance and repair**: Regularly maintain and repair equipment to ensure that it is functioning correctly and safely [1].

step10 **Equipment storage**: Store equipment in a dry, secure location to prevent damage and theft.

Some of the factors that affect the timing of pesticide application are:

- The pest life cycle and behavior, such as the stage of development, the feeding habits, and the activity patterns
- The crop growth stage and phenology, such as the emergence, flowering, and harvesting periods

- The weather conditions and forecasts, such as the temperature, humidity, wind speed, and precipitation
- The pesticide formulation and mode of action, such as the residual effect, the volatility, and the photo degradation

Some of the safety precautions that should be followed when handling or applying pesticides are:

- Read and follow the label instructions and safety data sheets carefully
- Wear appropriate personal protective equipment, such as gloves, goggles, masks, and boots
- Avoid contact with skin, eyes, mouth, and nose, and wash thoroughly after exposure
- Store and transport pesticides in secure and labeled containers, away from food, water, and children
- Dispose of empty containers and excess pesticides properly, according to local regulations

Some of the environmental conditions that influence the impact of pesticides are:

- The soil properties and characteristics, such as the texture, pH, organic matter, and microbial activity
- The water quality and availability, such as the runoff, leaching, and contamination potential
- The biodiversity and ecosystem services, such as the pollination, predation, and decomposition functions
- The climate change and variability, such as the greenhouse gas emissions, the temperature extremes, and the droughts

By considering these factors, farmers can optimize the use of chemical pesticides and reduce the risks of pest resistance, environmental contamination, and human health hazards[12]. However, chemical pesticides should not be the only or the primary method of pest management, but rather a part of an

integrated pest management (IPM) strategy that combines different pest control methods in a harmonious and ecological way.

Applying chemicals to an infested field requires careful planning and execution to ensure effective pest control while prioritizing safety and environmental considerations.

Here's a step-by-step guide to applying chemicals responsibly:

Pre-Application Planning:

- **Pest Identification:-** Confirm the identity of the pest or disease affecting the field. This information is crucial for selecting the appropriate chemical and determining the optimal application timing.
- **Selecting the Right Chemical:-** Choose a pesticide or chemical treatment that is effective against the identified pest and is suitable for the crop in question. Consider integrated pest management (IPM) principles.
- **Safety Precautions:**
  - ✓ **Read and Understand Labels:-** Thoroughly read and understand the label instructions on the pesticide container. Follow all guidelines for proper use, dosage, and safety precautions.
  - ✓ **Personal Protective Equipment (PPE):-** Ensure that all individuals involved in the application wear the recommended personal protective equipment (PPE), including gloves, goggles, respirators, and protective clothing.
  - ✓ **Training:-** Provide training to those applying the chemicals on the proper use of PPE, emergency response procedures, and adherence to safety guidelines.
  - ✓ **First Aid Kit**:- Have a first aid kit readily available on-site in case of accidental exposure or injury.

- ✓ **Proximity to Water Sources**:- Avoid spraying chemicals near water sources, wells, or bodies of water to prevent contamination. Comply with buffer zone requirements.

- **Environmental Considerations:**
  - ✓ **Weather Conditions**:- Check weather conditions before application. Avoid spraying during windy or rainy conditions to prevent drift and runoff.
  - ✓ **Temperature Considerations:-** Consider the temperature conditions for application. Some pesticides may be more effective within specific temperature ranges.
  - ✓ **Avoid Sensitive Areas:** - Identify and avoid areas with sensitive ecosystems, habitats, or neighboring crops that may be adversely affected by the chemicals.
- **Application Timing:**
  - ✓ **Consider Pest Life Cycle:** - Time the application based on the life cycle of the target pest. Apply pesticides when pests are most vulnerable, such as during specific developmental stages.
  - ✓ **Time of Day**:- Choose an appropriate time of day for application. Early morning or late afternoon is often preferable to minimize the impact on non-target organisms and reduce the risk of pesticide drift.
- **Equipment Calibration:**
  - ✓ **Calibrate Application Equipment**:- Calibrate spraying equipment to ensure accurate and uniform distribution of the chemical. Follow manufacturer guidelines for calibration.
  - ✓ **Nozzle Selection:-** Choose appropriate nozzles to minimize drift and optimize coverage. Adjust nozzle types based on the characteristics of the chemical and the target pest.
- **Application Technique:**
  - ✓ **Spraying Technique**: - Use proper spraying techniques to ensure even coverage. Maintain an appropriate spray height and speed, and overlap passes to avoid gaps in coverage.

https://www.youtube.com/watch?v=TenRNA_usxA&list=PLl16ITNuQF4OcEDAsQn7pBRz4ml9zI7NU

- ✓ **Avoid Over application:-** Avoid over application of chemicals, as this can lead to environmental contamination, resistance development, and economic waste.

- **Recordkeeping:**
  - ✓ **Maintain Detailed Records:-** Keep detailed records of the application, including date, time, weather conditions, pesticide used, dosage, and any observations made during and after application.
  - ✓ **Emergency Contact Information:-** Have emergency contact information readily available, including poison control and local emergency response, in case of accidental exposure or spills.
- **Post-Application Follow-Up:**
  - ✓ **Monitor Effects:-** Monitor the field for the effects of the chemical application. Assess whether the treatment was effective against the target pest.
  - ✓ **Evaluate Residue Levels: -** Assess residue levels on crops and in the environment, ensuring compliance with safety standards and any recommended waiting periods before harvest.
- **Communication:**
  - ✓ **Notify Neighbors: -** Inform neighboring farmers and residents about the planned chemical application, including the type of chemical used and safety precautions taken.
  - ✓ **Post Warning Signs:-** Place warning signs indicating that a pesticide has been applied. Follow local regulations for posting and notification requirements.
- **Waste Disposal:**
  - ✓ **Dispose of Containers Properly: -** Properly dispose of empty pesticide containers in accordance with local regulations. Rinse and triple-rinse containers before disposal.
  - ✓ **Unused Chemicals:-** Safely store and manage any unused pesticides according to manufacturer instructions. Dispose of unused chemicals through appropriate channels.

By following these guidelines, you can ensure that the application of chemicals is conducted responsibly, minimizing risks to human health, the environment, and non-target organisms while

effectively managing the pest issue in the field. Regular training, ongoing monitoring, and adherence to best practices are essential for sustainable and responsible chemical use in agriculture.

4.9. Pest resistance to chemicals

Pesticide resistance is a phenomenon where pests develop a decreased susceptibility to a pesticide that was previously effective at controlling the pest. This occurs when the pest population evolves via natural selection, with the most resistant specimens surviving and passing on their acquired heritable traits to their offspring. The evolution of pesticide resistance is usually discussed as a result of pesticide use, but it is important to keep in mind that pest populations can also adapt to non-chemical methods of control.

Resistance to pesticides has been reported in all classes of pests, including crop diseases, weeds, and rodents. The Insecticide Resistance Action Committee (IRAC) defines insecticide resistance as "a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species". Over 500 species of pests have evolved a resistance to a pesticide.

To combat pesticide resistance, it is important to use integrated pest management (IPM) strategies that incorporate a range of pest control methods, including biological, cultural, and chemical methods. IPM strategies aim to minimize the use of pesticides and reduce the risk of resistance developing.

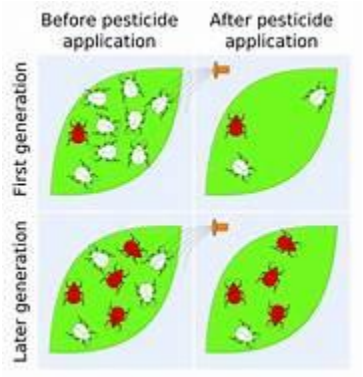


Figure 4.1 pests resistance to pesticide

4.10. Implementing a maintenance program for application and personal protective equipment

Implementing a maintenance program for application and personal protective equipment (PPE) is a crucial step to ensure the safety and effectiveness of chemical pest management. A maintenance program involves developing written policies and procedures, keeping records and logs, and performing regular inspections and repairs of the equipment and PPE.

The benefits of a maintenance program are:

- It extends the lifespan and reduces the cost of equipment and PPE
- It prevents equipment breakdowns and malfunctions that can cause accidents or injuries
- It ensures the optimal performance and accuracy of equipment and PPE
- It complies with the legal and regulatory requirements and standards

The components of a maintenance program are:

- A maintenance plan that specifies the type, frequency, and responsibility of maintenance tasks for each piece of equipment and PPE

- A maintenance schedule that outlines the dates and times of maintenance activities and inspections
- A maintenance checklist that lists the steps and criteria for each maintenance task and inspection
- A maintenance record that documents the details and results of each maintenance activity and inspection

Some of the best practices for implementing a maintenance program are:

- Train the staff on the proper use, handling, and maintenance of equipment and PPE
- Follow the manufacturer's instructions and recommendations for equipment and PPE
- Use the appropriate tools, materials, and methods for maintenance tasks and inspections
- Store and dispose of equipment and PPE in a safe and secure manner
- Review and update the maintenance program regularly and make improvements as needed

4.10.1. **Planning maintenance of application and protective equipment**

Instruction given by the manufacturers for cleaning, lubricating, and adjustment should be carefully learnt. An operator should familiarize himself with this instructions and working of the machine (equipments). It must be cleaned, washed and dried prior to storage and should be stored under such condition where it will keep dry.

Before putting the equipment to use, lubrications should be done according to instructions. Calibration of sprayers and dusters, in relation to the formulation of pesticides should be made, so that the correct dose is applied. Only those formulations for which the equipment is designed should be used

4.10.2. Supervising implementation.

Once planning for maintenance of application and personnel protective equipment is made ,then it must be supervised as to be implemented according to manufacturer's instruction.

4.10.3. Checking equipment's' function prior to use

- Check equipment's function (e.g. sprayer) before use.
- Do ensure any damaged equipment repaired before use.
- Check the nozzle is working correctly and do replace if necessary.
- Clean equipment's after use
- Store spraying equipment securely away children and animals.
- Always store equipment's separately from other.
- Wash gloves, aprons, boots, and face shields after use.

4.11. Implementing recording systems for chemical storage and use

4.11.1 Complying records with legalization and regulation

The records of implementation in chemical storage and use must be complying with legalization and regulation written on instruction label.

4.11.2 Recording risk assessment and control strategy

Risk assessment is important in chemical use because to take correction action in the futures. In the chemical use and at work place there may be risk to be occur so that the risk to be occurred and the control strategy to be taken in at that time must be recorded. Things have to be recorded are;

- Type of risk occurred
- Types of chemical that cause
- Form of that chemical (dust, liquid or gas)
- Date of risk occurred

- Control strategy taken -are have to recorded.
- Name and qualification of the person making recorded

It is an appropriate time to bring responsibility for record keeping and responsible Behavior home to where it should rest - with the farmer that is growing the crop and Reaping the final benefit.

Regulation should ensure that records kept by farmers have to be made available During any investigation, including the name of the ground contractor they used and the contractor's contact details.

Why keep records?

- Records can help you remember what happened in previous crops (what worked well/badly).
- ✓ What was used when and on what
- ✓ Chemical store records
- ✓ Accidents and incidents (health and safety).

4.11.3. Implementing clean up procedures

4.11.3.1. Instructions for cleaning-up materials and equipment's

- **Rinsing containers**

There are three types of system employed to rinse emptied containers. Manual rinsing is typically used by knapsack sprayer operators whilst, the other methods are normally associated with tractor powered sprayers

- ✓ Manual rinsing
- ✓ Pressure rinsing. A hose fitted with a spike - containing a nozzle - punctures the bottom of the container forcing water into the container, washing into the spray tank or sprayer mixing bowl.

- ✓ Integrated rinsing. The rinsing mechanism is usually built onto the sprayer‘s induction bowl or closed transfer system but can be an independent system. This fast, safe way washes containers and minimises the risk of spills. Most popular mechanised cleaning method

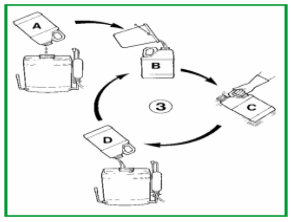
- **Manual Triple Rinsing of Containers**

a. Drain the container
b. Add clean water 25-30% of container capacity
c. Replace cap firmly and shake vigourously for at least 30 seconds
d. Empty rinsings into spray tank and drain container for 30 seconds
e. Spray the rinsings.

Repeat steps b-d at least twice more (until rinse water is clear)

Wear suitable protective clothing when rinsing containers.

NB:-Comply with local legislation where relevant



A. Add clean water to emptied pesticide containers



B. Replace cap and shake container. Add washings to sprayer and repeat twice more



C. Store emptied, cleaned containers, with tightened caps, upright in secure area ready for disposal



A study showed that triple rinsing containers with 30% water volume reduced chemical residues 120 times more efficiently compared with double rinsing with 20% water volume. Rinsing water volume is more important that the amount of time taken shaking the container.

Studies have shown that triple rinsing not only saves product but leaves the containers clean.

Thorough manual triple rinsing will remove 99.99% of chemical residues.

Rinsing non solid packaging (normally associated with dry formulations) is harder and has a higher risk of spillages due to the flimsy nature of the packaging.

4.11.3.2. Appropriate tools used in cleaning-up materials and equipment's

- For conveying water
- Container which is used to collect the water after rinsing
- Water hose Bucket used to fetch water
- Jug used to pour water

4.11.3.3. Disposal of containers and unused chemicals or biological agents

Disposal of Empty Crop Protection Product Containers

Where ever possible empty, washed containers should be disposed of through collection and recycling schemes.Collected containers can be either:-

- Recycled to make plastic products
- Used for power generation (fuel stock for cement kilns or power station)

- Destroyed in a high temperature incinerator (temperatures above 900 degrees C are required to ensure efficient burning

Metal **Glass** **Other materials**



Puncture **crush** **Burn to ash (where legal)**



Bury **Bury** **Bury**

Guidelines for Disposal of Pesticides and Empty Containers

Always dispose of pesticides and empty containers so they pose no hazard to humans or the environment. Follow label directions and consult your local extension agent if you have questions. The best solution to the problem of what to do with excess pesticide is to avoid having any.

Waste minimization strategies include:

- Buy only the amount needed for a year or a growing season.
- Minimize the amount of product kept in storage.
- Calculate how much diluted pesticide you will need for a job, and mix only that amount.
- Apply pesticide with properly calibrated equipment.
- Use all pesticides in accordance with label instructions.
- Purchase pesticide products packaged in such a way as to minimize disposal problems, or packaged in containers that have legal disposal operations available in your area.

The best disposal option for excess usable pesticide is to find a way to apply the material as directed by the label. Please note that the total amount of active ingredient applied to a site, including all previous applications, must not exceed the rate and frequency allowed by the labeling.

Other pesticide waste disposal options include:

- Follow valid label disposal directions.
- Return product to the dealer, formulator, or manufacturer.
- Participate in a federal indemnification program for canceled/suspended products.
- Employ a professional waste-disposal firm.
- Participate in a state or local "clean day"

4.12. Taking appropriate precautions during handling and disposal of pesticides.

Taking appropriate precautions during the handling and disposal of pesticides is crucial to ensure the safety of individuals, protect the environment, and comply with regulatory standards.

Here's a detailed guide on the precautions to be taken at each stage:

4.12.1 Handling Pesticides:

- **Personal Protective Equipment (PPE):-**
  - ✓ Appropriate Attire: Wear appropriate clothing, including long sleeves, pants, chemical-resistant gloves, and closed-toe shoes.
  - ✓ Eye Protection: Use safety goggles or a face shield to protect the eyes.
  - ✓ Respiratory Protection: Use respiratory protection, such as a mask or respirator, when required.
- **Handling Techniques:**
  - ✓ Avoid Skin Contact: Minimize skin contact with pesticides by using gloves and other protective clothing.

- ✓ No Eating or Drinking: Avoid eating, drinking, or smoking while handling pesticides to prevent ingestion.
- ✓ Frequent Hand Washing: Wash hands thoroughly after handling pesticides.

- **Mixing and Loading:**
  - ✓ Well-Ventilated Area: Mix and load pesticides in a well-ventilated area to minimize inhalation exposure.
  - ✓ Pre-Measured Containers: Use pre-measured containers to avoid spills and overuse.
- **Equipment Inspection:**
  - ✓ Regular Maintenance: Regularly inspect and maintain application equipment to prevent leaks and malfunctions.
  - ✓ Calibration: Calibrate equipment to ensure accurate application rates.
- **Emergency Preparedness:**
  - ✓ Emergency Kit: Have an emergency kit containing first aid supplies, emergency contacts, and spill response materials.
  - ✓ Emergency Response Plan: Be familiar with and follow an emergency response plan in case of accidental exposure or spills.

4.12.2 Storage of Pesticides:

- **Secure Storage:**
  - ✓ Locked Storage: Store pesticides in a locked and secure area to prevent unauthorized access.
  - ✓ Restricted Access: Limit access to trained personnel only.
- **Temperature Control:**
  - ✓ Temperature Regulation: Store pesticides at recommended temperatures to maintain their effectiveness.
  - ✓ Avoid Freezing: Protect pesticides from freezing, as it can alter their composition.
- **Separation and Segregation:**

- ✓ Incompatible Chemicals: Store pesticides separately based on compatibility to prevent unintended reactions.
- ✓ Segregation from Food and Feed: Keep pesticides away from areas where food and animal feed are stored.

- **Ventilation:**
  - ✓ Well-Ventilated Storage: Ensure proper ventilation in storage areas to prevent the build-up of fumes.
  - ✓ Avoid Confined Spaces: Avoid storing pesticides in confined spaces without adequate ventilation.

4.12.3 Disposal of Pesticides:

- **Follow Label Instructions:**
  - ✓ Read and Follow Instructions: Adhere to label instructions for disposal methods provided by the pesticide manufacturer.
  - ✓ Follow Local Regulations: Comply with local, state, and national regulations governing pesticide disposal.
- **Empty Containers:**
  - ✓ Triple Rinse: Triple rinse empty containers thoroughly before disposal.
  - ✓ Puncture or Crush: Puncture or crush containers to prevent reuse and recycle according to local guidelines.
- **Unused Pesticides:**
  - ✓ Return to Manufacturer: Return unused pesticides to the manufacturer or authorized collection programs when possible.
  - ✓ Disposal Events: Participate in pesticide disposal events organized by local authorities.
- **Spill Response:**

- ✓ Containment: Immediately contain and control spills to prevent further environmental contamination.
- ✓ Spill Kit: Have a spill response kit on hand with absorbents, gloves, and other necessary materials.

- **Professional Disposal Services:**
  - ✓ Hire Professionals: Consider hiring professional disposal services for large quantities of pesticides or highly hazardous materials.
  - ✓ Chemical Collection Programs: Utilize community programs for safe disposal of pesticides.

4.12.4 General Safety Considerations:

- **Training and Education:**
  - ✓ Training Programs: Provide comprehensive training for individuals involved in the handling and disposal of pesticides.
  - ✓ Stay Informed: Keep personnel informed about changes in regulations and best practices.
- **Communication:**
  - ✓ Communication Protocols: Establish clear communication protocols between individuals involved in pesticide use and disposal.
  - ✓ Community Awareness: Inform the local community about pesticide use and disposal practices.
- **Record Keeping:**
  - ✓ Documentation: Maintain detailed records of pesticide use, storage, and disposal activities.
  - ✓ Compliance Records: Keep records to demonstrate compliance with regulatory requirements.
- **Environmental Impact Assessment:**
  - ✓ Ecological Risk Assessment: Assess the potential environmental impact of pesticides, considering the toxicity of active ingredients.

- ✓ Mitigation Measures: Implement measures to minimize environmental harm, such as buffer zones and runoff prevention.

- **Continuous Improvement:**
  - ✓ Feedback Mechanism: Establish a feedback mechanism to gather insights from personnel and stakeholders.
  - ✓ Adaptation of Strategies: Be prepared to adapt pesticide handling and disposal strategies based on changing circumstances and emerging technologies.

Implementing these precautions during the handling and disposal of pesticides is essential to mitigate risks, protect human health, and safeguard the environment. Regular training, communication, and adherence to safety protocols contribute to the overall safety of pesticide management practices in agriculture.

Self-check-4	Written test

Part I: Write true if the statement is correct or false statement is incorrect (2pts each)

1. Pesticide resistance is a phenomenon where pests develop a decreased susceptibility to a pesticide that was previously effective at controlling the pest.
2. The pest life cycle and its behavior affect the timing of pesticide application.
3. Mix and load pesticides in a well-ventilated area to minimize inhalation exposure.
4. Regular inspection and maintain application equipment prevents leaks and malfunctions
5. Wearing gloves maximizes skin contact with pesticides

Part II: Choose the correct answers from the given alternatives (1pts each)

1. Which one is not the step that can be followed to identify the chemical requirements for pest management?

   A. Determine the pest threshold B. Select the appropriate pesticide C. Calculate the pesticide dosage D. None

2. Which one of the following are handling techniques of pesticides?
   A. Avoid skin contact
   B. No eating or drinking
   C. Frequent hand washing
   D. All
3. How the pesticide work to kill or control pest is: A. mode of action B. Selectivity C. pesticide

Part III. Give short answers for the following questions

1. List the steps followed to identify the chemical requirements for pest management.

2. List the four stages of insect pest life cycle

3. List types of chemical and explain them

4. Write at least 3 Waste minimization strategies

Operation sheet 4	**Implementing chemical application**

Objectives

1. To familiarize the learner with chemical application

2. To prepare materials, tools and equipment's for chemical application

Material required

1, Plot of land

2. Back pack sprayer (knap sack)

3. Meter

4. Protective equipment (cover all, glove and clothing)

5 Clean wastes

6. Chemical (2-4D)

7. Measuring material (cc)

Procedures

step1 Equipment serviceability: Check the equipment for any damage or wear and tear before use.

step2 Adjustment and control checks: Ensure that the equipment is properly calibrated and adjusted before use.

step3 Spray calibration: Calibrate the sprayer to ensure that the correct amount of pesticide is being applied and measuring the area.

step4 Tank filling: Fill the tank with the correct amount of pesticide and water.

step5 Prior warnings: A Post warning sign to alert people in the area that pesticide application is taking place.

step6 Cleaning ("decontamination") of equipment and PPE: Clean the equipment and personal protective equipment (PPE) after use to prevent contamination [1].

step7 Disposal of surplus spray: Dispose of any leftover pesticide in accordance with local regulations.

step8 Disposal of empty chemical containers: Dispose of empty chemical containers in accordance with local regulations.

step9 Equipment maintenance and repair: Regularly maintain and repair equipment to ensure that it is functioning correctly and safely.

step10 Equipment storage: Store equipment in a dry, secure location to prevent damage and theft.

LAP Test	Implementing chemical application

Instruction: You are required to perform any of the following

1. Perform chemical application

LG #31	LO#5 Ensure the correct selection and application of chemicals

Instruction sheet:

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

- Identifying, preparing, reading and interpreting Suitable chemicals and procedures for application and risk controls
- Selecting Application equipment in accordance with procedures
- Implementing Ensure calibration of equipment according to directions and standards
- Implementing Pre-operative checks and maintenance procedures
- Assessing Meteorological conditions as appropriate to application prior to and during chemical application
- Conducting Chemical application safely in accordance with hazards associated with the chemicals concerned
- Dealing with Chemical spills or accidents according to 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, prepare, read and interpret Suitable chemicals and procedures for application and risk controls
- Select Application equipment in accordance with procedures
- Implement Ensure calibration of equipment according to directions and standards

- Implement Pre-operative checks and maintenance procedures
- Assess Meteorological conditions as appropriate to application prior to and during chemical application
- Conduct Chemical application safely in accordance with hazards associated with the chemicals concerned
- Deal with Chemical spills or accidents according to 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-5

5.1. Reading and interpreting procedures for application

Reading and interpreting procedures for the application of pesticides requires a high level of skill and knowledge. The Ohio State University has published a comprehensive guide on best practices for effective and efficient pesticide application, which includes the following major principles:

- Positive identification of the pest(s)
- Selecting the pesticide specifically designed to control the identified pest(s)
- Selecting the proper equipment, particularly the correct type and size of nozzle
- Applying the pesticide at the right time and under the right conditions

The guide also provides detailed information on the tasks required for maximum biological efficacy, such as uniform mixing of pesticides in the sprayer tank, choosing a pump with sufficient capacity to deliver the required gallonage to the nozzles, ensuring hoses and fittings between the pump and nozzles are properly sized to minimize pressure losses, and ensuring minimum loss of pesticides as they are delivered from the nozzles to the target.

It is important to follow safety guidelines and take necessary precautions when handling toxic chemicals and pesticides to avoid any accidents or health problems. Anyone who work with chemicals must have to read, interpret and understand the procedures of chemical application written on ,either instructions on the chemical labels , in an operator's manual or MSDS.

5.2 Selecting chemical application equipment

The efficacy of all the chemicals depends up on their quality and application techniques. But among pesticides more precision is required for herbicides application as compared to insecticides and fungicides.

Application equipments: are used to apply difference pesticides in different forms.

Types of sprayers

A. **Hand operated sprayers: -** These are sprayers in which pressure is operated with human power or force many small capacity sprayer e.g. Knap sack or Back pack, foot sprayer, and Rocker sprayers. Bucket sprayer is common hand operated sprayers. Among these knapsack sprayer is very important (popular)due to its convenience in application as well as low cost of pump. Single person can operate this pump and about 1ha land can be sprayed in one dry part.

B. **Small power sprayers; t**he sprayers are operated 1to 3 horse power petrol or diesel engine i.e. Less power gene rooters. There consists of pump section chamber, delivery chamber, and discharge line. The spray liquid is blown out through primary unit by means of an intensive air .Air current travels through the nozzle with a great velocity and give spray maximum efficiency. The spray liquid blows through PVC tube and reach the nozzle where the speedy air blasts the liquid into particles. Due to fine particles the discharge capacity varies from 125 up to 200 L/ha which is very low as compared to knapsack sprayer.

C. **Tractor mounted sprayers:** This sprayers are useful for spraying of pre- emergence or post emergence pesticides

D. **Aerial sprayers** used for large area to treat water bodies or for insect control in large homogenous crop area.

E. Hand hold sprayer; vibrato jet a (controlled droplet application). Granular applicator used to apply granules in crop field. It has gravity flow system with rotating agitator.

The following considerations have to be taken into account during selection of application equipments.

i. Nozzle should be set properly
ii. Delivery should be carefully planned
iii. On each day after spraying the machine should be washed
iv. Pesticide should not be drained in to farms, ponds and water bodies.

5.3. Implementing equipment calibration

5.3.1. Calibration of hand held spraying equipment

- Always follow high hygiene standards when working with crop protection products
- Spraying equipment must be calibrated at least once in every season of use
- Keep calibration records
- Product labels often contain recommendations on optimum application volumes, timing and the choice of nozzles

Factors affecting application volume

- Forward speed
- Nozzle size, type and condition
- Sprayer pressure
- Operator accuracy

Forward speed: Forward speed will vary between spray operators

- ✓ Always calibrate in the actual spraying situation
- ✓ Crop density and growing conditions will have an effect on walking speed (flood/irrigated crops)
- ✓ It is very difficult to maintain an even forward speed when trying to walk at an unnatural forced pace
- ✓ Do not use adjusted forward speed to vary the output of hand held equipment unless there are no other alternatives to achieve the desired application volume

Sprayer Pressure

- Built in control systems
  - ✓ Pressure regulators

- External control sytems
  - ✓ Control flow valves

Several manufacturers make control flow valves that can be fitted behind the spray nozzle to keep constant pressure. Valves are available with a working pressure of 1bar (yellow), 1.5bar (red), 2bar (blue) and 3 bar (green).



Figure 5.1 different types of valves

Nozzles - fans, hollow cones

- Changing nozzles gives the greatest flexibility in spray liquid sprayer output
- Many different types of nozzles are available which can generate contrasting application volumes and spray qualities. Nozzles are colour coded according to emission rates



Figure 5.2 different types of Nozzles

Operator accuracy

- Even with a full, calibrated and checked sprayer operator accuracy can have a major impact on the final results achieved. It is important to:
  - ✓ Maintain a constant forward speed

- ✓ Keep the nozzle at a uniform height above/from the target
- ✓ If using a lever operated knapsack maintain a uniform pumping action
- ✓ If spraying in a Zig Zig pattern ensure forward speed is suited to the width of the spray area to ensure even cover
- ✓ Ensure accuracy in mixing the correct dose of product to the spray tank

Before carrying out any calibration:

- Fill the sprayer with water and test that the sprayer is working well and has no leaks.
- Check that the nozzle is functioning correctly. Change the nozzle if needed.

Why calibrate?

- Enables the accurate calculation of how much product to add per tank and that product‘s optimal safe use. Under-dosing can lead to product failure, over dosing can lead to un-acceptable crop residues and other risks.
- Both under-dosing and over-dosing lead to wasted product and wasted money.

This method allows the calibration of single and multi nozzle sprayers without the use of calculations.

- **Items required**
  - ✓ A clean non-leaking knapsack with appropriate working nozzle
  - ✓ A means of measuring swath width and area to spray
  - ✓ Graduated measuring jug
  - ✓ Clean water
  - ✓ Stopwatch or watch with a second hand
  - ✓ Calibration disc/chart
  - ✓ Calibration record sheet

Calibration process

I. Fill the knapsacks spray tank to maximum rated capacity with clean water.

II. Set the correct operating pressure.

III. Spray holding the nozzle at the required height and measure the swath width.

Using the calibration chart find out how far you must walk to cover $100m^2$

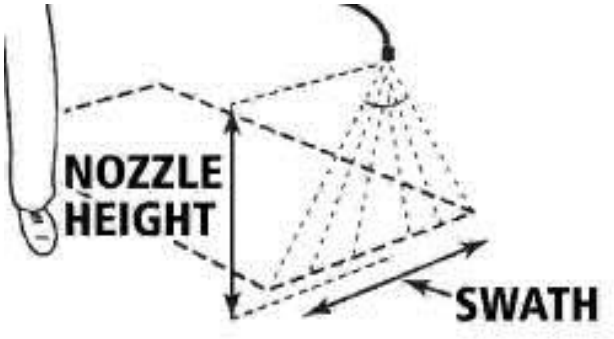


Figure 5.3 Calibration

Most nozzles have an optimum height of 50cms above the first intercepting surface

Calibration records - easy calibration

The following items should be recorded during a calibration:

Kalibottle‘ calibration method

This method allows the calibration of sprayers using the Kalibottle.

Items required:

- A clean non-leaking knapsack with working nozzle
- A means of measuring swath width and area to spray

- Kalibottle
- Clean water
- Stopwatch or watch with a second hand
- Calibration disc/chart
- Calibration record sheet

Kalibottles are designed to fit over the sprayer nozzle to collect its emitted spray during a calibration. The Kalibottle has a graduated scale which allows the user to determine the application volume per hectare.

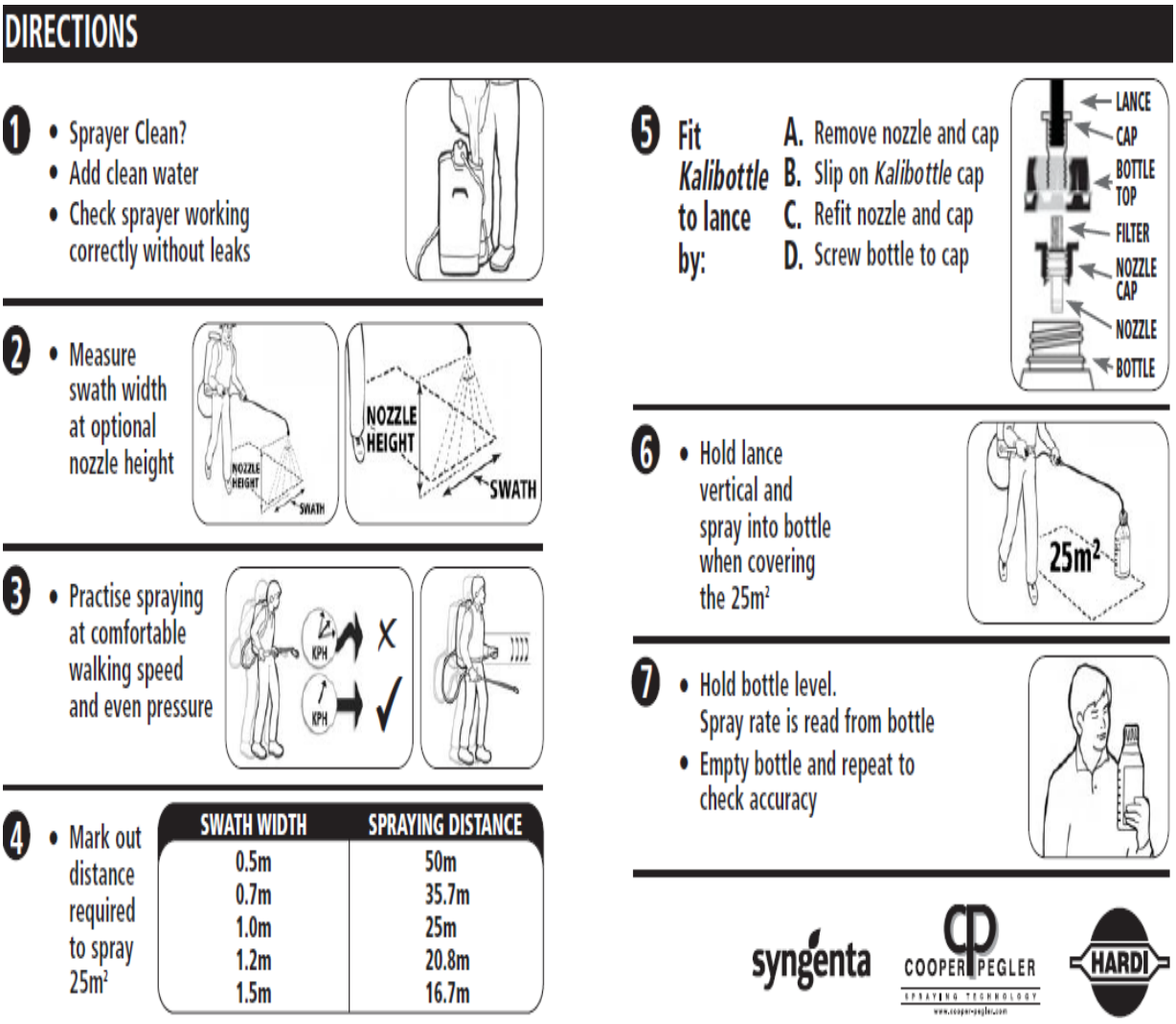


Figure 5.4 the steps to achieve an accurate calibration

Follow the steps to achieve an accurate calibration:

The formula for sprayer's calibration is;

Q = V1-V *A/a

Where

Q = Quantity of water required (L/ha)

V1 = volume of water (L) in the sprayer before spray.

V2 = Volume of water (L) in the sprayer after spray

A = one hectare (10000m^2)

a = measured area of spray (m^2)

Example; Quantity of water taken in hand operated knapsack sprayer is 10 liters. After spraying an area of 40m^2 the remaining water in the tank is 8 liters. Find out the quantity of water solution required to cover one hectare of field.

Solution

Q (L/ha) = 10-8*10000/40= 500 liters.

Area covered per unit hour can be calculated using formula given below.

Area (ha) = walking speed (m/hr) x spray width (m)/10000m^2

Example; a person walks with speed of 1km/hr covers swath of 0.5m wide. How much area will be cover in one hour (Answer =0.05ha/hr)

Chemical formulation: is mixture of one or more pesticide active ingredients with inert ingredients such as diluents. Active ingredients are chemicals in pesticide produce that control pest.

Ingredients are the chemicals in the pesticide product that added to dilute the pesticide or make the product safer , more effective , easer to mix , apply and more convenient to handle.

Procedures of calibration;

Step1. Measure the small area in sqm (L*W)

Step2. Pour measured quantity of water in tank of sprayer (water) = A liter.

Step3. Spray the area uniformly with pump and nozzle tube used for spray.

Step4. Measure the left over water in tank (water) = B liter.

Step5. Calculate the amount of water actually used for spraying the plot by subtracting (A-B) = water used (C) liter.

Step6. For 'x' sum water needed = c liter, then spray liquid for 1ha = c*10000/x, where; c=amount of water used and x=area in which used.

Disadvantages of chemicals (pesticides) in pest management

- Effects on non-target pests may harm useful organisms such as honeybee or Beneficial insects used as biological pest control.
- Cost of pesticides although low cost for use of pesticides, in other situation

  Pesticides are expensive choice; this is true for management of certain pests where biological control is a feasible alternative
- Residues and drift; residues remain in the soil and or in harvested produce. After application of pesticides. Drift occur when pesticides applied during unfavorable weather conditions. Wind may carry pesticides to area adjacent to crop fields and resulting in damage to neighboring plants and animals
- Toxicity because pesticide are toxic chemicals they have potential to be toxic humans, livestock and wild life
- Create pest problem; several potential pest problem s can develop with repeated use of pesticides. Such problems are;

  ✓ Pesticide resistance the repeated use of single pesticide may lead to the selection of pests that are resistant to pesticide.This is an enormous problem for use of all type of pesticides.

  ✓ Pest resurgence when the pesticide (usually on insecticide) kills the target pest ,and also kills beneficial insects ,the pest population often increase to level higher than the level preceding the application. The phenomenon is called pest resurgence (recovery).

- Pesticide treadmill; miss use of pesticide lead to more frequent application and Require higher rates of the product needed to control the same pest before This Phenomenon has been called pesticide treadmill.

5.4. Checking and implementing maintenance procedures

When it comes to maintaining pesticide application tools, it is important to follow proper procedures to ensure that the equipment is functioning correctly and safely. The Food and Agriculture Organization of the United Nations (FAO) has published guidelines on good practice for ground application of pesticides, which include maintenance and repair of equipment.

Here are some general steps for maintaining pesticide application tools:

- Equipment serviceability: Check the equipment for any damage or wear and tear before use ⁞
- Adjustment and control checks: Ensure that the equipment is properly calibrated and adjusted before use.
- Spray calibration: Calibrate the sprayer to ensure that the correct amount of pesticide is being applied.
- Tank filling: Fill the tank with the correct amount of pesticide and water.
- Prior warnings: Post warning signs to alert people in the area that pesticide application are taking place.
- Cleaning ("decontamination") of equipment and PPE: Clean the equipment and personal protective equipment (PPE) after use to prevent contamination.
- Disposal of surplus spray: Dispose of any leftover pesticide in accordance with local regulations
- Disposal of empty chemical containers: Dispose of empty chemical containers in accordance with local regulations
- Equipment maintenance and repair: Regularly maintain and repair equipment to ensure that it is functioning correctly and safely
- Equipment storage: Store equipment in a dry, secure location to prevent damage and theft.

Once the correct pesticide and their appropriate application procedure is selected. Then it must be checked and implemented carefully.

5.5. Assessing meteorological conditions

When applying pesticides, it is important to consider the current and future weather conditions to ensure efficient and effective pest control while mitigating drift. The four key weather factors that affect pesticides are temperature, wind, precipitation, and humidity. The worst weather conditions for applying pesticides are strong wind, high temperature, intensive rain, and low humidity.

It's very important to check weather conditions before using chemicals. The weather can play a very important part in deciding which chemicals to use because certain weather conditions can affect chemicals and how to they should be applied. Here are some examples: You should always consider the strength of wind when you're spraying. Generally, you shouldn't spray when winds are strong because the chemicals can drift or miss their target. They could also be carried around by the wind and settle on other parts of the farm, harming stock in ponds and the environment. Ideally you should spray when there is a light to gentle breeze (approx. 3-6 km/hour).

If it rains when you are applying chemicals or just after, the rain water can dilute the strength of the chemical you've just applied. The rain can also cause your chemicals to run off from the area you are targeting. Extreme temperatures, both hot and cold, are not good for applying chemicals.

- Some chemicals can evaporate in high temperatures.
- Water-soluble chemicals can evaporate in extreme temperatures. This can cause the chemical to be less effective or become useless.

It is best to use your chemicals early in the morning or late afternoon when the temperature is less likely to be extreme.

5.6. Conducting application

5.6.1 Conducting chemical application

Chemical application is one of the methods to control crop pests, such as insects, diseases, and weeds. Chemicals that are used to control crop pests are called pesticides, and they can be classified into different types, such as herbicides, fungicides, insecticides, etc. Depending on the type of pest, the type of crop, and the environmental conditions, different pesticides and application methods may be required.

Some of the common methods of pesticide application are:

- **Spraying**: This method involves applying pesticides in liquid form using a sprayer, such as a hand-held, backpack, or tractor-mounted sprayer. Spraying can cover large areas and reach the target pests effectively, but it may also cause drift, runoff, or contamination of non-target areas or organisms.
- **Dusting**: This method involves applying pesticides in powder form using a duster, such as a hand-cranked, motorized, or aerial duster. Dusting can be used for crops that have a dense canopy or are difficult to spray, but it may also be affected by wind, humidity, or rain.
- **Fumigation**: This method involves applying pesticides in gas form using a fumigant, such as ethylene dibromide, methyl bromide, or aluminum phosphide. Fumigation can be used for soil, seeds, or stored products, but it may also pose health and environmental risks, and require special equipment and safety measures.
- **Baiting**: This method involves applying pesticides mixed with food or other attractants using bait, such as a granule, pellet, or trap. Baiting can be used for pests that feed on specific substances, such as rodents, ants, or snails, but it may also attract non-target animals or cause secondary poisoning.

The choice of the pesticide and the application method depends on various factors, such as the pest biology, the crop characteristics, the weather conditions, the cost and availability of the chemicals and equipment, the safety and environmental regulations, and the efficacy and compatibility of the products[12435]. Therefore, it is important to follow the label instructions, the best management practices, and the integrated pest management principles when conducting chemical application to control crop pests.

Chemicals used for control of disease, pests and weeds need to be applied safely in such manner that they come in to contact with pests in case of direct action or eradication or in case of prophytotoxis , distributed over the surface of the plants to form uniformly distributed resistant deposit to secure appropriate covering (see figure 5.6).



Figure 5.5. Chemical application

Herbicides

Herbicides are chemicals used to control the growth of weeds and kill them. They work best on actively growing weeds. There are many different kinds of herbicides.

A **selective herbicide**: is a chemical that kills or controls specific types of plants, such as weeds, without harming the desired crop or vegetation.

Non-selective herbicide: is a chemical that kills or controls all types of plants, regardless of their species or characteristics. For example, 2,4-D is a selective herbicide that targets broadleaf weeds, while glyphosate is a non-selective herbicide that affects most plants. Selective and non-selective herbicides have different advantages and disadvantages, depending on the weed problem, the crop situation, and the environmental impact. Therefore, it is important to choose the right type of herbicide and follow the label instructions and best management practices when using them.

How herbicide act

Contact herbicides Will only kill the part of the plant they come in contact with. Example: diquat.

Translocated or systemic herbicides They move through the plant after being sprayed on the leaves or being taken up by the roots. Examples: glyphosate, fluazifop.

Pre-emergent herbicides Designed to kill seeds and underground storage organs, such as rhizomes and bulbs, by direct contact as they germinate or start to grow. Example: chlorsulfuron.

Post-emergent herbicides Designed to kill the plant after the seedling stage. Examples: glyphosate, fluazifop.

How long they last in the soil

Non-residual herbicides These are quickly inactivated by the soil. Example: glyphosate.

Residual herbicides These remain active in the soil for varying periods of time depending on the rate of application and the microbial breakdown capacity of the soil. Example: simazine.



With residual herbicides you will need to wait a period of time before you can replant the soil.

Insecticides

Insecticides are chemicals used to control pests that infest cultivated plants or to eliminate disease-carrying insects in specific areas. There are many types of insecticides available on the market, both synthetic and organic, to suit just about every area of your landscape.

Here are some of the best insecticides of 2024 according to The Spruce:

- **Bonide Dead Bug Brew**: This insecticide can kill a wide variety of pests, such as borers, beetles, caterpillars, leaf miners, and many more. It can be applied directly to fruits and vegetables and is safe for use around children and pets. However, it can cause collateral damage to beneficial species.
- **BioAdvanced 3-in-1 Insect Disease and Mite Control**: This product offers mite and fungi control and is well-researched. It is suitable for garden beds and can be used around edibles.

- **Ortho Home Defense Insect Killer**: This insecticide is best for indoor use and can kill a wide range of insects, including ants, roaches, spiders, and stink bugs. It is safe for use around children and pets .
- **Natria Neem Oil Spray**: This organic insecticide is made from neem oil and can be used on a variety of plants, including roses, flowers, fruits, and vegetables. It is safe for use around children and pets.
- **Wondercide Outdoor Pest Control**: This insecticide is best for lawns and can kill and repel a wide range of pests, including fleas, ticks, and mosquitoes. It is safe for use around children and pets.

It is important to note that insecticides can cause poisoning after being swallowed, inhaled, or absorbed through the skin. If you are handling insecticides, it is important to follow the instructions on the label and wear protective clothing. If you experience symptoms of poisoning, seek medical attention immediately.

Systemic insecticides are those that are designed to be sprayed onto plant material. The chemical then moves through the vascular system of the plant. When insects feed on the plant by sucking out the sap, they are killed by the insecticide in the sap.

- Ovacides are chemicals designed to kill the insect at the egg stage of development.
- Larvicides are those chemicals that are designed to kill the insect in the larval stage of their development.

Fungicides

Fungicides are pesticides that are used to kill parasitic fungi or their spores. They are used to control fungi that damage plants, including rusts, mildews, and blights. Fungicides can be classified into three categories: contact, Trans laminar and systemic. Contact fungicides are not absorbed into the plant

tissue and protect only the plant where the spray is deposited. Translaminar fungicides redistribute the fungicide from the upper, sprayed leaf surface to the lower, unsprayed surface. Systemic fungicides are taken up and redistributed through the xylem vessels.

There are many types of fungicides available on the market, both synthetic and organic, to suit just about every area of your landscape. Some of the most common types of fungicides include sulfur, copper salts, neem oil, rosemary oil, jojoba oil, the bacterium Bacillus subtilis, and the beneficial fungus Ulocladium oudemansii.

It is important to note that fungicides can cause harm to humans and animals if ingested or inhaled. If you are handling fungicides, it is important to follow the instructions on the label and wear protective clothing. If you experience symptoms of poisoning, seek medical attention immediately.

Fungicides are chemicals that are designed to kill fungi. They can be:

- preventative (preventing fungus from growing)
- curative (killing fungus they come into contact with)
- Systemic (travelling through the plant and killing fungus that grows on the plant).

5.7. Dealing with chemical accidents

Exposure to toxic chemicals can lead to accidents

Exposure to toxic chemicals can also lead to higher rates of accidents at work. For example, chemicals such as solvents and asphyxiants may slow your reaction time by affecting your nervous system or limiting the amount of oxygen that gets to your lungs. A slow reaction can be very serious (or even fatal) if you are in a dangerous situation that requires an immediate response. Unfortunately, when accidents occur in the workplace, management often blames the worker, claiming he or she was careless. This tendency to “blame the victim” is yet another reason to learn about the substances you work with, to make sure the proper control measures are in place, and to know your rights!

5.7.1. First aid

- Protect yourself by wearing appropriate protective equipment and clothes.
- Keep people (victim) away from any further spillage.
- Have current labels and material safety data sheets (MSDS)
- Assemble first aid kit with necessary suppliers.
- Always have clean source of water.
- If oral or dermal exposure is occurred the first objective is usually to dilute pesticide and prevent absorption.
- If inhalation exposure occurs, first protect yourself and then get the victim to fresh air immediately.
- Never give anything orally to an unconscious person
- If the spillage involves a significant volume notify to local emergency services.

https://www.youtube.com/watch?v=A_JsWGhjjbA

Self-check-5	Written test

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Insecticides are chemicals that are designed to kill or treat weed
2. Contact herbicides will only kill the part of the plant they come in contact with.
3. Calibration of sprayer to ensure that the correct amount of pesticide is being applied.
4. Some chemicals can evaporate in high temperatures.

1. Fungicide can be:

A. preventative B. curative C. Systemic D. All

2. Chemicals designed to kill the insect at the egg stage of development is: A. Ovacides

B. Larvicides C. Herbicide D. None

3. Which one is part of Knapsack sprayer? A. Tank B. Pressure pumps C. A&B

4. Which one is the method of pesticide application? A. Spraying B. Dusting C. Fumigation D. All

1. What is importance of selecting application equipment?

2. List the procedures of equipment calibration.

3. Write some consideration needed in spraying.

4. List the worst weather conditions for applying pesticides

Operation sheet 5	Implementing equipment calibration

Objectives

1. To familiarize the learner with equipment calibration

2. To prepare materials, tools and equipment's for chemical application

Material required

1, Plot of land

2. Back pack sprayer (knap sack)

3. Meter

4. Protective equipment (cover all, glove and clothing)

5. Clean wastes

6. Chemical (2-4D)

7. Measuring material (cc)

Procedures

1. Measure the small area

2. Pour measured quantity of water in tank of sprayer (water)

3. Spray the area uniformly with pump and nozzle tube used for spray.

4. Measure the left over water in tank (water).

5. Calculate the amount of water actually used for spraying the plot

LAP Test	Implementing equipment calibration

Instruction: You are required to perform any of the following

5. Perform Knapsack calibration

LG #32	LO#6 Coordinate contingency plan and document reports

Instruction sheet:

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

- Identifying potential risks Selecting Application equipment in accordance with procedures
- Coordinating Prefer contingency plans Implementing Pre-operative checks and maintenance procedures
- Reporting Contingency plan problem and status Conducting Chemical application safely in accordance with hazards associated with the chemicals concerned
- Documenting relevant information for continual analysis and effective planning management.

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:

- Coordinate Prefer contingency plans Implementing Pre-operative checks and maintenance procedures
- Report Contingency plan problem and status Conducting Chemical application safely in accordance with hazards associated with the chemicals concerned
- Document relevant information for continual analysis and effective planning management

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

Information Sheet-6

6.1. Identifying potential risks

Contingency planning is a process of preparing for unexpected events or situations that may disrupt the normal operations of an organization. It involves developing alternative courses of action in case the original plans fail or become obsolete.
Coordinate Contingency Plan and Document Reports in Crop Pest Management Practices

Coordinating a contingency plan for pest management is a process of preparing for unexpected events or situations that may disrupt the normal operations of an organization due to pest infestation or outbreak. It involves developing alternative courses of action in case the original plans fail or become obsolete.

Some steps to coordinate a contingency plan for pest management are:

- Identify the trigger for action, such as pest detection, a pest alert, or a pest risk analysis.
- Identify and target a key group of stakeholders, such as the National Plant Protection Organization (NPPO), the relevant ministries, the industry, the research institutions, and the public.
- Identify and describe the area(s) of concern, such as the pest distribution, the host range, the potential impact, and the environmental and social factors.
- Gather the necessary information, such as the pest biology, the pest detection methods, the pest management options, the legal basis, the available resources, and the communication channels.
- Review the information to determine the most appropriate response strategy, such as eradication, containment, or suppression.

- Develop a generic and/or a pest-specific contingency plan, outlining the overall aim, the objectives, the roles and responsibilities, the emergency measures, the surveillance and monitoring, the reporting and evaluation, and the budget and funding.
- Implement the contingency plan, following the procedures and actions specified in the plan, and coordinating with the relevant stakeholders.
- Review and update the contingency plan, based on the changing conditions and pest status, and incorporating the lessons learned and the best practices.

Coordinate Contingency Plans:

- Contingency Plan Team: Establish a dedicated team responsible for coordinating contingency plans. Include individuals with expertise in pest management, agronomy, environmental health, and safety.
- Communication Protocols: Develop clear communication protocols for reporting and responding to emergencies. Identify key personnel responsible for decision-making during contingencies.
- Training and Awareness: Conduct regular training sessions to ensure all team members are familiar with contingency plans and their roles. Enhance awareness about the importance of quick and effective responses.

Documentation of Contingency Plans:

- ✓ Detailed Plans: Document comprehensive contingency plans for various scenarios, such as pest outbreaks, weather-related challenges, equipment failures, or regulatory changes.
- ✓ Responsibilities: Clearly outline the responsibilities of each team member during emergencies. Designate roles for communication, assessment, implementation of actions, and monitoring.

- ✓ Resources Allocation: Document the allocation of resources; including personnel, equipment, and supplies, necessary for implementing contingency plans effectively.

Communication and Reporting:

- ✓ Reporting Channels: Establish reporting channels within the organization. Clearly define how information will be reported, who should be notified, and the timeframe for reporting during emergencies.
- ✓ Status Updates: Develop a standardized format for reporting the status of contingency plans. Include sections for problem description, current status, actions taken, and planned corrective measures.
- ✓ External Communication: Define communication strategies with external stakeholders, such as regulatory agencies, neighboring farms, and emergency services.

Integration with Crop Pest Management Practices:

- ✓ Alignment with SOPs: Integrate contingency plans seamlessly with existing standard operating procedures (SOPs) for Crop Pest Management Practices. Ensure that contingency measures align with routine practices.
- ✓ Continuous Monitoring: Emphasize the importance of continuous monitoring and adaptation of contingency plans based on the evolving nature of pest management challenges.

Simulation Exercises and Training:

- ✓ Simulated Scenarios: Conduct simulated emergency exercises to test the readiness of the contingency plans. Analyze outcomes and identify areas for improvement.
- ✓ Training Programs: Provide ongoing training programs for team members to stay updated on contingency plans, new technologies, and best practices in pest management.

Documentation of Reports:

- ✓ Record-Keeping: Maintain detailed documentation of contingency plans, including contact information, procedures, and updates. Keep records of training sessions, exercises, and actual responses to incidents.
- ✓ Lessons Learned: Document lessons learned from each incident and use them to refine and enhance contingency plans for future implementation.

When using chemicals, it is important to coordinate a contingency plan and document reports. A contingency plan outlines the steps to be taken in case of an emergency, such as a chemical spill. The plan should include the contact information for emergency services, the location of safety equipment, and the procedures for evacuating the area. It is also important to train personnel on the contingency plan and to conduct regular drills to ensure that everyone is prepared in case of an emergency.

Documenting reports is also important when using chemicals. Reports should include information such as the type and amount of chemical used the location of the application, and the date and time of the application. This information can be used to track the use of chemicals and to identify any potential issues or hazards.

Post-Incident Analysis and Continuous Improvement:

- ✓ Analysis: Conduct thorough post-incident analyses to identify successes, challenges, and areas for improvement. Analyze the effectiveness of implemented corrective measures.
- ✓ Adjustments: Implement changes to contingency plans based on lessons learned. Foster a culture of continuous improvement by encouraging feedback and proactive problem-solving.

By addressing these components, agricultural practitioners can effectively coordinate contingency plans and document reports in the context of Crop Pest Management Practices.

Some potential risks during the implementation of Crop Pest Management Practices are:

- **Pest resistance**: The repeated use of pesticides may select for pests that are resistant to the chemicals, making them harder to control and requiring higher doses or more frequent applications.
- **Pest resurgence**: The indiscriminate use of pesticides may kill natural enemies of pests, such as predators and parasites, and disrupt the ecological balance of the agro-ecosystem. This may lead to a rebound or increase of pest populations after the initial suppression[12].
- **Pest replacement**: The elimination of one pest species may create an ecological niche for another pest species to invade and become dominant. This may result in a shift or change of pest problems over time.
- **Environmental pollution**: The excessive or improper use of pesticides may contaminate water, soil, and air, and pose risks to non-target organisms, such as beneficial insects, wildlife, and humans. This may affect the ecosystem services and human health and well-being.
- **Economic losses**: The dependence on pesticides may increase the production costs and reduce the profitability of farmers. Moreover, the occurrence of pest resistance, resurgence, or replacement may reduce the crop yield and quality, and affect the marketability and competitiveness of the products[124].

To avoid or minimize these risks, it is recommended to adopt an Integrated Pest Management (IPM) approach, which is a strategy that aims to reduce the use of pesticides and minimize the environmental and health impacts of pest control. IPM involves using a combination of methods, such as resistant cultivars, crop rotation, biological control, cultural practices, and monitoring, to prevent and manage pest problems.

According to the **Food and Agriculture Organization of the United Nations (FAO)**, the misuse and overuse of pesticides can have serious negative impacts on human health and the environment. The FAO also suggests that pesticides play an important role in reducing losses in crop production .

However, the misuse of pesticides can lead to occupational exposure, risks for consumers, and environmental pollution.

In addition, **integrated pest management (IPM)** practices can pose risks and challenges. For instance, intercropping, which is a form of IPM, has yet to be widely adopted due to perceived risks and challenges including decreased crop yield, increased management complexity, a steep learning curve for successful management, and increased susceptibility to pests. Despite these challenges, intercropping has been shown to have clear benefits for weed, pathogen, and insect pest control, relative yield, and gross profitability. Farmers also need strong technical and financial support during the adoption process to help them troubleshoot the site-specific complexities and challenges of managing polycultures .

It is important to note that the benefits of IPM practices outweigh the risks, and the implementation of these practices can lead to sustainable and environmentally friendly crop production.

Regular risk assessments and ongoing monitoring can help agricultural practitioners identify, assess, and address potential risks during the implementation of Crop Pest Management Practices, ensuring a more resilient and sustainable farming system.

Pesticides can pose risks to human health and the environment. The health effects of pesticides depend on the type of pesticide used. Some pesticides can affect the nervous system, while others may irritate the skin or eyes. Some pesticides may be carcinogens, while others may affect the hormone or endocrine system in the body. Children are particularly susceptible to adverse effects from exposure to pesticides, including neurodevelopmental effects.

To identify potential risks when using pesticides, it is important to conduct a risk assessment. The process of evaluating the potential for health and ecological effects of a pesticide is called risk assessment. The risk assessment process includes identifying the hazards associated with the pesticide,

assessing the exposure to the pesticide, and characterizing the risk. The risk assessment process is crucial to making decisions about pesticides, both new and existing.

In addition to conducting a risk assessment, it is important to follow proper safety procedures when using pesticides. This includes wearing protective clothing, using the appropriate equipment, and following the instructions on the pesticide label. It is also important to coordinate a contingency plan and document reports when using pesticides.

Generally pesticides can pose risks to human health and the environment. To identify potential risks when using pesticides, it is important to conduct a risk assessment. Proper safety procedures should be followed when using pesticides and a contingency plan should be coordinated and reports should be documented.

6.2. Coordinating Prefer contingency plans

Contingency plans are an essential part of crop pest management practices. They help to prepare for and respond to pest outbreaks in a timely and effective manner. The International Plant Protection Convention (IPPC) has developed a guide for developing contingency plans for outbreaks of quarantine pests. The guide outlines the main components of both generic and pest-specific contingency plans and provides guidance on how National Plant Protection Organizations (NPPOs), in collaboration with relevant stakeholders, can effectively organize and allocate resources to eradicate or effectively contain pest outbreaks. The guide also discusses criteria for establishing and maintaining pest freedom, pest reporting, and includes several country case studies.

Plant Health Australia has also prepared a document to assist the development of contingency plans, or to develop technical strategies in the event of an invasion. It provides guidelines to assist scientists and regulators to develop response strategies for emergency plant pests and provide technical advice during an invasion.

In addition, Pesticide Environmental Stewardship recommends that contingency plans prepare responses to emergencies such as spills. These plans should be site-specific for storage, transport, and mixing areas. The plan should outline specific procedures to be followed when a pesticide spill occurs, and clearly identify the roles and responsibilities of each individual involved.

It is important to note that contingency plans should be tailored to the specific needs of the crop and the region in which it is grown. The implementation of these plans can lead to sustainable and environmentally friendly crop production.

Coordinating contingency plans for Crop Pest Management Practices involves establishing a systematic approach to handle unforeseen challenges and emergencies in agricultural settings. Here's a guide to help coordinate contingency plans effectively:

- **Establish a Contingency Planning Team:**
  - ✓ Form a dedicated team responsible for developing, implementing, and coordinating contingency plans.
  - ✓ Include representatives from different departments, such as farm management, pest control experts, environmental health and safety, and emergency response.
- **Risk Assessment:**
  - ✓ Conduct a thorough risk assessment to identify potential challenges and emergencies related to crop pest management.
  - ✓ Consider factors such as weather events, pest outbreaks, equipment failures, and changes in regulations.
- **Develop Comprehensive Contingency Plans:**
  - ✓ Create detailed contingency plans for various scenarios identified in the risk assessment.
  - ✓ Outline specific procedures, responsibilities, and communication protocols for each contingency plan.

- **Communication Protocols:**
  - ✓ Establish clear communication channels and protocols for reporting and responding to emergencies.
  - ✓ Define how information will be disseminated within the organization and to external stakeholders.
- **Training and Awareness Programs:**
  - ✓ Conduct regular training sessions to ensure that all relevant personnel are familiar with contingency plans.
  - ✓ Increase awareness about the importance of contingency planning and the role each individual plays in the process.
- **Integration with Existing Protocols:**
  - ✓ Integrate contingency plans with existing standard operating procedures (SOPs) for Crop Pest Management Practices
  - ✓ Ensure that contingency measures align seamlessly with routine practices.
- **Resource Allocation:**
  - ✓ Allocate necessary resources, including personnel, equipment, and supplies, to implement contingency plans effectively.
  - ✓ Identify backup resources and suppliers to address potential shortages during emergencies.
- **Regular Updates and Reviews:**

  - ✓ Schedule regular reviews of contingency plans to assess their relevance and effectiveness.
  - ✓ Update plans based on changes in technology, regulations, or lessons learned from previous incidents.
- **Collaboration with External Agencies:**
  - ✓ Establish collaboration and communication channels with relevant external agencies, such as environmental authorities or pest control experts.

- ✓ Share information and coordinate efforts to address larger-scale issues.

- **Simulation Exercises:**
  - ✓ Conduct simulated emergency exercises to test the readiness of contingency plans.
  - ✓ Analyze the outcomes of simulations to identify areas for improvement.
- **Documentation and Record Keeping:**
  - ✓ Maintain detailed documentation of contingency plans, including contact information, procedures, and updates.
  - ✓ Keep records of training sessions, exercises, and actual responses to incidents.
- Community Engagement:
  - ✓ Engage with the local community to share information about contingency plans.
  - ✓ Establish communication channels with neighboring farms to facilitate collaborative responses to shared challenges.
- Adaptability and Flexibility:
  - ✓ Design contingency plans with flexibility in mind to accommodate variations in pest types, severity, and other factors.
  - ✓ Update plans promptly based on feedback and evolving conditions.
- Post-Incident Analysis:
  - ✓ Conduct thorough analyses after each incident to identify successes, challenges, and areas for improvement.
  - ✓ Use post-incident analyses to refine and enhance contingency plans.
- Continuous Improvement:
  - ✓ Foster a culture of continuous improvement by encouraging feedback from personnel involved in emergency responses.
  - ✓ Implement changes to contingency plans based on lessons learned.

By following these steps, agricultural organizations can coordinate effective contingency plans for Crop Pest Management Practices, ensuring a proactive and organized response to unforeseen challenges in the agricultural environment.

6.3. Reporting Contingency plan problem and status

Reporting contingency plan problems and status during the implementation of Crop Pest Management Practices is essential for effective communication, problem-solving, and continuous improvement. Here's a guide on reporting contingency plan issues and providing status updates:

- Identification of Contingency Plan Problem:
  - ✓ Clearly describe the problem or issue encountered during the implementation of Crop Pest Management Practices.
  - ✓ Identify the specific aspect of the contingency plan affected.
- Documentation:
  - ✓ Document the details of the problem, including date, time, location, and individuals involved.
  - ✓ Include any relevant photos, data, or observations related to the issue.
- Severity Assessment:
  - ✓ Assess the severity and potential impact of the problem on crop health and overall pest management efforts.
  - ✓ Classify the issue based on urgency and importance.
- Communication Protocol:
  - ✓ Follow established communication protocols for reporting issues within the organization.
  - ✓ Clearly identify the responsible person or team to whom the report should be submitted.
- Status Update Format:
  - ✓ Use a standardized format for reporting contingency plan problems and status updates.
  - ✓ Include sections for problem description, current status, actions taken and planned corrective measures.

- Current Status:
  - ✓ Provide a clear overview of the current status of the contingency plan.
  - ✓ Include information on any immediate actions taken to mitigate the problem.
- Root Cause Analysis:
  - ✓ Conduct a root cause analysis to identify the underlying reasons for the contingency plan problem.
  - ✓ Document the contributing factors that led to the issue.
- Actions Taken:
  - ✓ Describe the specific actions taken to address the problem.
  - ✓ Include details on any changes made to the contingency plan or immediate responses implemented.
- Preventive Measures:
  - ✓ Outline preventive measures to avoid similar issues in the future.
  - ✓ Recommend adjustments or enhancements to the contingency plan based on lessons learned.
- Timeline for Resolution:
  - ✓ Provide an estimated timeline for resolving the issue.
  - ✓ Clearly communicate milestones and deadlines for implementing corrective measures.
- Collaboration and Communication:
  - ✓ Highlight any collaboration or communication efforts with relevant stakeholders, including farm personnel, management, and external partners.
- Continuous Monitoring:
  - ✓ Emphasize the importance of continuous monitoring to track the effectiveness of implemented solutions.
  - ✓ Outline a plan for ongoing surveillance and evaluation.
- Reporting Channels:

- ✓ Specify the reporting channels for ongoing updates on the status of the contingency plan problem.
- ✓ Ensure that the relevant individuals or teams are informed in a timely manner.

- Lessons Learned:
  - ✓ Document key lessons learned from the contingency plan problem.
  - ✓ Share insights that can contribute to the improvement of future contingency planning.
- Follow-Up Communication:
  - ✓ Establish a schedule for follow-up communications to ensure that stakeholders are informed about progress and resolution.
- Post-Resolution Evaluation:
  - ✓ After resolving the issue, conduct a post-resolution evaluation to assess the effectiveness of implemented corrective measures.
  - ✓ Document any adjustments made to the contingency plan based on the experience.

By following these steps, agricultural practitioners can effectively report contingency plan problems, address issues promptly, and contribute to the continuous improvement of Crop Pest Management Practices.

6.4. Documenting relevant information for continual analysis and effective management planning

Some relevant information documented for continual analysis and effective management planning for pest control are:

- The pest management policy and procedures of the organization or facility
- The pest identification, monitoring, and evaluation methods and results
- The pest prevention and control strategies and actions, including the use of non-chemical and chemical techniques

- The roles and responsibilities of the pest management team, staff, contractors, and stakeholders
- The performance indicators, measurements, and feedback mechanisms for the pest management program

Documented information for continual analysis and effective management planning for pest control can vary depending on the organization and its goals. However, the International Union for Conservation of Nature (**IUCN)** provides a **guidance note** for pest management planning that can be used to promote and support safe, effective, and environmentally sound pest management. The guidance note includes the definition of pests, pest management techniques, and principles of the guidance note.

Some examples of documented information that can be used for continual analysis and effective management planning for pest control include:

- **Scope of service**: A document that outlines the scope of pest control services provided by the organization.
- **Pest activity reports**: Reports that document the type and extent of pest activity in the organization.
- **Service reports**: Reports that document the pest control services provided by the organization, including all pesticide applications, in a searchable, organized system .
- **Corrective action reports**: Reports that document the corrective actions taken by the organization to address pest control issues.
- **Trap layout maps**: Maps that document the location of traps and other pest control devices in the organization.
- **Lists of approved pesticides**: Lists that document the approved pesticides for use in the organization.
- **Pesticide usage reports**: Reports that document the usage of pesticides in the organization.

- **Applicator licenses**: Licenses that document the certification of applicators to apply pesticides in the organization.

Please note that the guidelines for documented information may vary depending on the institution and location. It is important to follow the rules and regulations of your institution to ensure effective management planning and continual improvement of your organization's processes.

Documenting relevant information on implementing Crop Pest Management Practices is essential for maintaining effective and organized pest control strategies.
Here are key elements to consider when documenting information:

- Pest Identification:
  - ✓ Record the specific pests affecting crops
  - ✓ Include information on the life cycle, behavior, and preferred habitats of identified pests.
- Monitoring and Surveillance:
  - ✓ Document monitoring methods used to assess pest populations.
  - ✓ Record frequency and locations of monitoring activities.
  - ✓ Include data on pest thresholds triggering control measures.

- Cultural Practices:
  - ✓ Document cultural control methods employed, such as crop rotation or intercropping
  - ✓ Note any changes in planting dates or crop varieties used for pest management.
- Biological Control:
  - ✓ Record the introduction or promotion of beneficial organisms for pest control.
  - ✓ Document the success or failure of biological control methods.
  - ✓ Include details on the release rates and timing of beneficial organisms.
- Chemical Control:

- ✓ Maintain a pesticide application log.
- ✓ Include details on the type, amount, and formulation of pesticides used.
- ✓ Record application dates, targeted pests, and specific locations in the field.

- Integrated Pest Management (IPM) Plans:
  - ✓ Develop and document comprehensive IPM plans.
  - ✓ Include pest prevention strategies, monitoring schedules, and intervention thresholds.
  - ✓ Note any adjustments made based on monitoring results.
- Weather Conditions:
  - ✓ Document relevant weather conditions during pest outbreaks.
  - ✓ Note temperature, humidity, and precipitation levels.
  - ✓ Correlate weather data with pest activity for future analysis.
- Economic Thresholds:
  - ✓ Define economic thresholds for pests, indicating when control measures are economically justified.
  - ✓ Document the decision-making process for implementing control actions based on economic thresholds.
- Equipment and Application Techniques:
  - ✓ Record details about equipment used for pest control applications.
  - ✓ Include calibration records for sprayers and applicators.
  - ✓ Note any equipment maintenance or upgrades.
- Training and Education:
  - ✓ Document training sessions provided to farm personnel regarding pest identification and management practices.
  - ✓ Keep records of certifications and licenses related to pesticide application.

- Regulatory Compliance:
  - ✓ Ensure all pest management practices adhere to local, regional, and national regulations.
  - ✓ Maintain documentation demonstrating compliance with pesticide usage guidelines.

- Post-Treatment Evaluation:
  - ✓ Conduct post-treatment evaluations to assess the effectiveness of pest control measures.
  - ✓ Document any observed changes in pest populations and crop health.
- Record Keeping:
  - ✓ Maintain a centralized record-keeping system for easy access to information.
  - ✓ Organize records chronologically and categorize them by pest, crop, or specific field.
- Continuous Improvement:
  - ✓ Use documented information to analyze the effectiveness of pest management practices.
  - ✓ Identify areas for improvement and adjustments to future pest management strategies.

By systematically documenting these aspects of Crop Pest Management Practices, farmers and agricultural professionals can enhance decision-making, track trends, and continually improve their pest control strategies for sustainable and efficient agriculture.

6.5 Applying disposal of packaging materials, left over chemicals and washing of equipments

Proper disposal of packaging materials, leftover chemicals, and washing of equipment is crucial in maintaining a sustainable and environmentally friendly approach to Crop Pest Management Practices. Here are some guidelines for their disposal:

- **Packaging Materials:**
  - ✓ **Recycling**: Whenever possible, choose packaging materials that are recyclable. Separate recyclable materials from non-recyclables.

- ✓ **Reuse**: Consider reusing packaging materials for other purposes within the farm or for storage.
- ✓ **Disposal**: Dispose of non-recyclable packaging materials responsibly by following local waste disposal regulations. Avoid open burning.

- **Leftover Chemicals:**
  - ✓ **Chemical Inventory**: Keep a detailed inventory of the pesticides and chemicals used, including quantities and expiration dates.
  - ✓ **Storage**: Store leftover chemicals in their original, labeled containers in a secure and well-ventilated area.
  - ✓ **Disposal Options**: Check with local environmental agencies for specific guidelines on the disposal of unused or expired pesticides. Some options may include returning unused pesticides to the manufacturer or participating in a hazardous waste disposal program.
  - ✓ **Avoid Dumping**: Never dump leftover chemicals on the ground, in water bodies, or in open areas, as this can lead to environmental contamination.
- **Washing of Equipment:**
  - ✓ **Containment**: When washing equipment, use designated areas with containment structures to prevent runoff into water sources.
  - ✓ **Biodegradable Cleaners:** Use biodegradable and environmentally friendly cleaners whenever possible.
  - ✓ **Proper Drainage**: Ensure that wash water does not enter storm drains or natural water bodies. Instead, direct it to a designated treatment or containment system.
  - ✓ **Regular Maintenance**: Regularly maintain and inspect washing equipment to prevent leaks and ensure proper functioning.
- **Record Keeping:**
  - ✓ **Documentation**: Keep detailed records of all disposal activities, including dates, quantities, and methods used.

- ✓ **Compliance**: Ensure compliance with local, regional, and national regulations regarding the disposal of packaging materials, leftover chemicals, and wash water.

- **Training and Awareness:**
  - ✓ **Employee Training**: Train farm personnel on proper disposal procedures, emphasizing the importance of environmental stewardship.
  - ✓ **Signage**: Clearly label disposal areas and provide instructions for proper disposal.
- **Periodic Audits:**
  - ✓ **Regular Audits**: Conduct periodic audits to assess the effectiveness of disposal practices and identify areas for improvement.
  - ✓ **Adaptation**: Stay informed about any changes in local regulations or best practices and adapt disposal methods accordingly.

By implementing these measures, you can contribute to a sustainable and environmentally responsible approach to crop pest management while minimizing the impact on ecosystems and human health.

Self-check-6	Written test

Part I: Write true if the statements is correct or false statement is incorrect

1. When using chemicals, it is important to coordinate a contingency plan and document reports.
2. Packaging Materials can be disposed as reuse, reduce and recycle

Part II: Choose the best answer for the following question (2pts e

1. Which one are potential risks during the implementation of Crop Pest Management Practices
   A. Pest resurgence B. Pest replacement C. Environmental pollution D. All losses
2. Documenting relevant information on Crop Pest Management Practices includes
   B. Pest Identification B. Monitoring and Surveillance C. Cultural Practices D. all

Part III Give short answers

1. List at least 3 guidelines for washing equipment disposal.
2. What are the key elements to be considered when documenting relevant information on crop Pest Management Practices?
3. List relevant information documented for continual analysis and effective management planning for pest control.

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